The interplay between Quantitative Easing, Risk and Competition: The case of Japanese banking.

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Abstract

This paper employs, for the first time, bank level Boone indicator to measure competition in Japan to revisit the underlying linkage with bank risk-taking within the context of an extensive quantitative easing program. Japanese banking industry is an interesting case, given problems related to notorious nonperforming loans, originated back in the 1990s, whereas still causing controversies. We opt for a new measure of bank risk-taking based on a new data set of bankrupt and restructured loans. The dynamic panel threshold and panel Vector Autoregression analyses enable us to capture the potential endogeneity between the variables of interest. Our results demonstrate that quantitative easing and competition reduce bankrupt and restructured loan ratios, but also bank stability. Given the adoption of negative rate in January 2016 by the Bank of Japan, our study would provide insightful implications for future research.

JEL: G21, C23, E52

Keywords: Quantitative easing; Boone indicator; bank risk-taking; Japan; dynamic panel threshold analysis.

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1. Introduction

The competition and bank risk-taking nexus has sparked heated debates (Beck et al., 2013; Boyd & De Nicolo, 2005; Jiménez et al., 2013; Tabak et al., 2015). There is extensive research that reveals the mixed evidence as they report both positive and negative relationship between bank competition and risk (Berger et al., 2009; Fiordelisi & Mare, 2014; Fu et al., 2014; Liu & Wilson, 2013). One strand of the literature argues that there are benefits to be derived from enhanced competition as it promotes efficiency and prevents banks from taking excessive risk (Schaeck & Cihák, 2008; Stiroh & Strahan, 2003). On the other hand, some (Fu et al., 2014; Liu & Wilson, 2013) raise concerns due to uncertainties that could be brought by increased competition through excessive bank risk-taking. Others argue that stiff competition results in loss of high economic rents (e.g. lending opportunities and profit) associated with reduced competition, and this has an augmenting effect on risk (Allen & Gale, 2004; Keeley, 1990). Hence, whether higher competition destabilises the banking system by accumulating bank risk remains yet to reach unanimity.

In this paper, we build on the existing literature to investigate the relationship between bank competition and risk for an interesting market such as the Japanese banking industry. We innovate by using bank level Boone indicator to capture competition instead of its aggregate value or the Lerner index. As each research setting needs tailor-made research design, we address carefully the potential factors that could alter the course of the link between competition and risk. The case of Japan is of interest as it faces chronic problems with nonperforming loans, and is one of the first economies that an extensive and far-reaching program of quantitative easing has been initiated. We tackle the former factor in our measure of bank risk-taking by opting for a new data set, whilst we explore the impact of quantitative easing through the bank risk channel. Given the significance of quantitative easing for Japan, it warrants examining its impact at bank level.

The emerging of quantitative easing as a monetary policy tool to achieve price stability has raised concerns among academics and policymakers about its association with bank risk-taking (Chodorow-Reich, 2014; Claeys & Darvas, 2015). Low short-term interest rates prior to loan issuance result in banks granting more new risky loan portfolios, distorting their credit supply to favour borrowers with worse credit histories, lower ex-ante internal ratings, and weaker ex-post performance (Ioannidou et al., 2015; Jiménez et al., 2014). Less return from yields is another motive for financial institutions to accelerate their risk-taking activities (Chodorow-Reich, 2014; Rajan, 2005). Banking surveys based on credit standards in the US and the UK, on the contrary, do not suggest an excessive risk-taking by banks as a result of the enforcement of quantitative easing (Claeys & Darvas, 2015). However, will this positive finding remain when risk is characterised by different proxies, such as nonperforming loan ratios and Z-score?

The Bank of Japan was the pioneer in empowering quantitative easing policy. Currently, there has been a strong record of active and aggressive quantitative easing since 2010. We are interested in investigating whether the warning of heightened risks associated with this policy is supported by Japanese bank level data. Another prominent issue to be addressed is the effect of quantitative easing on the link between bank competition and risk. We hypothesise, based on the aforementioned literature, that quantitative easing and competition affect bank risk-taking. On the other hand, is there a mutual relationship between quantitative easing and bank competition? After the acute phase of the banking crisis in Japan (1997-1999), the banking system underwent major reforms, bailout and consolidation from 1999 to 2003. Their competition stance, hence, is expected to vary over time, also in light of the global financial crisis 2007-2008. Between 2000 and 2012, quantitative easing was launched twice (during March 2001-March 2006 and from October 2010). This could be considered as a macroeconomic shock to bank competition due to the relaxation of economic conditions, which in turn may affect the competition-risk nexus. The degree of competition in the banking industry, however, could also influence the quantitative easing-risk linkage (Altunbas et al., 2014). Therefore, we control for the effect of quantitative easing when measuring the competition-risk relationship, and vice versa. We also explore in depth the underlying causality among quantitative easing, competition and risk.

Apart from Japan's commitment to do "whatever it takes" in achieving growth through quantitative easing, Japan is of interest for the infamous nonperforming loan problem. This destructive effect of the banking crisis prolonged to the first half of the 2000s due to the reluctance of the government in admitting the nonperforming loan issue. Eventually, when doing nothing was too painful to tolerate, the government restructured the whole banking industry. However, this restructuring campaign was not to be without controversies as it incorporated funding of unprofitable firms, which in turn crowded out solvent firms and lengthened the revitalisation of the economy (Caballero et al., 2006). Moreover, there exists evidence of political influence, where regulators deferred solvency declaration of banks situated in prefectures supporting the then ruling party (Imai, 2009). When quantitative easing was first introduced, structural reforms of the financial system were essential for the policy to gain its full effectiveness (Bank of Japan, 2001). After the global financial crisis, nonperforming loans of all banks increased slightly from 11.4 trillion JPY in March 2008 to 12 trillion JPY in March 2009.[1] It is noteworthy that during 2008-2013, the government strategically aimed to assist small and medium enterprises (SMEs), which are Regional Banks' primary corporate clients, via the SME Financing Facilitation Act. One term in the Act involved reclassifying SME's nonperforming loans. This has alarmed the accumulated hidden credit risks within the banking system (Hoshi, 2011), as about 3-6% of total credit in Regional Banks was reclassified (International Monetary Fund, 2012).

Thereby, our study contributes to the literature in the following ways. First, whereas the current literature has mostly used the bank-specific Lerner index or aggregate Boone indicator as a proxy for competition (Liu & Wilson, 2013; Schaeck & Cihák, 2014), we innovate by providing bank level Boone indicators. Inspired by Delis (2012), we use the local regression technique to calculate the Boone indicator for each bank-year observation. Second, we opt for an original data set to capture risk that has been overseen by the literature to date. Bank risk-taking, our primary focus, is represented by bankrupt loan ratio and restructured loan ratio. Data on bankrupt and restructured loans are available for Japanese commercial banks and have not been used extensively in the Japanese banking literature (Mamatzakis et al., 2015). We also use the classical measure of bank default risk, Z-score, to enhance the robustness of our analyses. The use of bankrupt and restructured loans at semi-annual data frequency allows an enriched information set in our modelling of competition and quantitative easing.[2] Third, we employ a bank level proxy of quantitative easing – the bank specific lending rate (Delis & Kouretas, 2011). The advantages of this microeconomic measure lie on the absence of aggregation bias and the ample set of information. This bank-specific variable ensures its compatibility with the bank level Boone indicator and risks in our analyses. We also conduct the analyses with two other proxies for quantitative easing: the 10-year Japanese government bond yield and Bank of Japan total assets. To examine the risk-competition, and risk-quantitative easing relationships, we employ the dynamic panel threshold analysis, where Generalised Methods of Moments type estimators are used to tackle the issues of endogeneity (Kremer et al., 2013). This methodology allows us to examine whether these relationships are stable over the observed period (financial years from 2000 to 2014) which embraces quite a

[1] Source: Japan Financial Services Agency

[2] Bankrupt loans are loans to borrowers in legal bankruptcy and past due loans by 6 months or more. Restructured loans are named after the sum of past due loans by 3 months but less than 6 months and restructured loans. See Data section and Appendix A for more details.

few important events. They are the final phase of the banking crisis (2000-2001), the restructuring period (2001-2003), the presence of quantitative easing (2001-2006 and from 2010), the global financial crisis (2007-2008), and the Tohoku earthquake (2011). Fourth, we extend our analysis by using a panel vector autoregression (VAR) approach to address the underlying causality and the potential endogeneity among competition, quantitative easing and risk.

Our results show that competition and quantitative easing reduce bank risk in terms of bankrupt and restructured loan ratios. However, the former two appear to undermine overall bank stability. The results could entail the countervailing effects of quantitative easing on bank risk-taking (Buch et al., 2014; De Nicolò et al., 2010). On the one hand, quantitative easing alleviates interest rate burden for borrowers and inflates values of pledged assets. On the other hand, it may induce banks to engage in riskier projects on the search for higher yield. Along these lines, Jiménez et al. (2014) argue that low interest rates reduce the probability of default for current variable rate loans, but at the same time banks tend to issue new loans to borrowers with worse credit ratings. Regarding the causality between the variables of interest, the panel VAR analysis suggests that quantitative easing initiates its causal relationship with risk and competition. Regarding competition and risk, the former triggers the relationship with the latter.

The paper proceeds as follows. Section 2 briefly reviews the literature and associated hypotheses. Section 3 presents the methodologies. Section 4 introduces the data. Section 5 discusses the results. Finally, section 6 concludes.

2. Related literature and hypotheses

In this section, we establish our research hypotheses based on the literature regarding the competition-risk nexus and the relationship between quantitative easing and bank risk. The two renowned hypotheses about the impact of competition on financial stability, an important part of our main investigation objectives, have been well defined in the literature as introduced in the following sections.

2.1 The Competition – Fragility hypothesis

The underlying theory of this hypothesis poses the view of uncertainty created by a competitive banking industry. The rationale behind this is the threat of market share being reduced by the entry of newly established banks as well as stronger competence of incumbent rivals. The rise in bank competition could be attributed to, e.g., consolidation, deregulation, and technological advances (Berger & Mester, 2003; Jeon et al., 2011; Keeley, 1990). The liberalisation of geographic restriction and relaxation in unconventional banking activities have also fostered bank competition (Berger & Mester, 2003). There exists evidence suggesting that when deregulation took place (e.g. in the US during 1970s–1980s), poor performers were more vulnerable due to the incompetence in keeping pace with their counterparts and potential entrants (Stiroh & Strahan, 2003). Deregulation also fuelled bank consolidation, resulting in a large number of banks disappearing from the market due to mergers (Berger & Mester, 2003). In developing banking markets, beside the lift in entry barriers, technological development is another catalyst for heightened competition brought by foreign bank entry (Jeon et al., 2011).

One of the main arguments for greater risks corresponding to increased competition is profit reduction. This reasonably serves as a motive for bank managers to take excessive risks to pursue business targets, to preserve market shares, and eventually to protect market power. Of course, the notion of falling profitability could also raise concerns among banks' executives and jeopardise their position. Consequently, they may have the incentive to stretch their risk tolerance ability. Keeley (1990) is among the studies laying the first bricks of the debate of an increasing level of fragility in association with intensified competition. The results lend support for the hypothesis to the extent that amplified competition lowers bank charter value, which in turn promotes extra risk-taking through either higher leverage or asset risk.

Apart from profitability, a number of factors have been put forward as arguments for the *competition-fragility* hypothesis. Boot and Greenbaum (1992) and Allen and Gale (2004) show that in a less concentrated banking market, the arising asymmetric information would discourage proper credit screening. Consequently, the rise in credit risk could accumulate the latent uncertainty within the banking system. Another fundamental factor of financial safety in association with competition is liquidity. Liquidity constraints could be better handled in a more concentrated market as information regarding the probability of withdrawal of depositors is private (Smith, 1984). Furthermore, as modelled in Allen and Gale (2000), financial distress would be less contagious as banks would be willing to provide liquidity to temporarily illiquid banks. Other proponents of these views argue that a few large banks in highly concentrated markets are easier to supervise than many small banks. Large banks are also more flexible in diversifying investment portfolios, which in turn lowers the fragility of the banking system (Allen & Gale, 2000).

2.2 The Competition - Stability hypothesis

Contrasting the previous hypothesis, Boyd and De Nicolo (2005) propose that market concentration intensifies risk. Ceteris paribus, less competition implies that banks could be granted more market power; they in turn would impose higher lending rates on loan portfolios. The rise in loan rates, thus, could increase bankruptcy probability for borrowers. On the other hand, this would magnify the moral hazard incentives within the borrowers themselves in an attempt to reap greater returns.

As opposed to the *competition-fragility* hypothesis, Caminal and Matutes (2002) present a model explaining the ambiguous relationship between market power and bank failure. They argue that it is not always valid the argument that higher probability of default is due to higher degree of competition. In fact, if investments were assumed to be subject to a large aggregate shock, at the presence of intermediate monitoring costs, a monopolistic bank would be exposed to more bankruptcy risk than a competitive bank. This arises from less credit rationing which can serve as an imperfect substitute for monitoring.

Advocates of the *concentration-stability* hypothesis dispute that a few incumbent banks are generally easier to be regulated and monitored to prevent contagion risk than in a competitive banking industry (Beck, 2008; Beck et al., 2006). Financial support from the government to big banks may also prevent a distress time from turning into a crisis (Schaeck et al., 2009). Nevertheless, there are still arguments along the lines of the "too-big-to-fail" hypothesis, especially in light of financial conglomerates emerging recently as a result of the consolidation trend. Yet, such global banks due to the complexity of their operations require appropriate regulatory control across borders. However, it is possible that big banks are politically powerful to compromise the power of their supervisors (Johnson & Kwak, 2011). Even Basel III guidelines would probably not be adequate to account for all the potential risk-holding aspects of global banks. On the other hand, given that global banks are commonly subsidised by the government, their risk-taking motives could be twisted, hence, threatening overall financial stability.

In a similar vein, Anginer et al. (2014) address the issue of systemic risk in association with competition on 1872 published banks in 63 countries over 1997-2009. Competition is measured by the Lerner index and Panzar-Rosse *H*-statistic, whereas systemic risk is computed from the Merton distance-to-default model. More especially, Anginer et al. (2014) use the correlation in risk-taking behaviour obtained from a time series analysis. A bank's change distance-to-default is regressed on average change in distance-to-default excluding the examined bank. The results show that heightened competition leads to more diversified risk-taking activities which subsequently enhance bank resilience to shocks.

A growing body of bank competition literature of which empirical findings support the *competition-stability* has adopted the prevailing Boone indicator as a competition proxy. The evidence in Schaeck and Cihák (2008) indicates that competition (measured by the Boone indicator) stabilises the banking systems in Europe and the US (1995-2005). In a recent study examining banks in major European countries, Schaeck and Cihák (2014) confirm their previous findings of competition being stability-enhancing. It is noteworthy that the relationship is conveyed through the efficiency channel which reallocates profit from cost-inefficient banks to the cost-efficient ones.

As the literature has yet to reach a consensus over the two hypotheses, we attempt to revisit the competition-risk dispute by investigating their existence in Japanese banking using bank level Boone indicator, while taking into account the impact of quantitative easing. The next section reviews the relationship between quantitative easing and bank risk as another primary investigatory subject in our study.

2.3 Quantitative easing and risk hypothesis

After a long history of nearly zero policy rates during the 1990s to avoid deflationary slump (Leigh, 2010), the Bank of Japan initiated quantitative easing policy in March 2001 through long-term government bond purchase. Thereafter, assets purchased were broadened to private assets held by private banks, asset-backed securities and asset-backed commercial papers (Girardin & Moussa, 2011). Officially ended in March 2006, the first quantitative easing period did not firmly prove its effectiveness in detaching the economy from the deflation circle (Bowman et al., 2015; Ueda, 2012; Ugai, 2007).

The importance of quantitative easing has been addressed in its significant impact on aggregate demand, financial markets and economic growth (Bowman et al., 2015; Glick & Leduc, 2012; Schenkelberg & Watzka, 2013). Regarding its effect on the banking system, the bank lending channel is emphasised as a main conduit (Bowman et al., 2015; Hosono, 2006). As Lucas (2014) points out, the success of quantitative easing (in the US) is partly indicated by increased risk-taking, hence more bank lending. Starting with the zero lower bound interest rate policy, Hosono (2006) investigates the different impacts of expansionary monetary policy on bank lending. This paper addresses the three important bank characteristics, namely size, liquidity and capitalisation, which could alter a bank's reaction to monetary policy stance.

Results indicate that expansionary monetary policy in Japan is less effective for undercapitalised banks. Lending of small, less liquid and well-capitalised banks are more exposed to monetary policy shocks than their counterparts.

Inspired by Hosono (2006) but slightly more comprehensive is Bowman et al. (2015), which particularly focus on the first quantitative easing period. Bowman et al. (2015) show that bank lending, through the transmission of quantitative easing, appears in the liquidity channel. The results suggest that liquidity injection of the central bank was inhibited by interbank illiquidity, thus the size of credit boosted was relatively small. Unlike findings of Hosono (2006), less-capitalised banks benefit more from quantitative easing than their well-capitalised peers. Weaker banks, in terms of higher nonperforming loan to asset ratio, also appear to be more sensitive to liquidity injection. Bank size is reported to be insignificant in affecting the relationship between bank lending growth and liquidity. Kobayashi et al. (2006) also find evidence to support that financially weaker banks and firms reap more benefits from quantitative easing through positive excess stock returns.

To this end, to the best of our knowledge, no study has established a clear link between quantitative easing in Japan and bank risk-taking using bank level information. Academics and policymakers have addressed the potentially disproportionate bank risk-taking associated with the enactment of quantitative easing (Chodorow-Reich, 2014; Claeys & Darvas, 2015). Quantitative easing is supposed to encourage financial institutions to attempt socially desirable risk-taking. However, banks may be deviated from their secured path when excessive risk-taking is recorded (Claeys & Darvas, 2015). In addition, under lax lending standards and low interest rates, the likelihood that more risky borrowers being offered new loans could rise, and so could credit risk (Ioannidou et al., 2015; Jiménez et al., 2014). The countervailing effect of interest rate changes on bank risk is also addressed in Buch et al. (2014). Lower interest rates could reduce the cost burden for borrowers, increase the collateral value, and subsequently raise the likelihood of repayment. In parallel, the borrowing capacity rises accordingly to higher prices of collaterals, and banks are induced to engage in riskier projects to offset lower profit in association with lower interest rates. On the contrary, Lucas (2014) argues that quantitative easing could unintentionally reduce bank risk-taking incentives. Banks benefit from the term premium in the yield curve if their asset duration exceeds their liabilities'. When the yield curve is flat, they may be discouraged in issuing long-term loans which may be more desirable by borrowers.

In this regard, we leave our quantitative easing-risk hypothesis open: *The implementation of quantitative easing could lead to either an increase or a reduction in bank risk.*

3. Methodology

3.1 Marginal cost

In order to attain values for the Boone indicator, we need to model bank marginal cost. In line with Fiordelisi and Mare (2014) and Fu et al. (2014), marginal cost is obtained from a flexible translog cost function specification[3]:

$$\ln TC_{it} = \alpha_0 + \alpha_1 \ln Q + \frac{1}{2}\alpha_2 \ln Q^2 + \sum_{j=1}^{2}\beta_j \ln P_j + \frac{1}{2}\sum_{j=1}^{2}\sum_{k=1}^{2}\delta_{jk} \ln P_j \ln P_k + \sum_{j=1}^{2}\gamma_j \ln Q \ln P_j$$
$$+\varphi_1 t + \frac{1}{2}\varphi_2 t^2 + \varphi_3 t \ln Q + \sum_{j=1}^{2}\varphi_j t \ln P_j + \varepsilon_{it} \qquad (1)$$

with total costs TC_{it}, total earning assets Q (loans, investments, and securities) (Delis, 2012), price of inputs P_j (which have to satisfy the condition of homogeneity of degree one), time trend t and a composed error term ε_{it}. Two input prices are incorporated: i) price of funds P_1 is defined as interest expenses divided by deposits and borrowed funds; ii) price of physical capital and labour P_2 as noninterest expenses divided by fixed assets[4].

The marginal cost MC for bank i at time t can be derived from equation (1) as follows:

$$MC_{it} = \frac{\partial TC_{it}}{\partial Q_{it}} = \frac{TC_{it}}{Q_{it}} \cdot \frac{\partial \ln TC_{it}}{\partial \ln Q_{it}} = \frac{TC_{it}}{Q_{it}}\left(\alpha_1 + \alpha_2 \ln Q + \sum_{j=1}^{2}\gamma_j \ln P_j + \varphi_3 t\right) \qquad (2)$$

3.2 The Boone indicator

The Boone indicator of competition has quite a few advantages in comparison with others. This measure accounts for both a lift in entry barriers or more aggressive interaction between market participants (Boone, 2008b), while other indicators contain limitations or biases. As Beck (2008) argues, concentration ratios such as the Herfindahl-Hirschman index and three (five)-bank concentration ratio are rather unreliable measures of competition as they only weigh concentration levels. Concentration ratio could rise following an increase in competition, as uncompetitive participants would have to exit the market. Hence, if one interpreted higher

[3] Subscripts (*it*) are omitted for simplification.

[4] Due to data unavailability, we are unable to extract data from general and administrative expenses which include personnel expenses and non-personnel expenses associated to physical capital. Hence, we define the second input price in line with Fu et al. (2014).

concentration ratios as a proxy for uncompetitive markets, the results could be misleading (Schaeck & Cihák, 2014). Other measures of competition such as the Panzar-Rosse H-statistic and Lerner index also have some limitations. While H-statistic requires a priori assumption of long-run equilibrium operating markets (Panzar & Rosse, 1987), it is ambiguous whether the Lerner index captures the degree of product substitutability (Vives, 2008). Mirzaei and Moore (2014) argue that the H-statistic does not embrace the evolution of bank competition as there is only one score obtained over time. Even though time-varying scores are achievable (Bikker & Haaf, 2002; Jeon et al., 2011), they are either increasing or decreasing which may be inapplicable in effect.

Introduced by Boone et al. (2007) and Boone (2008b), firms' (banks') market power can be measured through profit elasticity β in a simple profit equation:

$$\ln \pi_{it} = \alpha + \beta \ln mc_{it} + u_{it} \qquad (3)$$

where π_{it} and mc_{it} are profit and marginal costs of bank i at time t. β is the Boone indicator of market power which is expected to be negative as higher marginal costs would result in lower profits. Intuitively, in a competitive market, inefficient banks signified by comparatively high marginal costs are penalised more harshly since they will endure high loss in profits, compared to operating in an uncompetitive market. Hence, the larger the absolute value of β, the more intense the degree of competition.

In our paper, we employ the non-parametric methodology used in Delis (2012) to compute the Boone indicator for individual banks in each period. This allows us to create bank level estimates of competition. We estimate equation (3) by using a local regression analysis[5], which

[5] According to Loader (1999), a local regression $Y_i = \mu(x_i) + \varepsilon_i$ with predictor variable x and response variable Y is estimated by smoothing the unknown function $\mu(x_i)$. This is obtained through fitting a polynomial model within a sliding window of x. Each point in the neighbourhood of x is assigned a weight corresponding to its distance from x. In particular, the closer the point to x, the larger its weight. The next step is to choose an optimal bandwidth h which controls the smoothness of fit and a smoothing window (x-$h(x)$, x+$h(x)$). In other words, for each observation x_i, all neighbour points within the sliding window h are used in the following locally weighted least squares criterion: $\sum_{i=1}^{n} W\left(\frac{x_i - x}{h}\right)\left(Y_i - \left(a_0 + a_1(x_i - x)\right)\right)^2$ with W is the weight function of the form $W(u) = \begin{cases} \left(1 - |u|^3\right)^3 & if\ |u| < 1 \\ 0 & otherwise \end{cases}$ where $u = (x_i - x)/h(x)$. Following Delis (2012), we use the generalised cross-validation method to obtain our bandwidth of 0.42.

fits the relation between log profits and log marginal costs on the neighbourhood subsample of each observation to obtain individual β_{it}.[6]

3.3 The Lerner index

We also use the Lerner index, another proxy of bank market power, to achieve a comprehensive analysis with different indicators of competition. The Lerner index is formulated as follows:

$$Lerner_{it} = \left(P_{Q_{it}} - MC_{it}\right) / P_{Q_{it}} \tag{4}$$

where $P_{Q_{it}}$ is output price calculated as operating income divided by earning assets. This indicator captures pricing ability above marginal cost, which has been used extensively in the banking literature (Berger et al., 2009; Fiordelisi & Mare, 2014; Fu et al., 2014; Koetter et al., 2012). Values of the index are bounded between 0 and 1, with the former presenting perfect competition while the latter indicating pure monopoly. A negative Lerner index entails inability to price above marginal cost which might be a consequence of non-optimal behaviour (Fu et al., 2014).

3.4 Dynamic panel threshold analysis

To examine the risk-competition, risk-quantitative easing nexus, we adopt the dynamic panel threshold model introduced by Kremer et al. (2013). This methodology allows for the estimation of a threshold effect within a panel data framework involving endogenous regressors. Apart from tackling endogeneity concerns, another advantage of this methodology in the case of Japanese banking is that no priori assumption needed with regard to structural breaks. Such breaks, within the present threshold model, are endogenously determined from the underlying data generating process. The model estimates threshold values for competition and quantitative easing over times, which in turn signify regime changes. In some details, the model specification is written as:

$$y_{it} = \mu_i + \beta_1 q_{it} I\left(q_{it} \le \gamma\right) + \delta_1 I\left(q_{it} \le \gamma\right) + \beta_2 q_{it} I\left(q_{it} > \gamma\right) + \varphi z_{it} + \varepsilon_{it} \qquad i = \left(1, \dots, N\right), t = \left(1, \dots, T\right) \tag{5}$$

[6] In regression (3), the Boone indicator is averaged over the entire sample across the whole examined period. Put differently, it cannot be measured for individual banks. To overcome this drawback, empirical research has modified this model to yield values of β for each period (Schaeck & Cihák, 2014; Van Leuvensteijn et al., 2011) by adding a time dummy and its interaction with marginal costs in order to increase the frequency of the indicator. However, the number of observations achieved from this approach does not rise significantly as they are average values for each period.

where μ_i indicates bank-specific fixed effect[7]; $I(.)$ is the indicator function indicating the regime defined by the threshold variable (q_{it}) and the threshold level γ; q_{it} is both the threshold variable and the regime-dependent regressor. z_{it} is a vector of control variables, which may include both endogenous and exogenous variable. As in Kremer et al. (2013), we account for the regime intercept (δ_1) because omitting the intercept may result in biases in the threshold estimates and regression slopes (Bick, 2010). e_{it} is the error term.[8] As in Caner and Hansen (2004) and Kremer et al. (2013), we estimate equation (5) using GMM to account for endogeneity. The first lag of the endogenous variable is used as the instrument.

4. Data

Our data are extracted from semi-annual financial reports of Japanese commercial banks published on the Japanese Bankers Association website. Our sample consists of 3491 observations from financial years 2000 to 2014. Three particular types of commercial banks are examined in our study, namely City Banks, Regional Banks I and Regional Banks II. They form more than half the banking system and correspond to various types of operations. If City Banks involve more in different aspects of banking business, Regional Banks are prone to conventional banking activities. City Banks are referred as *Main Banks* in the *horizontal keiretsu* network – the enterprise groups consisting of one large firm for every major sector pre- and post-crisis. These banks act as the core of the business group and offer venture capital for affiliates. The number of City Banks has declined over time since the crisis occurred in the 1990s. Besides, during the restructuring period, City Banks benefited from the tendency of mergers in empowering their resistance to overcome the consequences of the crisis[9].

The operating locations of Regional Banks are refined by their scope of business, with smaller geographic region restriction for Regional Banks II. These banks are the smallest in

[7] To eliminate bank-specific fixed effects, as suggested by Kremer et al (2013), we employ the forward orthogonal deviations transformation proposed by Arellano and Bover (1995).

[8] The estimation procedure is as follows. First, a reduced-form regression is estimated for endogenous variables as a function of the instrumental variables. Second, using least squares, we estimate equation (5) for a fixed threshold with the predicted values of endogenous variables obtained from the first step regression. Third, the second step regression is repeated to find the estimator of the threshold value associated with the smallest sum of squared residuals. The critical values for the 95% confidence intervals of the threshold value are: $\Gamma = \{\gamma : LR(\gamma) \leq C(\alpha)\}$, with $C(\alpha)$ is the 95% percentile of the asymptotic distribution of the likelihood ratio statistic $LR(\gamma)$ (Caner & Hansen, 2004). The slope coefficients are estimated by GMM procedure for the formerly used instruments and estimated threshold.

[9] Mitsui Bank and Taiyo-Kobe Bank to form Sakura Bank; Fuji, Dai-Ichi Kanyo, and Industrial Bank of Japan to form Mizuho Bank; Sanwa and Tokai Banks to form UFJ Banks; UFJ Banks and Bank of Tokyo-Mitsubishi; Sumitomo Bank and Sakura Bank (Nakamura, 2006) .

comparison with the other two. Unlike City Banks, Regional Banks mainly invest in government bonds and originate loans for small and medium firms in their specific areas where their head offices are located. Thus, Regional Banks are more committed to the local development of the prefectures. There are other different kinds of banks currently operating in Japan, for example, Trust Banks, Long-Term Credit Banks, *Shinkin* banks (credit cooperatives), and foreign banks. Due to data unavailability or differences in business features, we do not observe non-commercial banks in our study.

As dependent variables representing bank risk-taking, we opt for bankrupt loans to total assets (BRL ratio), restructured loans to total assets (RSL ratio), and the natural logarithm of Z-score[10]. The first two variables characterise credit risk, whereas the remaining variable is a proxy for overall bank stability. They are incorporated respectively in the model to analyse the highlighted hypotheses. Bankrupt and restructured loans are obtained from data of risk-monitored loans disclosed under the Banking Law (see Appendix A). Bankrupt loans are named after the sum of bankrupt loans and non-accrual loans,[11] while restructured loans are the sum of the other two categories: past due loans by 3 months or more but less than 6 months, and restructured loans.[12] The ratios of these risk-monitored loans to assets capture credit risk, similar to nonperforming loan to asset ratio that has been widely used in the literature to test for the *competition-fragility* nexus (Beck, 2008). Bank stability indicated by the Z-score is another gauge for the likelihood of bank failure (Beck et al., 2013; Laeven & Levine, 2009). This is defined as the number of standard deviations below the mean of returns on assets that would result in insolvency by evaporating capital ($Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$) (Boyd & De Nicolo, 2005).

To ensure the robustness of our estimation, we analyse the dynamic panel threshold model with two proxies for competition, the Boone indicator and the Lerner index, with the former being our primary interest. With regard to quantitative easing, we choose the bank-specific lending rate calculated as interest income on loans divided by loans and bills discounted (Delis

10 Nonperforming loan ratio and Z-score are used extensively in the literature to represent bank risk (Agoraki et al., 2011; Beck, 2008; Buch et al., 2012).

11 Reported in Japanese commercial banks' balance sheets, these loans are named loans to borrowers in legal bankruptcy, and past due loans in arrears by six months or more.

12 The Japanese Bankers Association originally defined restructured loans as loans of which interest rates were lowered. In 1997, the definition was extended to loans with any amended contract conditions and loans to corporations under on-going reorganisation (Montgomery & Shimizutani, 2009).

& Kouretas, 2011)[13]. We employ bank-specific lending rate as the threshold variable for quantitative easing for several reasons. First, under the zero lower bound interest rate policy, short-term interest rates are inoperative (Girardin & Moussa, 2011). Second, the Bank of Japan loan rate, uncollateralised overnight call rates, and the Bank of Japan's total reserves, the amount of asset purchases, and government bond yields do not reflect individual bank characteristics in relation to changes in quantitative easing. Third, we could avoid aggregation bias and enhance the compatibility of quantitative easing proxy with the dependent variable and the Boone indicator. For each set of models with different threshold variables, we also control for the impact of either competition or quantitative easing. For instance, when proxies for competition are treated as threshold variables, quantitative easing will appear among the determinants, and vice versa. As quantitative easing influences deposit interest rates, it may in turn affect bank competition in the loan market. In addition, one may argue that lending rate is not a direct measure of quantitative easing, and may be affected by competition. To tackle the potential endogeneity between the three main variables of interest, we treat them as endogenous in the dynamic panel threshold model.[14] For robustness, we also use the 10-year Japanese government bond yield and the Bank of Japan total assets (Lyonnet & Werner, 2012) as other proxies for quantitative easing.

Regarding a subset of explanatory variables, we specify a number of control variables varying from bank characteristics to macroeconomic impact. To account for capitalisation and the potential moral hazard problem, we use the capital to assets ratio (Tabak et al., 2012)[15]. Bank size is taken as the natural logarithm of total assets (Delis & Kouretas, 2011). We also take into consideration the impact of revenue diversification which is the ratio of non-interest income to total operating income (Anginer et al., 2014; Beck et al., 2013), assets diversification represented by the ratio of securities to assets (Zhang et al., 2013), and liquidity which is defined as liquid assets[16] to total assets (Jeon et al., 2011). GDP growth is included to reflect the influence of macroeconomic environment (Jiménez et al., 2013). Market capitalisation is

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13 We could also use the amount of asset purchases or Japanese government bond's yield as measures for quantitative easing (Bowman et al., 2015; Lyonnet & Werner, 2012; Voutsinas & Werner, 2011).

14 We use the first lag of the endogenous variable as its instrument to preserve information. Following Kremer et al. (2013), all available lags of the endogenous regressor are also examined. In fact, the corresponding results reveal little variation in the parameters estimated.

15 As capital ratio is part of the formula of Z-score, we exclude it from models in which *ln*Z-score is used.

16 Liquid assets = Cash and due from banks + call loans + receivables under resale agreements + receivables under securities borrowing transactions + bills bought + monetary claims bought + trading assets + trading account securities + money held in trust (Radić, 2014).

accounting for financial market development and also functioning as an alternative source of fund for incumbent firms (Beck et al., 2013). Descriptive statistics of data used are displayed in Table 1.

[INSERT TABLE 1 ABOUT HERE]

5. Results

5.1 The Boone indicator

As introduced in section 3.2, the Boone indicator is estimated for each bank in the sample. This provides much more information on competition in the Japanese banking industry than other measures. More in details, the average indicator for the entire sample from 2000 to 2014 is estimated at -0.0542.[17] Reported in Mirzaei and Moore (2014), the average Boone indicator for Japanese banking between 1999 and 2011 is -0.02.[18] Figure 1 illustrates the mean value of the Boone indicator over time for all banks in our sample. Its highest score in absolute value is recorded in March 2002 at -0.0813, indicating the toughest degree of competition for the entire period. During the restructuring period (September 2000 to March 2003), the government imposed policy changes on the banking system in order to revitalise its resilience to the aftermaths of the crisis. In addition, undercapitalisation and the threat of nonperforming loans induced fragile banks to agree to merger proposals from financially healthier banks. The consolidation tendency was augmented by a number of mergers between large City Banks, indicating an adverse phase for *too-big-to-fail* banks in maintaining their market power. Afterwards, the average score slightly increased to -0.0483 in March 2004 and became relatively flat until September 2008. This may serve as evidence in supporting the positive outcomes of government intervention. Within that time frame, the turbulence caused by the huge amount of nonperforming loans had been alleviated gradually.

[INSERT FIGURE 1 ABOUT HERE]

There was a shift in the Boone indicator which signified higher competition during the US subprime crisis. At the end of March 2009, the corresponding Boone indicator dropped from -0.0489 (in September 2008) to -0.0659. The contagion of the global financial crisis possibly deviated Japanese banks from their profit goals. The deterioration of profit, in turn, could reduce bank market power. Between September 2009 and September 2012, the Boone indicator

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[17] Delis (2012) includes Japan in the sample of 84 countries. The average Boone indicator for Japanese banks during 1988-2005 is -0.584.

[18] Note that the data are obtained from World Bank for the whole banking system.

had a similar stable trend as after the restructuring period, before slightly decreased towards the end of the sample period.

The corresponding stiff competition is identified by higher absolute values of the Boone indicator. There is no specific benchmark for the value of β in general, yet what we have found implies a moderate degree of competition in the banking sector, as the figures are not too distant from zero. Table 2 provides further insight of competition among each bank type. In general, competition within City Banks (-0.0654) and Regional Banks II (-0.0559) are more intense than between Regional Banks I (-0.0518). The largest magnitude (absolute value) of Boone indicator is recorded for City Banks in March 2002 at -0.1906. The trend of competition in City Banks during the restructuring period is more volatile than those in the other two types, indicating the effect of the aforementioned consolidation tendency. The onset of the US credit crunch 2007-2008 seemed to impose a pronounced effect on competition between Regional Banks II, notably at -0.0809 in March 2009. A potential explanation could rest on the size factor which may denote a bank's resistance to external shocks. Regional Banks II are the smallest compared to the other two and operate under more limited geographic restrictions. Hence, the potentially high likelihood that Regional Banks II being more exposed to exogenous shocks would erode their profits and weaken their market power. Nevertheless, competition in Regional Banks II appeared to be more relatively stable compared to City Banks and Regional Banks I after the global financial crisis.

With regard to the Lerner index, its trend over time illustrated in Figure 1 shows support for previous findings of the Boone indicator.[19] Our result reveals that the average Lerner index is 0.2565, with some variation across bank types (the average Lerner index reported for Japanese banks from 2003 to 2010 in Fu et al. (2014) is 0.2521). The level of competition is relatively tougher for City Banks (0.1467) and Regional Banks II (0.2421) than for Regional Banks I (0.2777), in line with the rank of Boone indicators formerly reported for three types. The trend of the Lerner index over time is very similar to the pattern of the Boone indicator (see Fig. 1). The two points expressing the strongest competitive environment are also observed in March 2002 and March 2009. Our results, however, are different from findings of Liu and Wilson (2013), possibly because they obtain the Lerner index by estimating the whole banking system, including Trust Banks, *Shinkin* Banks and Credit cooperatives during 2000-2009.

[19] There are some exceptional cases when market power characterised by the Lerner index is negative, but occasionally found. Agoraki et al. (2011) and Fu et al. (2014) explain the implication of negative Lerner index by the non-optimising behaviour of banks which are unable to price above marginal cost.

Concerning the three types in our sample, Liu and Wilson (2013) find that City Banks have the greatest market power, followed by Regional Banks I and Regional Banks II. Similar interpretation is drawn from Montgomery et al. (2014) as large banks enjoy greater market power post-mergers.

[INSERT TABLE 2 ABOUT HERE]

5.2 Risk and competition: *The Boone indicator as the threshold variable*

Table 3 reports results from the dynamic panel threshold analysis for the relationship between competition and risk, with the Boone indicator as the threshold variable. Columns 1 to 3 report findings with three proxies for risks (bankrupt loan ratio, restructured loan ratio, and *ln*Z-score, respectively). In the first two models, the threshold values found are very similar to each other (-0.0457 and -0.0481 for Models 1 and 2, respectively). The impact of the Boone indicator in the low regime is negative and insignificant. In the high regimes, the regime-dependent coefficients of the Boone indicator are positive and statistically significant (0.5654 and 0.4257). It suggests that when above the threshold value, the Boone indicator is positively associated with bankrupt loan/restructured loan ratios. In other words, the higher the bank competition, the lower the risk. Comparing the magnitude of the coefficients, we observe a stronger effect when risk is captured by bankrupt loan ratio (0.5654 against 0.4257). Compared to restructured loans, bankrupt loans are more detrimental as they have a smaller likelihood of recovery. This could suggest a more favourable effect of competition on reducing riskier loan portfolios. Our results, therefore, support the *competition-stability* hypothesis, in line with findings of Schaeck and Cihák (2014) for EU banks. Also examining Japanese banks but using Z-score to proxy for risk, Liu and Wilson (2013) report the existence of the *competition-fragility* hypothesis for all banks during 2000-2009.

There is a positive relationship between the Boone indicator and *ln*Z-score in both regimes. The parameters reported in column 3 are 0.3231 and 1.156 for the low and high regimes, respectively. Thus, in terms of overall bank soundness, competition appears to reduce bank stability, supporting the *competition-fragility* hypothesis. This implication is in line with the finding of Liu and Wilson (2013) who also use *ln*Z-score as an indicator for bank stability. The threshold value is identified at -0.1026, putting approximately 94% observations of the sample in the high regime (3283). To this end, there is evidence that both competition-risk hypotheses exist in Japanese banking. Competition is found to be a risk-reducing factor in terms of credit risks, but not in the case of overall bank soundness.

We are more confident in the credibility of the former interpretation which support the *competition-stability* hypothesis, since Z-score contains some limitations. As argued in Demirgüç-Kunt and Detragiache (2011), Z-score is an accounting-based measure, which may not fully reflect the solvency of individual banks, especially if banks are able to smooth out data before reporting. Cihák and Hesse (2007) also cast doubts on whether Z-score produces a fair measure of default risk across financial institutions. An example given in their study is cooperative banks that are less focused on profitability. Another problem of Z-score is the volatility measure in the denominator of its formula. Lepetit and Strobel (2013) compare different alternatives for the construction of Z-score. They provide evidence that the mean and standard deviation of return on assets calculated for the whole sample and the current capital ratio best fit their data.[20] Our proxies of credit risks are straightforward from balance-sheet data. We do not have the issue of comparability discussed in Demirgüç-Kunt & Detragiache (2011) for the use of nonperforming loans, as banks operate under the same reporting rules. Furthermore, the data set of bankrupt and restructured loans represents a more realistic picture of the problem that Japanese banks encountered.

[INSERT TABLE 3 ABOUT HERE]

The number of banks over time in each regime classified by the Boone indicator threshold is reported in Table 4. In the low regime, there are 611 (column 1), 562 (column 2), and 208 (column 3) observations. The high regime consists of many more observations: 2880 (column 1), 2929 (column 2), and 3283 (column 3). The patterns of the number of banks are rather clearer in columns 1 and 2 than in column 3, in which we observe some breaks in September 2003, September 2007, and March 2009. From September 2003 to September 2007, competition appeared less intensified as there were significantly fewer observations in the low regimes. From September 2009 to September 2012, a similar trend prevailed. Between March 2008 and March 2009, the number of observations in the low regime increased quite significantly. This highlights tougher competition, probably in connection with the onset of the global financial crisis. In column 3, the identification of strong competition may not be obvious as the majority of banks are classified in the high regime. However, the threshold value itself (-0.1026) signifies a rather high level of competition in comparison to those reported in columns 1 and 2 of Table 3 (-0.0457 and -0.0481).

[INSERT TABLE 4 ABOUT HERE]

[20] Tsionas (2014) provides more discussion regarding the limitations of Z-score.

The impact of other control variables is a non-trivial concern. Quantitative easing is the variable that we consider of particular importance in affecting the risk-competition connection. We find a significant and positive impact of bank lending rate on all dependent variables. Thereby, while a rise in lending rate would increase bank stability (column 3, Table 3), it would also raise bank risk-taking in terms of higher bankrupt/restructured loan ratios (columns 1 and 2, Table 3). This finding could give support to the argument of Buch et al. (2014). Quantitative easing could explain for this reduction in credit risk because lower lending rates mitigate the interest burden for borrowers. However, banks may involve in riskier activities to seek for high yield so as to compensate for the low interest margin.

We find a negative impact of capitalisation, assets diversification and liquidity on risk-monitored loan ratios. Well-capitalised banks are expected to have lower credit risk as the risk of capital loss outweighs the temptation from higher returns associated with riskier investments, in line with the finding reported in Tabak et al. (2015) for Brazilian banks. Concerning the favourable impact of asset diversification on risk, the result proposes that when diversifying earning assets, banks would benefit from lower risk-monitored loan ratios. The reason could be that managers of banks which have a well-diversified asset portfolio are expected to also effectively control their loan-generating practices. Regarding liquidity, banks having high liquidity ratio are found to be less sensitive to risk. Liquidity not only enhances banks' resilience to shocks, but also liberates banks in managing outstanding loans, rolling over debts and considering prospective loan applications. Highly liquid banks, hence, could be more flexible in extending loan maturity or amending loan contracts, which in turn would give temporarily troubled borrowers valuable opportunities to defend their financial health and commit to loan repayment.

In terms of bank size and revenue diversification, we find that large banks would have higher restructured loan ratio (column 2, Table 3), but also higher overall bank stability (column 3, Table 3) compared to their smaller peers. This could be explained through the segmentation of Japanese banking. Loan financing of systemically important banks, e.g. City Banks, is not refined within specific locations and particular types of borrowers. This may increase the likelihood of greater restructured loan ratio in comparison to small banks. However, it is more likely for *too-big-to-fail* banks to prevent restructured loans from transferring to bankrupt loans as they could benefit from various funding sources and better access to information. These advantages could also enhance bank stability. Moreover, as a feature of the *keiretsu* network, Japanese City Banks have strong ties with their clients (Lincoln et al., 1996). Management assistance from City Banks could aid temporarily distressed borrowers to reverse the situations. Affiliated firms could benefit from strategic advice of their *Main* banks to encounter challenging periods. Our results support Liu and Wilson (2013) to the extent that Japanese large banks are less risky than their smaller peers. In terms of the impact of revenue diversification, an increase in this ratio is reported to enhance bank soundness (column 3, Table 3). The more diversified the bank is in business activities, the less risk it may incur. Nguyen et al. (2012) also report that South Asian banks are more stable in response to diversifying their income.

Turning to the influence of macro-economic variables, an increase in GDP growth would positively affect risk-monitored loan ratios. Dell'Ariccia and Marquez (2006) argue that the pro-cyclical bank lending pattern is supposed to influence bank risk since banks are more likely to relax lending standards and expand credit during economic upturn. Nevertheless, the result indicates a favourable impact of GDP growth on bank stability (column 3, Table 3), in line with Agoraki et al. (2011). With regard to the effect of market capitalisation on risk, our result denotes that the development of the stock market would have a positive effect on the banking market through lower rate of bankrupt loans (column 1, Table 3) and higher bank soundness (column 3, Table 3). There is a weak implication that firms can seek funding from alternative markets to repay their debts. However, in developed financial markets, credit information sharing would easily assist creditors to detect firms with bad reputation and moral hazard behaviour (Beck et al., 2013).

Table 5 reports the results for the competition and risk relationship with other proxies of quantitative easing. We find consistent threshold values for the Boone indicator, as well as its relationship with risk across models. The magnitudes of the impact of the threshold variable on the dependent variable are also very similar to those reported in Table 3. In particular, competition is found to reduce credit risk (high regimes, columns 1 to 4), but enhance bank soundness (columns 5 and 6). As lower bond yield and higher Bank of Japan assets indicate more aggressive quantitative easing (Krishnamurthy & Vissing-Jorgensen, 2011; Lyonnet & Werner, 2012), results in columns 1 to 4 show that quantitative easing reduces risk-monitored loan ratios, in line with results in columns 1 and 2 of Table 3. This relationship is drawn from a positive association between bond yield and bankrupt/restructured loan ratios (columns 1 and 3), and a negative association between these ratios and Bank of Japan assets (columns 2 and 4). For the impact of control variables, there is little variation in terms of signs and magnitudes, with an exception of revenue diversification. This variable reveals a statistically significant effect in reducing risk-monitored loan ratios (columns 1 to 4).

[INSERT TABLE 5 ABOUT HERE]

5.3 Risk and quantitative easing: *Quantitative easing as the threshold variable*

Findings for the risk-quantitative easing nexus are reported in Table 6. There exists a positive relationship between lending rate and risk in all different model specifications (columns 1 to 3). A rise in lending rate is found to increase bankrupt/restructured loan ratios and *ln*Z-score, statistically significant in both regimes. When risk is measured by bankrupt loan ratio and restructured loan ratio, the threshold value is identified at 1.2052% (column 1) and 1.0562% (column 2). When *ln*Z-score is in play, the threshold value is 0.9401% (column 3). To this end, quantitative easing is beneficial in terms of reducing credit risk. The effect is more prominent in the high regimes, where the coefficients are 0.037 (column 1) and 0.0385 (column 2). Although the coefficients indicating the impact of lending rate on risk-monitored loan ratios in the low regimes are statistically significant, the magnitude is quite negligible (0.0088 and 0.0063 in columns 1 and 2, respectively). Nevertheless, this favourable effect of lower risky loan ratios associated with quantitative easing may be at the expense of bank stability. The reason is that, reported in column 3, *ln*Z-score is also reduced, given an aggressive quantitative easing policy. Notably, the magnitude of the coefficients for the impact of lending rate provides insightful implications. Compared to the detrimental effect that quantitative easing could impose on bank stability (0.3416 and 0.2833 in the low and high regimes, respectively), the beneficial impact that it exerts on credit risk is quite small. In a nutshell, comparing the results to the hypotheses set out in section 2, we can conclude that quantitative easing could lower credit risk but may harm overall bank stability.

In an attempt to explain the aforementioned findings, the implication of variability in our results could be interpreted by the countervailing effect of low interest rates on bank risk-taking as discussed in Buch et al. (2014). On the one hand, quantitative easing may reduce risk, as it aims to facilitate lending so that increased investment could boost economic growth. Both banks and borrowers can benefit from ample liquidity injected by quantitative easing to strengthen their resistance to exogenous shocks. Low interest rates would encourage more potential borrowers to apply for funding because of a greater probability of fulfilling their repayment duties. Evidenced in Jiménez et al. (2014), low interest rate reduces the cost burden of existing loans for borrowers. Therefore, lower bankrupt/restructured loan ratios would be expected. On the other hand, quantitative easing could amplify risk. When banks foresee an extended period of low interest rate, they may alter their risk-taking appetites towards riskier projects to pursue greater gains (Altunbas et al., 2014; Gambacorta, 2009). In more details, low yield and abundant liquidity accelerate asset prices and promote leverage, in turn induce excessive risk-taking (Dell'Ariccia et al., 2010). Larger loanable proportion of collaterals and the search for yield (Rajan, 2005) may drive banks to grant more risky loan portfolios (Jiménez et al., 2014), or to invest in higher yield-higher risk instruments. Another risk-taking channel could be through a typical type of moral hazard, where banks realise the continuity of quantitative easing policy in difficult economic times. As Altunbas et al. (2014) argue, banks may perceive the presence of a so-called *insurance effect*, in which the enforcement of monetary easing is expected during financial downturn to decelerate the fall of asset values. The prediction of lower probability of large downside risk, therefore, would magnify bank risk-taking. This perception may well be the case of prolonged low interest rate and extensive quantitative easing in Japan. Taken together, these arguments could explain for lower bank stability corresponding to quantitative easing.

[INSERT TABLE 6 ABOUT HERE]

Interestingly, in terms of control variables, the results reveal a negative association between the Boone indicator and risk-monitored loan ratios. Hence, greater competition would be harmful for banks because of higher bankrupt/restructured loan ratios. This finding is reinforced by the positive association between the Boone indicator and *ln*Z-score in column 3, indicating higher bank stability in lower competition. In this case, when competition is a control variable, the results do not uncover its desirable impact in reducing risky loan ratios shown in columns 1 and 2 of Table 3. The impact of other determinants in Table 6 is similar to findings reported in Tables 3 and 5, with minor variation. In particular, in terms of diminishing risk and enhancing bank soundness, there are four variables: capital ratio, asset diversification, liquidity and market capitalisation. In contrast, higher GDP growth is found to increase risk-monitored loan ratios, probably due to the softened lending standards during good economic times (Dell'Ariccia & Marquez, 2006). Turning to Z-score, there is a favourable impact on bank stability during economic upturn and when banks divert their focus to noninterest income. Bank stability increases corresponding to larger bank size, while bankrupt loan ratio decreases.

The number of banks in each regime is shown in Table 7. Analysing the trend of the number of observations in column 1, we observe a significant increase of banks in the low regime after the global financial crisis. Especially, from March 2011 to March 2015, almost all banks in the sample charged less than 1.2052% lending rate. Note that this time frame covers the on-going quantitative easing policy (since October 2010). Illustrated in column 3, the distribution of the number of banks in the low regime provides further evidence for the initial quantitative easing period. Recall that the threshold value for column 3 is 0.9401%, which is lower than the values for columns 1 (1.2052%) and 2 (1.0562%). From September 2003 to March 2006, the number of banks charging lending rate lower than 0.9401% increased monotonically. This tendency indicates the effect of the first quantitative easing period (March 2001-March 2006). In the high regimes of all model specifications, it is confirmed that the number of observations gradually decreased during this period.

[INSERT TABLE 7 ABOUT HERE]

In Table 8, we use the 10-year Japanese government bond yield (columns 1 to 3) and Bank of Japan assets (columns 4 to 6) to replace lending rate as the threshold variable. The results show a positive influence of bond yield on *ln*Z-score in both regimes of column 3. This is in line with previous findings of quantitative easing reducing bank stability, reported in column 3 of Table 6. The magnitude of the impact in the high regime (0.6513, column 3) is also notable compared to other models. Interestingly, bond yield affects risk-monitored loan ratios differently in two regimes. There is a statistically significant positive relationship between bond yield and bankrupt/restructured loan ratio in the high regimes. The coefficients of bond yield's impact are 0.0131 (column 1) and 0.0107 (column 2). This relationship turns out negative in the low regimes (-0.017 in column 1 and -0.0149 in column 2). It is also worth noting that the absolute magnitudes of the impact of bond yield on risk-monitored loans in the two regimes are approximately the same (around 0.01). Additionally, the threshold value is consistently realised at 1.032%. Thus, when bond yield is below 1.032%, quantitative easing increases credit risk. In this regard, more aggressive quantitative easing would encourage banks to enrol more risk. First, banks may tend to soften lending standards due to low yield and interest rate, thereby issuing loans to less creditworthy borrowers (Jiménez et al., 2014). Second, as Ioannidou et al. (2015) argue, due to low monetary policy rate, banks may be less concerned about the compensation which should be required for the higher risk taken. In fact, Ioannidou et al. (2015) find that during monetary expansion, banks charge riskier borrowers relatively less than what they would. When bond yield is greater than 1.032%, quantitative easing reduces credit risk, similar to our previous conclusion drawn from lending rate (Table 6).

[INSERT TABLE 8 ABOUT HERE]

The periods where bond yield is lower than the threshold value (1.032%) happened in March 2003, September 2010, and from September 2011 to March 2015. The last time frame includes the current quantitative easing period. If we combine this finding with the aforementioned impact of the threshold, the on-going quantitative easing may pose a threat to the banking system by augmenting credit risk. Regarding control variables, similar to the results reported in Table 6, we also find that competition increases credit risk and bank fragility. Larger size, higher capital ratio, more liquidity, greater asset diversification, revenue diversification and market capitalisation would help lower credit risk. Higher GDP growth, on the other hand, would increase credit risk exposure. In terms of bank stability, it would be enhanced following larger bank size, more diversified income, higher GDP growth, and greater market capitalisation.

A first glance at columns 4 to 6, where the Bank of Japan total assets are used to proxy for quantitative easing, reveals a consistent estimate of the threshold value at 118,437,502 mil JPN. There is a negative association between the Bank of Japan assets and risk variables. For credit risk, this relationship is statistically significant in the low regime (-0.0347 in column 4 and -0.0286 in column 5), implying a favourable impact of quantitative easing. The influence of Bank of Japan assets on risk-monitored loan ratios in the high regime is insignificant. Differently, for bank stability, when the Bank of Japan assets are greater than the threshold, more aggressive quantitative easing policy would reduce bank soundness (-0.1709 in column 6). The relationship between quantitative easing and bank stability is insignificant in the low regime. These results strengthen those reported in columns 1 to 3, where bond yield is the proxy for quantitative easing. Up to a certain level of asset purchases (118,437,502 mil JPN), quantitative easing lessens credit risk. When the amount of asset purchases passed the threshold, quantitative easing reduced bank stability.

The time frame in each regime complements these findings. First, the periods of high regimes coincide with the two quantitative easing periods. In particular, the amount of asset purchases which were higher than the threshold are recorded from March 2001 to March 2006, and from March 2011 to March 2015. Hence, the more asset purchases of the Bank was not really effective due to its detrimental impact on bank stability. Second, the period of low regimes falls in to the gap between the two quantitative easing periods, and also embraces the global financial crisis. During this interval (September 2006-September 2010), more asset purchases would mitigate credit risk. However, overall, the estimated impact suggests that the reduction in credit risk may not be considerable compared to the reduction in bank soundness (e.g. -0.0347 in column 4 versus -0.1709 in column 6). The influence of other control variables appears consistent as previously reported in columns 1 to 3 and in Table 6.

5.4 Competition and quantitative easing: *Quantitative easing as the threshold variable*

As quantitative easing affects risk and thereby indirectly competition, it is worth exploring whether the former asserts a direct effect on bank competition. To test this hypothesis, we apply threshold modelling where competition is the dependent variable and quantitative easing is the threshold variable. We respectively include a number of control variables such as risk, as measured by bankrupt loan ratio, restructured loan ratio, and *ln*Z-score. In addition, we also include some environmental variables such as bank size, capital ratio, asset diversification, revenue diversification, liquidity, GDP growth, and market capitalisation. The results are reported in Table 9.

[INSERT TABLE 9 ABOUT HERE]

In Table 9, the proxy for quantitative easing – the bank lending rate – is the threshold variable, whereas the Boone indicator is the dependent variable. The threshold values for lending rate are 0.8496% (column 1), 0.6935% (column 2), and 0.7397% (column 3), corresponding to different risk variables included in the models. The important finding is the different impacts that lending rate places on the Boone indicator. It is positive in the low regimes, and negative in the high ones. The former implies that more aggressive quantitative easing would cause higher competition. In contrast, the latter indicates lower competition in response to a more extensive quantitative easing program. The magnitude of the effect of quantitative easing on competition is larger in the low regimes (0.0905; 0.0667; 0.1095 compared to -0.0657; -0.0276; -0.0805), although the numbers of observations in the low regimes are significantly fewer.

The number of observations in each regime enlightens the implication of our findings (Table 10). Overall, the high regimes outnumber the low ones. The number of banks classified in the low regime only started increasing significantly recently, particularly, since September 2010 in column 1, March 2013 in column 2, and September 2012 in column 3. Based on the threshold values, more banks in the sample experienced a decrease in competition as a result of greater quantitative easing, considerably before the second quantitative easing period. After September 2012 to March 2015, there was an upward trend of the number of banks charging lending rate lower than the threshold, corresponding to the extensive quantitative easing program.

[INSERT TABLE 10 ABOUT HERE]

Based on our results, during the first two third of the sample period, the majority of banks in the sample are found to enjoy a less competitive environment brought by quantitative easing. The reason could be due to the implicit subsidisation from the government. First, quantitative easing policy aims to facilitate investment and spending through lowering lending rates paid by households and businesses (Wright, 2012). As a result, financial institutions are injected with ample liquidity to increase loan financing at low rates. Second, quantitative easing may generate the standard case of moral hazard which is the *insurance effect* discussed in Altunbas et al. (2014). Banks are less concerned about the fall of asset values as they could predict an extension of the program, or at least the prolonged low short-term interest rate, which could serve as a cushioning effect to prevent further downturn. Thereby, the threat of closure if they take on more risk would not be too high. Besides, according to Boone (2008a), more intense competition is a result of an increase in the number of firms in the industry, more aggressive interaction between firms, or a fall in costs of other incumbents. In the case of Japan, the number of commercial banks from the first quantitative easing period to before the second one did not change significantly, indeed, decreased slightly. We conjecture it is the relaxed economic condition and the implicit government protection that quantitative easing created less competition in the banking industry.

From September 2010 onwards, more banks are categorised in the low regime in which they face intense competition due to quantitative easing. It could be the case that Japanese commercial banks have become close substitutes as quantitative easing facilitates the whole banking system more extensively in the second program. Furthermore, as set out in its monetary policy statement on 30/10/2012, the Bank of Japan has committed to provide banks with unlimited long-term funding to match the net increase in loan financing to non-financial sectors. Being closer substitutes indicates more aggressive interaction between banks. As shown in Boone (2008a), it is a condition for more intense competition.

In terms of control variables, the impact of bank stability on the Boone indicator is positive, in line with the positive association between the Boone indicator (as the threshold variable) and *ln*Z-score, which we find for both regimes in column 3 of Table 3. Higher capital ratio and GDP growth reduce competition, similar to findings of Delis (2012). Capital-abundant banks tend to exercise their market power more greatly than their peers. These banks could be able to define their own high margin and take advantages of variable funding sources which result in lower costs. Higher liquidity ratio, in contrast, would lead to greater competition.

We further replace lending rate with bond yield and Bank of Japan assets. The relationship with the Boone indicator is reported in Table 11. Unlike lending rate, the analysis identifies a consistent positive relation between bond yield and the Boone indicator in both regimes (columns 1 to 3), while it is negative for the Bank of Japan assets (columns 4 to 6). The impact is statistically significant in almost all regimes, except the high one in column 6. The threshold estimates for bond yield are 1.33% (columns 1 and 3) and 1.685% (column 2). The corresponding time periods when the threshold values were recorded are March 2005 and September 2007. The impact of bond yield on the Boone indicator is more pronounced in the high regimes (0.0655, 0.5397, and 0.042 compared to 0.0149, 0.0113, and 0.009). With the Bank of Japan assets, we also find two threshold values. Reported in columns 4 and 6, it is 121,771,462 mil JPN recorded in March 2001, which marked the start of the first quantitative easing program. In column 5, the threshold estimate is 124,746,234 mil JPN recorded in September 2011. To this end, these results suggest that greater quantitative easing would lead to more intense competition. Besides, the different impacts of quantitative easing on competition between regimes are revealed only when lending rate is used.

[INSERT TABLE 11 ABOUT HERE]

5.5 Robustness check with the Lerner index as a competition proxy

We further conduct the dynamic panel threshold analysis, replacing the Boone indicator by the Lerner index to examine the robustness of our findings. The results are reported in Tables A1 to A7 in the Appendix.

For the risk and competition relationship (Table A1), the threshold values are 0.2661 (column 1), 0.2835 (column 2), and 0.4117 (column 3). Unlike the Boone indicator, the Lerner index exhibits a negative relationship with risk-monitored loan ratios (columns 1 and 2). The results show that higher competition would lead to an increase in bankrupt loan ratio in both regimes and restructured loan ratios in the low regime. However, although statistically significant, the economic impact is not very strong. The reason is that in column 1, the parameters are significant at the 10% level in both regimes (-0.0116 and -0.0018), and the magnitude of the impact of the Lerner index in column 2 is quite small (-0.005 for the low regime). The positive relation between the Lerner index and *ln*Z-score in the low regime of column 3 (0.1878) also suggests that competition reduces bank stability. Overall, by using the Lerner index, we find a presence of the *competition-fragility* hypothesis. This is in line with the results reported in column 3 of Table 3. The distributions of the number of observations in each regime are reported in Table A2.

Consistent with findings for the impact of covariates in columns 1 to 3 of Table 3, we find a desirable effect of capitalisation, asset diversification, liquidity, and market capitalisation in reducing risk. Higher GDP growth and lending rate, in contrast, would engage banks in higher credit risk exposure. Therefore, quantitative easing would introduce a stabilising effect on credit risk, but not on bank soundness as we find a positive impact of higher lending rate on *ln*Z-score (column 3). The impact of bank size is important for restructured loan ratios and bank stability, while revenue diversification is a significant determinant in all model specifications. However, the influence of revenue diversification on risk variables varies. The more diversified a bank, the higher the risk-monitored loan ratios, but at the same time, the higher the bank stability.

In Table A3, we report the results with bond yield and Bank of Japan assets as proxies for quantitative easing. The impact of the Lerner index in each regime and the threshold values across columns 1 to 6 remains similar to those reported in Table A1. Regarding the impact of other control variables, the results also do not vary significantly.

Table A4 shows the results for the relationship between risk and quantitative easing, where the Lerner index is a control variable, and lending rate is the threshold variable. The threshold values of lending rate in columns 1 and 2 are consistent with those reported in columns 1 and 2 of Table 6. The impact of lending rate on risk-monitored loan ratios remains positive and significant in both regimes. Some variation is found for bank stability. The threshold of lending rate in column 3 is 0.6929%, positively related to bank stability, and statistically significant in the low regime only (the coefficient is 0.6754). To this end, our previous conclusion of less credit risk and higher bank fragility associated with greater quantitative easing remains unchanged, regardless of competition proxies. When we use bond yield and Bank of Japan assets as the threshold variable (Table A5), this conclusion is upheld, but minor variability exists. For example, compared to column 1 of Table 8, column 1 of Table A5 shows a positive impact of bond yield on bankrupt loan ratio in both regimes. Therefore, if using only the Lerner index, we may miss the different impacts that bond yield could impose in different regimes.

Regarding the relationship between competition and quantitative easing, compared to the aforementioned results with the Boone indicator, we find that in the case of Lerner index capturing competition, the nexus between competition and quantitative easing is clearly negative (columns 1 to 3 of Table A6). It is statistically significant in both regimes with the threshold value identified at 0.692%. It appears that by focusing only on the Lerner index we would have missed the change in the sign of the relationship between competition and quantitative easing between two regimes. Replacing lending rate by bond yield and Bank of Japan assets, the results shown in Table A7 are similar to those reported in Table 11. In more details, the Lerner index is positively related to bond yield and negative related to Bank of Japan assets. The threshold values are consistent at 1.33% for bond yield and 124,746,234 mil JPN for the Bank of Japan assets. Hence, more aggressive quantitative easing would lead to more intensified competition.

5.6 The panel VAR specification

Given some variability in our results, which could be driven by endogeneity issues, we attempt to address the underlying dynamics between risk, competition, and quantitative easing. We adopt the methodology of panel vector autoregression (VAR) to account for the causality relationship as well as the existence of unobservable heterogeneity, specified by an individual specific term. An advantage of the model is assumption-free for the relationship between variables. We treat all three variables in the equation system as endogenous.[21] Risk, taken as bankrupt loan ratio, restructured loan ratio, and *ln*Z-score, is incorporated respectively in the analysis. The Boone indicator and lending rate are proxies for competition and quantitative easing, respectively. We also include bank size as an exogenous control variable because of its importance in the Japanese banking structure. As discussed in the Data section, City Banks are the biggest in size and operate in a wide range of geographic regions, whereas Regional Banks II are the smallest. The nature of banking business also varies across three types. Besides, *two-big-to-fail* City banks are at the centre of the *keiretsu* network as well as being the important nodes channelling the impact of quantitative easing.

Following the estimation of panel VAR, we derive the Impulse Response Functions (IRFs) (Fig. 2 to 4), which enable us to interpret the reaction of one variable to a shock in another variable in the system. We also report the Variance Decomposition (VDCs) for forecast horizons of 5 and 10 periods to illustrate the variance of the response variable corresponding to a shock in another variable (Table 12). All model specifications satisfy stability condition.[22]

[21] Following Love and Ariss (2014), we run the model on lag order 1 to preserve information.

[22] The variables enter the equation system as endogenous, with the most exogenous ones appearing first (Love & Zicchino, 2006). Following Love and Zicchino (2006), fixed effects are removed by using the *Helmert procedure* (Arellano & Bover, 1995).

[INSERT FIGURE 2 ABOUT HERE]

Regarding the risk-competition nexus, a shock to the Boone indicator has a negative and significant impact on bankrupt loan ratio (Fig.2, second row, first column). This negative relationship is in line with the results reported in Tables 6 and 8. Fig. 4 (second row, first column) reveals a positive and significant response of *ln*Z-score to shocks in the Boone indicator. This positive association is similar to findings of Tables 3, 5, 6, and 8. Restructured loan ratio, on the other hand, does not show a significant response to shocks in the Boone indicator. In terms of reverse causality, shocks in risk variables generate insignificant responses of the Boone indicator. Two scenarios can be at play to interpret the results. First, a positive shock in the Boone indicator which denote lower competition will lead to decreased credit risk and increased bank stability. This case gives support to the *competition-fragility* hypothesis. Second, a negative shock in the Boone indicator, referred as higher competition, will cause bankrupt loan ratio to decline and enhance bank stability. This situation is in line with the *competition-stability* hypothesis.

[INSERT FIGURE 3 ABOUT HERE]

In terms of the risk-quantitative easing nexus, in the short-term, there is a positive and significant response of risk-monitored loan ratios to a one standard deviation shock in lending rate (Fig. 2-3, last row, first column). This positive reaction is similar to the findings in Tables 3 and 6. There is no evidence for a significant response of bank stability to a shock in lending rate. The diagrams also reveal insignificant responses of lending rate to shocks in risk variables. Thus, if there exists a positive shock in lending rate, which translates into decreased quantitative easing, credit risk could rise accordingly. Hence, the simulation base of panel VAR could reinforce the claim of lower credit risk as a result of quantitative easing.

[INSERT FIGURE 4 ABOUT HERE]

The first order VAR model takes the form of: $w_{it} = \mu_i + \Phi w_{it-1} + e_{i,t} \quad i = 1,..., N; \qquad t = 1,..., T$ (7)

where w_{it} is a vector of three random variables: quantitative easing *QE*, Competition *Comp* and risk *R* (bankrupt loan ratio, restructured loan ratio and *ln*Z-score), Φ is a 3x3 matrix of coefficients, μ_i is a vector of *m* individual effects, and $e_{i,t}$ is a multivariate white-noise vector of *m* residuals. The equation system to be estimated with lag order one is as follows:

$$\begin{aligned} QE_{it} &= \mu_{10} + a_{11}QE_{it-1} + a_{12}Comp_{it-1} + a_{13}R_{it-1} + e_{1i,t} \\ Comp_{it} &= \mu_{20} + a_{21}QE_{it-1} + a_{22}Comp_{it-1} + a_{23}R_{it-1} + e_{2i,t} \\ R_{it} &= \mu_{30} + a_{31}QE_{it-1} + a_{32}Comp_{it-1} + a_{33}R_{it-1} + e_{3i,t} \end{aligned} \quad (8)$$

Turning to the competition-quantitative easing linkage, diagrams from the IRFs yield consensus findings for the relationship between these two aspects across different proxies for risk. A shock in lending rate would generate a negative response in the Boone indicator, marginally significant in the short-run (Fig. 2-4, last row, second column). Investigating the reverse causality, we observe an insignificant response of lending rate to a shock in the Boone indicator (Fig. 2-4, second row, last column). These findings are in line with the negative association between lending rate and the Boone indicator reported in the high regimes of Table 9. If the shock in lending rate is positive, which represents reduced quantitative easing, competition would increase. Yet, if there is a negative shock in lending rate, quantitative easing would cause higher competition.

Complementing findings of the IRFs, the VDCs show that changes in competition is important in explaining the variation in bankrupt loan ratio (5.66%), restructured loan ratio (1.26%) and *ln*Z-score (12.79%) (Table 12, 10 periods). In contrast, about 0.36% and 12.4% variation in the Boone indicator is due to innovations from restructured loan ratio and *ln*Z-score, respectively. Variation of bankrupt loan ratio does not explain the variation in competition at all. Findings from the IRFs and VDCs reveal that competition triggers its relationship with risk.

[INSERT TABLE 12 ABOUT HERE]

Regarding the risk-quantitative easing relationship, about 46.79% variation in bankrupt loan ratio is explained by variation in quantitative easing, while only 0.03% variation in quantitative easing is explained by shocks in bankrupt loan ratio. Similarly, 30.89% variation in restructured loan ratio is due to shocks in quantitative easing, while 0.07% variation in quantitative easing is explained by changes in restructured loan ratio. Differently, changes in quantitative easing is not so important in explaining the variation of bank stability. The reason is that while 3.01% variation in lending rate is due to innovations in *ln*Z-score, only 0.68% variation in *ln*Z-score is attributed to variation in lending rate. To this end, along with results from the IRFs, quantitative easing is found to originate its relationship with risk.

The variation in the Boone indicator indicated by variation in lending rate is distinguishably larger than the variation in lending rate explained by changes in the Boone indicator (8.35%, 6.14%, 10.3% in comparison to 0.01%, 0.01%, 0.12% in columns 1-3, respectively). A conclusion of the causality starting from quantitative easing to competition can be drawn.

6. Conclusion

Revisiting the risk-competition debate using the dynamic panel threshold analysis, we find evidence to support the *competition-stability* hypothesis in Japanese banking, to the extent of credit risk. In more details, competition represented by the bank-level Boone indicator is found to reduce bank risk-taking by diminishing bankrupt and restructured loan ratios. However, this desirable effect may be offset by a decrease in overall bank stability. Similarly, regarding the risk-quantitative easing nexus, a more extensive quantitative easing program would assist banks in lowering their risk-monitored loan ratios. Yet, it could threaten bank solvency. Further exploring the causality relationship between competition, quantitative easing and risk, we find that competition and quantitative easing cause risk in most models.

Our findings indicate that in an environment where quantitative easing is taking place, banks might find it more challenging to compete with their counterparts. To improve their competitiveness, banks could strengthen their competence from other aspects, e.g. capitalisation, liquidity, and asset diversification. Bank executives could enhance banking services by, e.g., diversifying their investments or increasing unconventional business activities to offer more benefits to their customers in time and cost savings. In addition, focusing on relationship banking, improving their flexibility in debt rollover, and operating more efficiently may also be among the tactics bringing banks ahead their rivals. The proposed threshold values for lending rates and the Boone indicator in this study may also be useful for bank managers to construct their risk management policy.

For policymakers, e.g. the Japan Financial Services Agency, relaxing entry and exit for the banking industry, promoting small and medium sized banks, or disentangling business operation restrictions could create a competitive environment which in turn would diminish bank risk-taking. Policymakers could also encourage the mutual assistance prevailing under the *keiretsu* network. Note that a disadvantage of *keiretsu* affiliation is that main banks could exert their monopoly power in loan financing. Our analyses show that attempts to discourage competition increase credit risk. Therefore, our results argue that *keiretsu* should be applied with extreme caution.

Last but not least, to take into account the stability of the banking system while exerting quantitative easing, regulators may revise rules associated with the initial credit screening and barriers in lending principles. In more details, avoiding incorrect evaluations at the beginning of the loan generating process and complying with lending standards help banks lessen the possibilities of future uncertainty. These policies should not contradict with but promote the efficacy of quantitative easing and the *Abenomics* - the current monetary and economic growth policy. Given that the Bank of Japan has adopted negative interest rate in January 2016 for the first time in its history, Japan would warrant a very interesting platform for future research. If the negative interest rate could drive economic recovery, it would open up a new era for monetary policy.

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Table 1. Descriptive Statistics

Variable	Mean	S.D.	Min	Max
BRL ratio	0.0263	0.0219	0.0000	0.6765
RSL ratio	0.0092	0.0093	0.0000	0.1958
*Ln*Zscore	3.9335	0.5223	0.0000	5.6410
Boone indicator	-0.0542	0.0579	-1.6390	-0.0391
Lerner index	0.2565	0.3365	-4.0314	12.4053
Lending rate	0.0106	0.0024	0.0012	0.0366
Size	14.5717	1.1591	12.0571	19.0109
Capital ratio	0.0432	0.0240	-0.7882	0.1279
Asset diversification	0.2394	0.0770	0.0000	0.4807
Liquidity ratio	0.0722	0.0380	0.0089	0.3679
Revenue diversification	0.2220	0.0817	0.0577	2.0619
GDP growth	0.0032	0.0234	-0.0787	0.0543
Bond yield	0.0122	0.0039	0.0041	0.0185
Bank of Japan assets	18.7201	0.2530	18.3119	19.5192
Market capitalisation	19.2235	0.2546	18.8248	19.6968

Notes: This Table reports the descriptive statistics for key variables employed in the dynamic panel threshold analysis. Number of observations: 3491. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=*ln*(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, Bond yield: 10-year Japanese government bond yield, Bank of Japan assets and market capitalisation is in natural logarithm. S.D.: Standard deviation.,

Table 2. Boone Indicator and Lerner Index per Bank Type.

Variable	Boone			Lerner		
Time	City	Regional 1	Regional 2	City	Regional 1	Regional 2
Sep-00	-0.0840	-0.0575	-0.0581	0.1337	0.2001	0.1732
Mar-01	-0.1129	-0.0597	-0.0683	-0.1054	0.1321	0.1356
Sep-01	-0.1332	-0.0605	-0.0886	-0.2174	0.1146	0.0830
Mar-02	-0.1906	-0.0625	-0.0894	-0.7096	0.0647	0.0289
Sep-02	-0.0517	-0.0535	-0.0795	0.0709	0.1813	0.1597
Mar-03	-0.1206	-0.0515	-0.0810	-0.8319	0.1173	0.0257
Sep-03	-0.0429	-0.0699	-0.0469	0.2166	0.2190	0.2822
Mar-04	-0.0616	-0.0452	-0.0503	0.1374	0.3101	0.2645
Sep-04	-0.0601	-0.0469	-0.0455	0.1992	0.3177	0.3030
Mar-05	-0.0562	-0.0461	-0.0510	0.0917	0.5084	0.2993
Sep-05	-0.0432	-0.0486	-0.0458	0.3346	0.3169	0.3385
Mar-06	-0.0432	-0.0457	-0.0563	0.3082	0.3628	0.3086
Sep-06	-0.0413	-0.0464	-0.0550	0.3191	0.3303	0.2757
Mar-07	-0.0467	-0.0453	-0.0579	0.2326	0.3249	0.2593
Sep-07	-0.0546	-0.0496	-0.0468	0.2172	0.2880	0.2889
Mar-08	-0.0574	-0.0489	-0.0539	0.2117	0.2482	0.2143
Sep-08	-0.0513	-0.0453	-0.0537	0.0899	0.1893	0.1809
Mar-09	-0.0598	-0.0562	-0.0809	-0.0583	-0.0060	-0.0608
Sep-09	-0.0428	-0.0433	-0.0452	0.1706	0.2947	0.2577
Mar-10	-0.0445	-0.0443	-0.0493	0.2579	0.2994	0.2286
Sep-10	-0.0483	-0.0440	-0.0453	0.3296	0.3270	0.3011
Mar-11	-0.0435	-0.0442	-0.0442	0.2450	0.2942	0.2965
Sep-11	-0.0458	-0.0438	-0.0446	0.3260	0.3461	0.3194
Mar-12	-0.0579	-0.0464	-0.0438	0.3335	0.3280	0.3254
Sep-12	-0.0513	-0.0436	-0.0435	0.2787	0.3167	0.3245
Mar-13	-0.0586	-0.0605	-0.0426	0.3910	0.3630	0.3309
Sep-13	-0.0916	-0.0519	-0.0437	0.4174	0.3879	0.3878
Mar-14	-0.0419	-0.0612	-0.0439	0.3781	0.3673	0.3775
Sep-14	-0.0450	-0.0642	-0.0430	0.4285	0.4013	0.3927
Mar-15	-0.0438	-0.0663	-0.0451	0.3356	0.3895	0.3878
Total	-0.0654	-0.0518	-0.0559	0.1467	0.2777	0.2421

Notes: This Table reports the average Boone indicator and the Lerner index per bank type over time. Sep: September; Mar: March; 00-15: 2000-2015.

Table 3. Dynamic Panel Threshold Analysis for the Risk-Competition Nexus (Boone Indicator).

	1		2		3	
Dependent variable	BRL ratio		RSL ratio		lnZ-score	
Threshold estimates	-0.0457		-0.0481		-0.1026	
95% confidence interval	[-0.0459 -0.0457]		[-0.0493 -0.0457]		[-0.1151 -0.0988]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	-0.0571	0.0382	-0.0116	0.0097	0.3231*	0.1775
High regime	0.5654***	0.0849	0.4257***	0.0554	1.1560***	0.1676
Intercept	-0.0249***	0.0044	-0.0152***	0.0025	-0.1453***	0.0240
Impact of covariates						
Lending rate	0.0421***	0.0032	0.0372***	0.0020	0.182***	0.0300
Size	-0.0002	0.0038	0.0096***	0.0027	0.0758***	0.0307
Capital ratio	-0.6081***	0.1054	-0.1051***	0.0421		
Asset diversification	-0.0454***	0.0091	-0.0128***	0.0050	0.1204	0.1598
Liquidity	-0.0429***	0.0096	-0.0084	0.0068	0.0982	0.2349
Revenue diversification	0.0144*	0.0087	0.0125	0.0080	0.1927***	0.0655
GDP growth	0.0573***	0.0074	0.0462***	0.0046	0.2623***	0.0596
Market capitalisation	-0.0029***	0.0008	-0.0008	0.0005	0.0373***	0.0090
Obs in low regime	611		562		208	
Obs in high regime	2880		2929		3283	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (lending rate) as its instrument. The threshold variable is the Boone indicator. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = (ROA_{it} + Capital\,ratio_{it}) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table 4. Number of Observations in Each Regime for the Risk-Competition Nexus.

	1		2		3	
	BRL ratio		RSL ratio		lnZ-score	
	-0.0457		-0.0481		-0.1026	
	Low	High	Low	High	Low	High
Sep-00	41	87	37	91	11	117
Mar-01	43	82	43	82	19	106
Sep-01	42	86	42	86	20	108
Mar-02	51	74	51	74	30	95
Sep-02	17	110	17	110	10	117
Mar-03	42	79	39	82	21	100
Sep-03	13	108	13	108	5	116
Mar-04	13	107	12	108	4	116
Sep-04	13	107	9	111	3	117
Mar-05	14	105	11	108	3	116
Sep-05	10	109	8	111	4	115
Mar-06	13	104	9	108	4	113
Sep-06	11	106	8	109	2	115
Mar-07	11	105	11	105	6	110
Sep-07	12	103	11	104	2	113
Mar-08	23	91	23	91	5	109
Sep-08	29	86	28	87	4	111
Mar-09	49	65	46	68	12	102
Sep-09	5	109	5	109	0	114
Mar-10	9	103	7	105	3	109
Sep-10	5	106	3	108	1	110
Mar-11	4	107	2	109	0	111
Sep-11	6	105	3	108	0	111
Mar-12	9	102	8	103	1	110
Sep-12	7	103	3	107	0	110
Mar-13	15	95	15	95	10	100
Sep-13	17	93	15	95	5	105
Mar-14	23	87	22	88	6	104
Sep-14	29	81	27	83	9	101
Mar-15	35	75	34	76	8	102
Obs	611	2880	562	2929	208	3283

Notes: This Tables report the number of observations in each regime over time for the risk-competition nexus, with the Boone indicator being the threshold value, and lending rate being the proxy for quantitative easing. Threshold values for the Boone indicator are obtained from the dynamic threshold analysis, reported in Table 3. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right)/\sigma ROA_{it}$. The second row shows dependent variables, the third row shows the threshold values, the fourth row indicates low and high regimes, Mar: March, Sep: September, 00-15: 2000-2015, Obs: number of observations.

Table 5. Dynamic Panel Threshold Analysis for the Risk-Competition Nexus (Boone Indicator and other proxies for Quantitative Easing).

	1		2		3		4		5		6	
Dependent variable	BRL ratio		BRL ratio		RSL ratio		RSL ratio		lnZ-score		lnZ-score	
Threshold estimates	-0.0457		-0.0457		-0.0481		-0.0481		-0.1026		-0.1026	
95% confidence interval	[-0.0459 -0.0457]		[-0.0459 -0.0457]		[-0.0494 -0.0457]		[-0.0494 -0.0457]		[-0.1151 -0.0988]		[-0.1151 -0.0988]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	-0.0571	0.0374	-0.0571	0.0365	-0.0116	0.0092	-0.0116	0.0084	0.3226*	0.1815	0.3221*	0.1815
High regime	0.5436***	0.0881	0.5416***	0.0982	0.407***	0.0603	0.4066***	0.0723	1.1667***	0.1737	1.1679***	0.1756
Intercept	-0.0241***	0.0047	-0.024***	0.0050	-0.0145***	0.0027	-0.0145***	0.0032	-0.1465***	0.0245	-0.1467***	0.0246
Impact of covariates												
Yield	0.0153***	0.0011			0.0136***	0.0007			0.0675***	0.0119		
BoJ assets			-0.0275***	0.0021			-0.0244***	0.0013			-0.1208***	0.0214
Size	-0.0033	0.0037	-0.0039	0.0037	0.0069***	0.0026	0.0064***	0.0028	0.065**	0.0313	0.0627**	0.0310
Capital ratio	-0.5848***	0.1028	-0.5772***	0.1037	-0.0845**	0.0409	-0.0778*	0.0404				
Asset diversification	-0.0592***	0.0091	-0.0560***	0.0096	-0.0249***	0.0051	-0.0221***	0.0057	0.0690	0.1596	0.0836	0.1630
Liquidity	-0.0127	0.0102	0.0082	0.0109	0.0183***	0.0067	0.0368***	0.0075	0.2391	0.2618	0.3328	0.2764
Revenue diversification	-0.0097***	0.0034	-0.0071*	0.0037	-0.0089***	0.0026	-0.0065**	0.0030	0.0910	0.0625	0.1030	0.0641
GDP growth	0.0621***	0.0082	0.0368***	0.0082	0.0505***	0.0058	0.0281***	0.0055	0.2859***	0.0596	0.1739***	0.0673
Market capitalisation	-0.0074***	0.0009	0.0014	0.0010	-0.0047***	0.0006	0.0031***	0.0006	0.0176	0.0120	0.0562***	0.0079
Obs in low regime	611		611		562		562		208		208	
Obs in high regime	2880		2880		2929		2929		3283		3283	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (10-year Japanese government bond yield and the natural logarithm of the Bank of Japan Total assets) as its instrument. The threshold variable is the Boone indicator. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = (ROA_{it} + Capital\,ratio_{it}) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table 6. Dynamic Panel Threshold Analysis for the Risk-Quantitative Easing Nexus (lending rate).

	1		2		3	
Dependent variable	BRL ratio		RSL ratio		lnZ-score	
Threshold estimates	1.2052%		1.0562%		0.9401%	
95% confidence interval	[0.9861% 1.2102%]		[0.9613% 1.1205%]		[0.9216% 1.0122%]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	0.0088***	0.0026	0.0063***	0.0020	0.3416***	0.0442
High regime	0.0370***	0.0090	0.0385***	0.0036	0.2833***	0.0751
Intercept	-0.1288***	0.0417	-0.1469***	0.0194	0.3061	0.2818
Impact of covariates						
Boone	-0.1359***	0.0557	-0.079***	0.0234	0.937***	0.3350
Size	-0.014***	0.0031	-0.0014	0.0022	0.1029***	0.0356
Capital ratio	-0.5453***	0.1079	-0.0560	0.0372		
Asset diversification	-0.0791***	0.0088	-0.0387***	0.0055	0.1920	0.1889
Liquidity	-0.0619***	0.0110	-0.0243***	0.0076	0.1413	0.2368
Revenue diversification	-0.0068	0.0059	-0.0061	0.0042	0.2777***	0.0771
GDP growth	0.0387***	0.0083	0.0297***	0.0050	0.2827***	0.0602
Market capitalisation	-0.002**	0.0009	-0.0003	0.0005	0.0374***	0.0107
Obs in low regime	2352		1789		1090	
Obs in high regime	959		1702		2401	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (Boone) as its instrument. The threshold variable is lending rate. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table 7. Number of Observations in Each Regime for the Risk-Quantitative Easing Nexus.

	1		2		3	
	BRL ratio		RSL ratio		lnZ-score	
	1.2052%		1.0562%		0.9401%	
	Low	High	Low	High	Low	High
Sep-00	46	82	5	123	0	128
Mar-01	45	80	2	123	0	125
Sep-01	58	70	18	110	1	127
Mar-02	60	65	35	90	2	123
Sep-02	63	64	35	92	5	122
Mar-03	65	56	36	85	9	112
Sep-03	68	53	41	80	14	107
Mar-04	74	46	44	76	15	105
Sep-04	71	49	47	73	16	104
Mar-05	78	41	54	65	25	94
Sep-05	84	35	55	64	31	88
Mar-06	90	27	61	56	41	76
Sep-06	92	25	61	56	33	84
Mar-07	80	36	53	63	19	97
Sep-07	76	39	38	77	5	110
Mar-08	75	39	37	77	2	112
Sep-08	79	36	38	77	5	110
Mar-09	87	27	52	62	10	104
Sep-09	94	20	66	48	25	89
Mar-10	96	16	71	41	43	69
Sep-10	97	14	78	33	50	61
Mar-11	102	9	82	29	62	49
Sep-11	103	8	86	25	68	43
Mar-12	106	5	91	20	75	36
Sep-12	104	6	94	16	78	32
Mar-13	106	4	98	12	85	25
Sep-13	107	3	99	11	88	22
Mar-14	108	2	101	9	90	20
Sep-14	109	1	105	5	96	14
Mar-15	109	1	106	4	97	13
Obs	2532	959	1789	1702	1090	2401

Notes: This Tables report the number of observations in each regime over time for the risk-quantitative easing nexus, with lending rate being the threshold variable, and the Boone indicator being the proxy for competition. Threshold values of lending rate are obtained from the dynamic threshold analysis, reported in Table 6. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$. The second row shows dependent variables, the third row shows the threshold values, the fourth row indicates low and high regimes, Mar: March, Sep: September, 00-15: 2000-2015, Obs: number of observations.

Table 8. Dynamic Panel Threshold Analysis for the Risk-Quantitative Easing Nexus (10-year Japanese government bond yield and Bank of Japan assets)

	1		2		3		4		5		6	
Dependent variable	BRL ratio		RSL ratio		lnZ-score		BRL ratio		RSL ratio		lnZ-score	
Threshold variable	Yield		Yield		Yield		BOJ assets		BOJ assets		BOJ assets	
Threshold estimates	1.032%		1.032%		1.484%		118,437,502 mil JPN		118,437,502 mil JPN		118,437,502 mil JPN	
95% confidence interval	[1.032% 1.032%]		[1.032% 1.032%]		[1.484% 1.484%]		[118,437,502 118,437,502]		[118,437,502 118,437,502]		[118,437,502 118,437,502]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	-0.017***	0.0014	-0.0149***	0.0010	0.0856***	0.0113	-0.0347***	0.0098	-0.0286***	0.0050	-0.1219	0.0929
High regime	0.0131***	0.0049	0.0107***	0.0028	0.6513***	0.1882	0.0007	0.0015	-0.0010	0.0010	-0.1709***	0.0194
Intercept	-0.1427***	0.0253	-0.1222***	0.0151	-2.2627***	0.8002	0.6492***	0.1814	0.504***	0.0910	-0.9858	1.9967
Impact of covariates												
Boone	-0.1837***	0.0528	-0.122***	0.0296	0.7841***	0.2696	-0.1767***	0.0530	-0.1151***	0.0273	0.8562***	0.2814
Size	-0.0232***	0.0035	-0.0095***	0.0026	0.058**	0.0295	-0.0245***	0.0031	-0.0108***	0.0023	0.0543*	0.0283
Capital ratio	-0.4923***	0.1082	-0.0085	0.0390			-0.4981***	0.1034	-0.0142	0.0362		
Asset diversification	-0.1008***	0.0087	-0.0602***	0.0053	0.1431	0.1502	-0.1093***	0.0087	-0.0691***	0.0051	0.0609	0.1414
Liquidity	-0.0737***	0.0111	-0.0326***	0.0078	0.2455	0.2653	-0.0897***	0.0116	-0.0474***	0.0078	0.1494	0.2634
Revenue diversification	-0.0178***	0.0046	-0.016***	0.0035	0.1182*	0.0606	-0.0197***	0.0043	-0.0181***	0.0033	0.1033*	0.0562
GDP growth	0.0847***	0.0119	0.0712***	0.0078	0.3185***	0.0741	0.0081	0.0083	-0.0018	0.0053	-0.0463	0.0750
Market capitalisation	-0.0113***	0.0018	-0.0083***	0.0012	0.0479***	0.0082	0.0002	0.0011	0.0028***	0.0006	0.1032***	0.0067
Obs in low regime	1114		1114		2898		1156		1156		1156	
Obs in high regime	2377		2377		593		2335		2335		2335	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (Boone) as its instrument. The threshold variable is the 10-year Japanese government bond yield and Bank of Japan (BOJ) assets. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\, ratio_{it}\right) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table 9. Dynamic Panel Threshold Analysis for the Competition-Quantitative Easing Nexus.

	1		2		3	
Dependent variable	Boone		Boone		Boone	
Threshold variable	Lending rate		Lending rate		Lending rate	
Threshold estimates	0.8496%		0.6935%		0.7397%	
95% confidence interval	[0.7274% 0.9307%]		[0.6925% 0.921%]		[0.7028% 0.8084%]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	0.0905***	0.0233	0.0667	0.0417	0.1095**	0.0510
High regime	-0.0657***	0.0226	-0.0276***	0.0102	-0.0805***	0.0260
Intercept	0.7444***	0.1201	0.4389**	0.2130	0.9231***	0.1936
Impact of covariates						
BRL ratio	-0.0151	0.3644				
RSL ratio			-0.5595	0.4007		
lnZ-score					0.3487***	0.1058
Size	-0.0083	0.0173	-0.0052	0.0152	-0.0091	0.0186
Capital ratio	0.5151	0.3782	0.4606***	0.1868		
Asset diversification	-0.0406	0.0407	-0.0431	0.0386	-0.0415	0.0682
Liquidity	-0.1226***	0.0505	-0.1315***	0.0489	-0.1015	0.0796
Revenue diversification	0.0345	0.0268	0.0296	0.0252	0.0065	0.0437
GDP growth	0.0716*	0.0419	0.0886***	0.0398	-0.0507	0.0596
Market capitalisation	0.0051	0.0032	0.0049*	0.0027	-0.0088*	0.0046
Obs in low regime	624		181		287	
Obs in high regime	2867		3310		3204	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (BRL ratio, RSL ratio, or lnZ-score) as its instrument. The threshold variable is lending rate. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table 10. Number of Observations in Each Regime for the Competition - Quantitative Easing Nexus (Boone indicator and lending rate).

	1		2		3	
	0.8496%		0.6935%		0.7397%	
	BRL ratio		RSL ratio		lnZ-score	
	Low	High	Low	High	Low	High
Sep-00	0	128	0	128	0	128
Mar-01	0	125	0	125	0	125
Sep-01	0	128	0	128	0	128
Mar-02	1	124	0	125	0	125
Sep-02	0	127	0	127	0	127
Mar-03	1	120	1	120	1	120
Sep-03	2	119	0	121	0	121
Mar-04	3	117	0	120	0	120
Sep-04	3	117	0	120	1	119
Mar-05	4	115	1	118	1	118
Sep-05	3	116	0	119	0	119
Mar-06	7	110	0	117	2	115
Sep-06	5	112	0	117	0	117
Mar-07	2	114	1	115	1	115
Sep-07	0	115	0	115	0	115
Mar-08	0	114	0	114	0	114
Sep-08	0	115	0	115	0	115
Mar-09	1	113	0	114	0	114
Sep-09	2	112	0	114	0	114
Mar-10	9	103	0	112	1	111
Sep-10	17	94	1	110	2	109
Mar-11	27	84	1	110	2	109
Sep-11	36	75	1	110	3	108
Mar-12	51	60	3	108	8	103
Sep-12	56	54	6	104	22	88
Mar-13	71	39	14	96	27	83
Sep-13	75	35	23	87	42	68
Mar-14	80	30	33	77	50	60
Sep-14	82	28	45	65	57	53
Mar-15	86	24	51	59	67	43
Obs	624	2867	181	3310	287	3204

Notes: This Tables report the number of observations in each regime over time for the competition-quantitative easing nexus, with lending rate being the threshold variable, the Boone indicator being the dependent variable. Threshold values are obtained from the dynamic threshold analysis, reported in Table 9. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\, ratio_{it}\right) / \sigma ROA_{it}$. The second row shows the threshold values, the third row shows the endogenous variable used in each model specification, the fourth row indicates low and high regimes, Mar: March, Sep: September, 00-15: 2000-2015, Obs: number of observations.

Table 11. Dynamic Panel Threshold Analysis for the Competition-Quantitative Easing Nexus (Boone Indicator and other proxies for Quantitative Easing)

	1		2		3		4		5		6	
Threshold variable	Yield		Yield		Yield		BoJ assets		BoJ assets		BoJ assets	
Threshold estimates	1.330%		1.685%		1.330%		121,771,462 mil JPN		124,746,221 mil JPN		121,771,462 mil JPN	
95% confidence interval	[1.33% 1.415%]		[1.33% 1.685%]		[1.33% 1.415%]		[119,777,762 126,958,482]		[118,437,506 126,208,495]		[106,002,035 216,697,081]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	0.0149***	0.0035	0.0113***	0.0030	0.009***	0.0036	-0.0678***	0.0262	-0.0606***	0.0240	-0.0482*	0.0279
High regime	0.0655***	0.0194	0.5397***	0.1971	0.042**	0.0201	-0.0233***	0.0047	-0.0213***	0.0068	-0.0070	0.0061
Intercept	-0.2102***	0.0873	-2.1249***	0.7925	-0.1344	0.0908	0.8180*	0.4895	0.7236	0.4703	0.7625	0.5488
Impact of covariates												
BRL ratio	-0.6179	0.5332					-0.5277**	0.2597				
RSL ratio			-0.9872**	0.4582					-0.9149*	0.5102		
lnZ-score					0.0509	0.0749					0.0888	0.0766
Size	0.0000	0.0202	0.0001	0.0163	0.0103	0.0156	-0.0020	0.0166	-0.0005	0.0159	0.0081	0.0147
Capital ratio	0.1163	0.5167	0.4185	0.2912			0.1832	0.3176	0.4294	0.2941		
Asset diversification	-0.0042	0.0707	-0.0017	0.0514	0.0627*	0.0380	-0.0066	0.0425	-0.0157	0.0595	0.0582	0.0408
Liquidity	-0.1293**	0.0574	-0.1257***	0.0518	-0.0876	0.0579	-0.1362***	0.0555	-0.1341**	0.0588	-0.0961	0.0614
Revenue diversification	0.0213	0.0206	0.0177	0.0209	0.0349*	0.0199	0.0193	0.0207	0.0122	0.0215	0.0296*	0.0178
GDP growth	0.1291***	0.0452	0.1521***	0.0428	0.0799*	0.0476	0.0972***	0.0324	0.1322***	0.0423	0.0726*	0.0427
Market capitalisation	-0.0136***	0.0051	-0.0053*	0.0032	-0.0081	0.0062	0.0022	0.0032	0.0014	0.0039	-0.0046	0.0068
Obs in low regime	1824		3246		1824		1409		1520		1409	
Obs in high regime	1667		245		1667		2082		1971		2082	

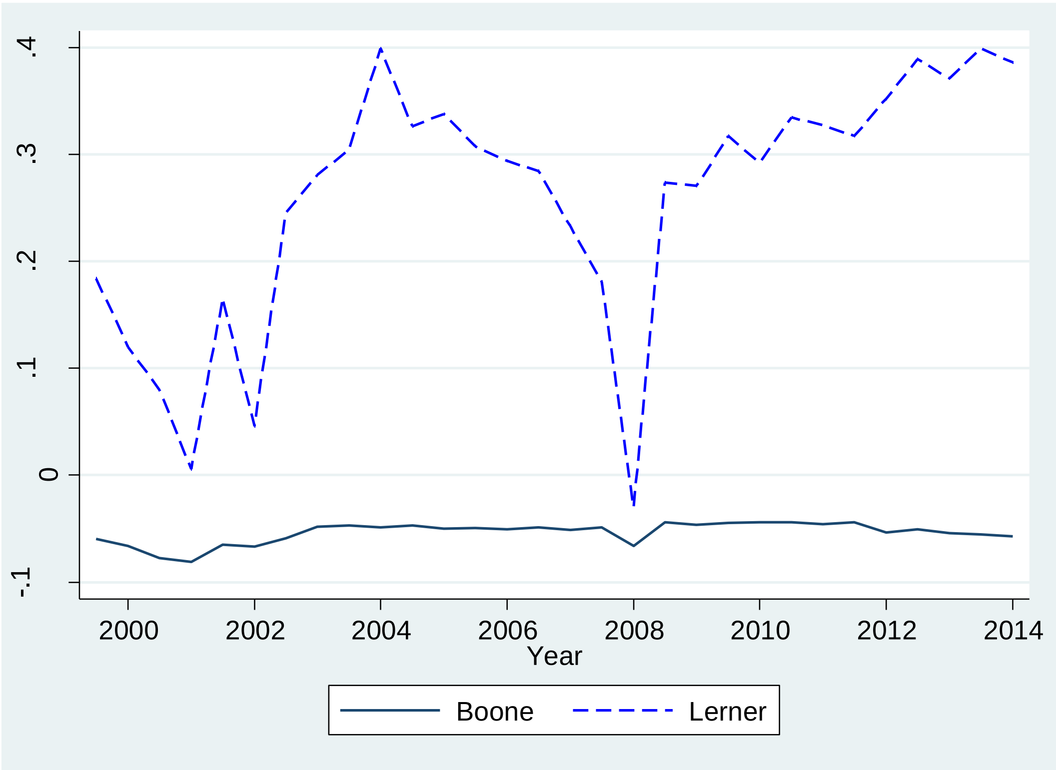
Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (BRL ratio, RSL ratio, or lnZ-score) as its instrument. The threshold variable is the 10-year Japanese government bond yield (Yield) and the Bank of Japan total assets (BoJ assets). BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\, ratio_{it}\right) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural lo-3garithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table 12. Variance Decompositions.

	1				2				3			
Periods	Variables	QE	Boone	BRL ratio	Variables	QE	Boone	RSL ratio	Variables	QE	Boone	lnZ-score
5	QE	0.9997	0.0001	0.0002	QE	0.9997	0.0001	0.0002	QE	0.9888	0.0004	0.0108
5	Boone	0.0438	0.9561	0.0000	Boone	0.0292	0.9683	0.0025	Boone	0.0567	0.8303	0.1130
5	BRL ratio	0.2801	0.0765	0.6434	RSL ratio	0.1168	0.0166	0.8667	lnZ-score	0.0039	0.1429	0.8532
10	QE	0.9996	0.0001	0.0003	QE	0.9992	0.0001	0.0007	QE	0.9686	0.0012	0.0301
10	Boone	0.0835	0.9164	0.0000	Boone	0.0614	0.9350	0.0036	Boone	0.1030	0.7729	0.1240
10	BRL ratio	0.4679	0.0566	0.4756	RSL ratio	0.3089	0.0126	0.6785	lnZ-score	0.0068	0.1279	0.8653

Notes: This Table reports the variance decompositions of the panel vector autoregression model for 5 and 10 periods ahead. There are 3 models, each has 3 variables: quantitative easing *QE* proxied by the lending rate, competition proxied by the Boone indicator, and risk. Column 1: risk is represented as bankrupt loan (BRL) ratio, column 2: risk is restructured loan (RSL) ratio, column 3: risk is taken as ln *Z*-score, $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$.

Figure 1. The Boone Indicator and the Lerner Index



Notes: This Figure illustrates the average values of the Boone indicator and the Lerner index over time. Year denotes financial year.

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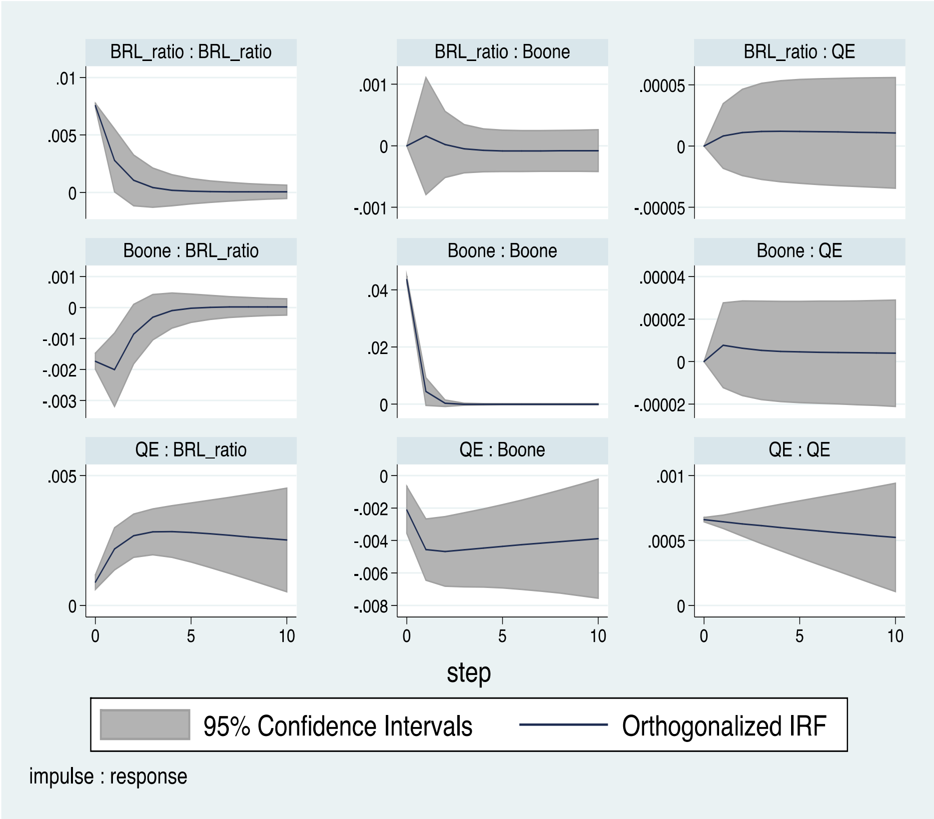
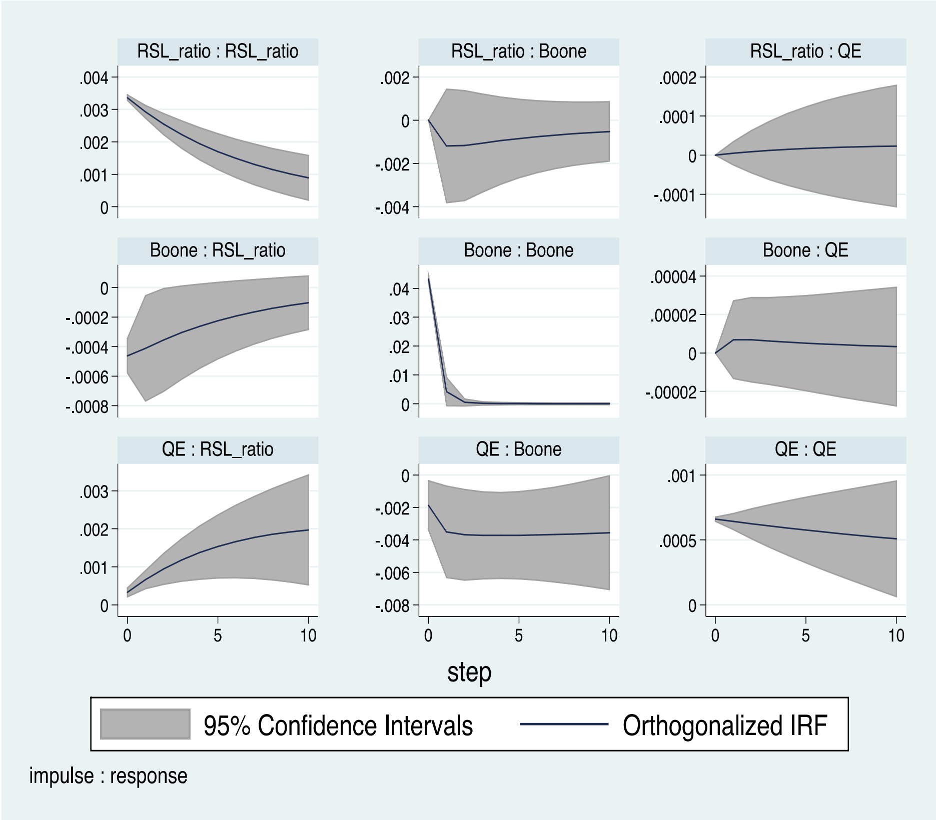
Figure 2: Impulse Response Functions-Bankrupt loan ratio



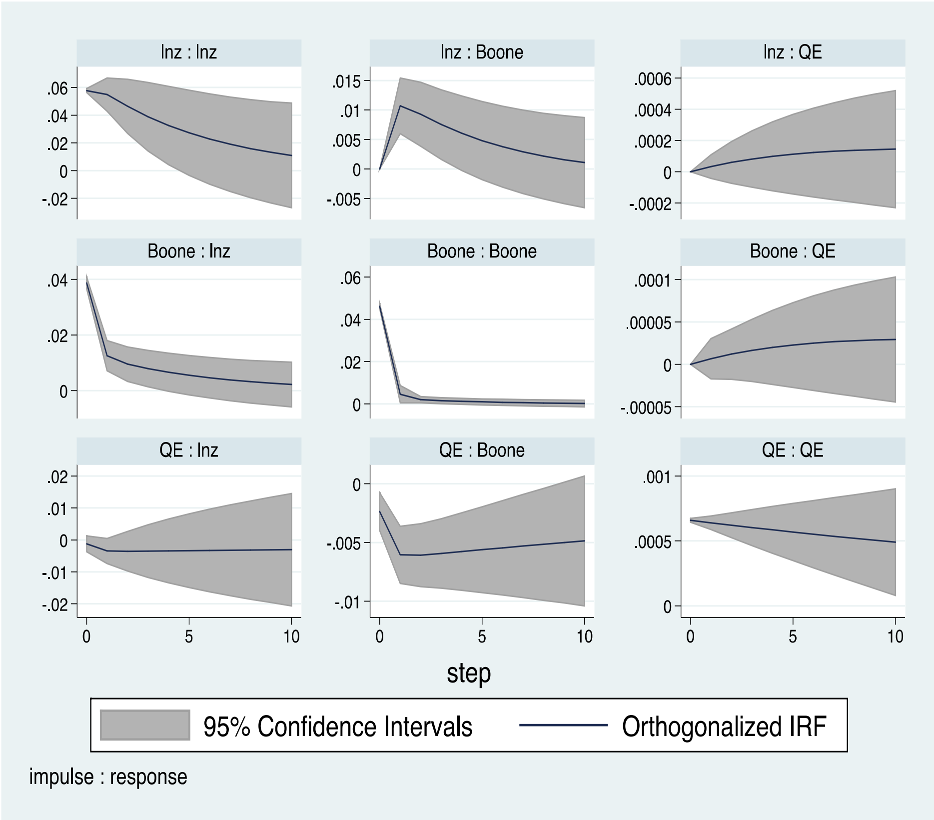
Notes: This figure illustrates the impulse-response functions (IRFs) of each endogenous variable with respect to one standard deviation shock in other variables. QE: Quantitative easing proxied by bank lending rate; Boone is the Boone indicator of competition; BRL_ratio is bankrupt loan ratio; step: number of periods. Errors are 5% on each side generated by Monte-Carlo simulation.

Figure 3: Impulse Response Functions-Restructured loan ratio



Notes: This figure illustrates the impulse-response functions (IRFs) of each endogenous variable with respect to one standard deviation shock in other variables. QE: Quantitative easing proxied by bank lending rates; Boone is the Boone indicator of competition; RSL_ratio is restructured loan ratio; step: number of periods. Errors are 5% on each side generated by Monte-Carlo simulation.

Figure 4: Impulse Response Functions-Bank stability



Notes: This figure illustrates the impulse-response functions (IRFs) of each endogenous variable with respect to one standard deviation shock in other variables. QE: Quantitative easing proxied by bank lending rate; Boone is the Boone indicator of competition; lnz is the natural logarithm of Z-score $Z_{it} = (ROA_{it} + Capital\,ratio_{it}) / \sigma ROA_{it}$; step: number of periods. Errors are 5% on each side generated by Monte-Carlo simulation.

Table A1. Dynamic Panel Threshold Analysis for the Risk-Competition Nexus (Lerner Index).

	1		2		3	
Dependent variable	BRL ratio		RSL ratio		lnZ-score	
Threshold estimates	0.2661		0.2835		0.4117	
95% confidence interval	[-0.1724 0.3027]		[0.2728 0.3433]		[0.3997 0.4164]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	-0.0116*	0.0061	-0.005***	0.0016	0.1878***	0.0354
High regime	-0.0018*	0.0010	-0.0005	0.0006	-0.0091	0.0059
Intercept	0.0047***	0.0009	0.0023***	0.0004	-0.1046***	0.0180
Impact of covariates						
Lending rate	0.039***	0.0031	0.0347***	0.0017	0.2387***	0.0340
Size	-0.0007	0.0038	0.0094***	0.0026	0.0762***	0.0302
Capital ratio	-0.6053***	0.1046	-0.0997***	0.0393		
Asset diversification	-0.0443***	0.0104	-0.0161***	0.0047	0.0214	0.1316
Liquidity	-0.0345***	0.0104	-0.0045	0.0063	-0.0279	0.1979
Revenue diversification	0.0216***	0.0053	0.0142***	0.0029	0.1527***	0.0576
GDP growth	0.064***	0.0072	0.0438***	0.0047	0.0674	0.0910
Market capitalisation	-0.0013*	0.0008	0.0003	0.0005	0.0131	0.0117
Obs in low regime	1160		1392		3134	
Obs in high regime	2331		2099		357	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (lending rate) as its instrument. The threshold variable is the Lerner index. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table A2. Number of Observations in Each Regime for the Risk-Competition Nexus (Lerner index).

	1		2		3	
	BRL ratio		RSL ratio		Z-score	
	0.2661		0.2835		0.4117	
Time	Low	High	Low	High	Low	High
Sep-00	68	60	89	39	128	0
Mar-01	85	40	97	28	123	2
Sep-01	95	33	105	23	127	1
Mar-02	99	26	107	18	124	1
Sep-02	69	58	81	46	125	2
Mar-03	88	33	102	19	119	2
Sep-03	42	79	53	68	116	5
Mar-04	37	83	50	70	115	5
Sep-04	25	95	32	88	107	13
Mar-05	27	92	34	85	101	18
Sep-05	14	105	18	101	104	15
Mar-06	14	103	23	94	90	27
Sep-06	15	102	17	100	101	16
Mar-07	25	91	28	88	98	18
Sep-07	22	93	29	86	107	8
Mar-08	48	66	60	54	110	4
Sep-08	84	31	90	25	115	0
Mar-09	100	14	105	9	114	0
Sep-09	47	67	56	58	111	3
Mar-10	39	73	50	62	110	2
Sep-10	16	95	20	91	104	7
Mar-11	30	81	43	68	109	2
Sep-11	13	98	17	94	94	17
Mar-12	18	93	25	86	98	13
Sep-12	19	91	26	84	98	12
Mar-13	11	99	22	88	86	24
Sep-13	3	107	6	104	72	38
Mar-14	2	108	2	108	86	24
Sep-14	0	110	0	110	69	41
Mar-15	5	105	5	105	73	37
Obs	1160	2331	1392	2099	3134	357

Notes: This Tables report the number of observations in each regime over time for the risk-competition nexus. The Lerner index is the proxy for competition, while lending rate is the proxy for quantitative easing. Threshold values are obtained from the dynamic threshold analysis, reported in Table A2. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right)/\sigma ROA_{it}$. The second row shows the threshold values, the third row shows the endogenous variable used in each model specification, the fourth row indicates low and high regimes, Mar: March, Sep: September, 00-15: 2000-2015, Obs: number of observations.

Table A3. Dynamic Panel Threshold Analysis for the Risk-Competition Nexus (Lerner index and other proxies for Quantitative Easing).

	1		2		3		4		5		6	
Dependent variable	BRL ratio		BRL ratio		RSL ratio		RSL ratio		lnZ-score		lnZ-score	
Threshold estimates	0.2661		0.2661		0.2835		0.2835		0.4117		0.4117	
95% confidence interval	[-0.1724 0.3003]		[-0.1724 0.3039]		[0.2728 0.3433]		[0.2707 0.3436]		[0.3997 0.4164]		[0.3997 0.4163]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	-0.0115*	0.0060	-0.0115*	0.0060	-0.005***	0.0016	-0.005***	0.0015	0.1878***	0.0358	0.1879***	0.0362
High regime	-0.0016*	0.0009	-0.0017*	0.0009	-0.0004	0.0005	-0.0005	0.0006	-0.0074	0.0078	-0.0082	0.0077
Intercept	0.0048***	0.0009	0.0046***	0.0009	0.0024***	0.0004	0.0023***	0.0005	-0.1032***	0.0203	-0.1042***	0.0211
Impact of covariates												
Yield	0.0143***	0.0012			0.0128***	0.0007			0.0867***	0.0138		
BoJ assets			-0.0258***	0.0021			-0.023***	0.0013			-0.1552***	0.0252
Size	-0.0034	0.0038	-0.0039	0.0038	0.007***	0.0027	0.0066***	0.0028	0.0598*	0.0307	0.0566*	0.0307
Capital ratio	-0.5839***	0.1027	-0.5769***	0.1034	-0.0806**	0.0380	-0.0744**	0.0375				
Asset diversification	-0.0562***	0.0104	-0.0535***	0.0108	-0.0267***	0.0052	-0.0243***	0.0058	-0.0487	0.1275	-0.0313	0.1313
Liquidity	-0.0061	0.0116	0.0134	0.0123	0.0208***	0.0068	0.0383***	0.0074	0.1540	0.2300	0.2732	0.2487
Revenue diversification	-0.0011	0.0051	0.0016	0.0054	-0.0059*	0.0031	-0.0035	0.0036	0.0156	0.0509	0.0318	0.0530
GDP growth	0.0694***	0.0080	0.0454***	0.0079	0.0486***	0.0058	0.0271***	0.0057	0.0963	0.0913	-0.0484	0.1066
Market capitalisation	-0.0055***	0.0008	0.0027***	0.0010	-0.0034***	0.0006	0.0038***	0.0006	-0.0120	0.0156	0.0375***	0.0101
Obs in low regime	1160		1160		1392		1392		3134		3134	
Obs in high regime	2331		2331		2099		2099		357		357	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (10-year Japanese government bond yield and the natural logarithm of the Bank of Japan Total assets) as its instrument. The threshold variable is the Lerner index. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = (ROA_{it} + Capital\,ratio_{it}) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table A4. Dynamic Panel Threshold Analysis for the Risk-Quantitative Easing Nexus (lending rate and Lerner index).

	1		2		3	
Dependent variable	BRL ratio		RSL ratio		lnZ-score	
Threshold estimates	1.2052%		1.0554%		0.6929%	
95% confidence interval	[1.1976% 1.2102%]		[0.9847% 1.1212%]		[0.6922% 0.7089%]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	0.0249***	0.0024	0.0145***	0.0015	0.6754***	0.2843
High regime	0.054***	0.0085	0.049***	0.0033	0.0083	0.0498
Intercept	-0.1340***	0.0378	-0.1575***	0.0153	3.3572***	1.3170
Impact of covariates						
Lerner	-0.0054	0.0045	-0.001	0.0015	0.2069***	0.0306
Size	-0.0045	0.0028	0.0036*	0.0021	-0.0160	0.0357
Capital ratio	-0.6234***	0.0999	-0.1048***	0.0425		
Asset diversification	-0.0566***	0.0102	-0.0285***	0.0058	-0.1910	0.1678
Liquidity	-0.043***	0.0109	-0.0125*	0.0067	0.0612	0.2138
Revenue diversification	0.0178*	0.0091	0.002	0.0035	-0.2582***	0.0726
GDP growth	0.0427***	0.0078	0.0282***	0.0043	-0.0771	0.0723
Market capitalisation	-0.0023***	0.0009	-0.0005	0.0005	0.0288***	0.0117
Obs in low regime	2352		1784		179	
Obs in high regime	959		1707		3312	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (Lerner index) as its instrument. The threshold variable is lending rate. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table A5. Dynamic Panel Threshold Analysis for the Risk-Quantitative Easing Nexus (10-year Japanese government bond yield, Bank of Japan assets, and Lerner index)

	1		2		3		4		5		6	
Dependent variable	BRL ratio		RSL ratio		lnZ-score		BRL ratio		RSL ratio		lnZ-score	
Threshold variable	Yield		Yield		Yield		BOJ assets		BOJ assets		BOJ assets	
Threshold estimates	0.709%		1.032%		1.484%		118,437,502 mil JPN		118,437,502 mil JPN		118,437,502 mil JPN	
95% confidence interval	[0.709% 1.032%]		[0.709% 1.032%]		[1.484% 1.484%]		[118,437,502 118,437,502]		[118,437,502 118,437,502]		[113,693,826 118,437,502]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	0.0081***	0.0015	-0.0117***	0.0009	-0.0072	0.0117	-0.045***	0.0083	-0.0339***	0.0043	-0.0204	0.0943
High regime	0.0238***	0.0020	0.0169***	0.0023	0.4954***	0.1927	-0.0169***	0.0014	-0.0097***	0.0008	0.0245	0.0197
Intercept	-0.0651***	0.0121	-0.1359***	0.0131	-2.0014***	0.8190	0.5089***	0.1540	0.4399***	0.0795	0.8089	2.0389
Impact of covariates												
Lerner	-0.0053	0.0047	0.0020	0.0014	0.191***	0.0512	-0.0054	0.0047	0.0008	0.0015	0.1869***	0.0503
Size	-0.0107***	0.0033	-0.0039*	0.0022	-0.0573**	0.0282	-0.0139***	0.0029	-0.0053***	0.0020	-0.0523*	0.0269
Capital ratio	-0.5889***	0.0995	-0.0814*	0.0448			-0.5913***	0.0949	-0.0817*	0.0437		
Asset diversification	-0.0795***	0.0105	-0.053***	0.0054	-0.1529	0.1694	-0.0917***	0.0105	-0.0623***	0.0052	-0.1914	0.1622
Liquidity	-0.0291***	0.0118	-0.0041	0.0071	0.0405	0.2623	-0.0507***	0.0123	-0.0221***	0.0072	-0.0286	0.2642
Revenue diversification	-0.0019	0.0110	-0.0205***	0.0041	-0.4013***	0.0939	-0.0032	0.0110	-0.0189***	0.0039	-0.4069***	0.0902
GDP growth	0.0694***	0.0075	0.0653***	0.0058	-0.0925	0.1230	-0.0156**	0.0072	-0.0218***	0.0040	-0.1059	0.1288
Market capitalisation	-0.0127***	0.0014	-0.0108***	0.0010	0.0766***	0.0119	0.0054***	0.0011	0.0051***	0.0006	0.0369***	0.0084
Obs in low regime	671		1114		2898		1156		1156		1156	
Obs in high regime	2820		2377		593		2335		2335		2335	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (Lerner index) as its instrument. The threshold variable is the 10-year Japanese government bond yield and Bank of Japan (BOJ) assets. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = (ROA_{it} + Capital\, ratio_{it}) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table A6. Dynamic Panel Threshold Analysis for the Competition-Quantitative Easing Nexus (Lerner index and lending rate).

	1		2		3	
Dependent variable	Lerner		Lerner		Lerner	
Threshold variable	Lending rate		Lending rate		Lending rate	
Threshold estimates	0.6925%		0.6925%		0.6922%	
95% confidence interval	[0.6925% 0.6931%]		[0.6925% 0.6931%]		[0.6922% 0.7028%]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	-0.3378***	0.1323	-0.3415***	0.1325	-0.3098**	0.1396
High regime	-0.0467*	0.0243	-0.0268	0.0182	-0.0725***	0.0223
Intercept	-1.4765**	0.6572	-1.5923***	0.6568	-1.2034*	0.6585
Impact of covariates						
BRL ratio	-0.2179	0.6517				
RSL ratio			-0.9287*	0.5479		
lnZ-score					0.2983***	0.1172
Size	-0.0209	0.0179	-0.0159	0.0149	-0.0136	0.0178
Capital ratio	0.5714	0.5851	0.614*	0.3399		
Asset diversification	0.0786	0.0629	0.0659	0.0447	0.1044*	0.0517
Liquidity	-0.0787	0.0642	-0.0767	0.0546	-0.0290	0.0614
Revenue diversification	0.1871***	0.0339	0.1831***	0.0336	0.1747***	0.0470
GDP growth	0.3219***	0.0667	0.3421***	0.0619	0.2116***	0.0663
Market capitalisation	0.0195***	0.0046	0.0196***	0.0038	0.0078	0.0056
Obs in low regime	177		177		176	
Obs in high regime	3314		3314		3315	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (BRL ratio, RSL ratio, or lnZ-score) as its instrument. The threshold variable is the bank specific lending rate. BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = (ROA_{it} + Capital\,ratio_{it}) / \sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.

Table A7. Dynamic Panel Threshold Analysis for the Competition-Quantitative Easing Nexus (Lerner index and other proxies for Quantitative Easing)

	1		2		3		4		5		6	
Threshold variable	Yield		Yield		Yield		BoJ assets		BoJ assets		BoJ assets	
Threshold estimates	1.330%		1.330%		1.330%		124,746,234 mil JPN		124,746,234 mil JPN		124,746,234 mil JPN	
95% confidence interval	[1.33% 1.685%]		[1.26% 1.33%]		[1.26% 1.33%]		[118,437,502 124,746,234]		[119,777,762 124,746,234]		[109,020,450 144,384,522]	
Impact of threshold variables	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.	Est.	S.e.
Low regime	0.0131**	0.0059	0.0132***	0.0053	0.0104*	0.0053	-0.0741***	0.0244	-0.0713***	0.0246	-0.056*	0.0288
High regime	0.0553***	0.0205	0.0525***	0.0205	0.0333	0.0234	-0.0207***	0.0082	-0.0112	0.0082	-0.0079	0.0075
Intercept	-0.1695*	0.0980	-0.1558	0.0974	-0.0866	0.1092	0.9781**	0.4859	1.1064**	0.5179	0.8833	0.5902
Impact of covariates												
BRL ratio	-0.6423	0.4896					-0.6768	0.4967				
RSL ratio			-0.0093*	0.0049					-0.0056	0.0052		
lnZ-score					0.0169	0.0889					0.0326	0.0928
Size	0.0030	0.0197	-0.0045	0.0192	0.0177	0.0163	0.0033	0.0194	0.0009	0.0187	0.0183	0.0156
Capital ratio	0.2466	0.4829	0.6435*	0.3352			0.2345	0.4831	0.6488*	0.3331		
Asset diversification	0.0816	0.0697	0.0747	0.0478	0.162***	0.0600	0.0672	0.0765	0.0898*	0.0525	0.1529***	0.0600
Liquidity	-0.0935	0.0659	-0.0722	0.0667	-0.0333	0.0828	-0.1229*	0.0730	-0.1027	0.0683	-0.0608	0.0850
Revenue diversification	0.2953***	0.0993	0.2857***	0.1036	0.3168***	0.0884	0.2904***	0.0999	0.2896***	0.1053	0.3112***	0.0891
GDP growth	0.3204***	0.0570	0.3059***	0.0564	0.2823***	0.0631	0.359***	0.0591	0.3521***	0.0574	0.3281***	0.0703
Market capitalisation	0.0101*	0.0056	0.0178***	0.0057	0.0166***	0.0071	0.0171***	0.0047	0.0185**	0.0083	0.0149*	0.0090
Obs in low regime	1824		1824		1824		1520		1520		1520	
Obs in high regime	1667		1667		1667		1971		1971		1971	

Notes: This Tables report the results from the dynamic threshold analysis using the first lag of the endogenous variable (BRL and RSL ratio, or lnZ-score) as its instrument. The threshold variable is the 10-year Japanese government bond yield (Yield) and the Bank of Japan total assets (BoJ assets). BRL ratio: bankrupt loans to assets, RSL ratio: restructured loans to assets, Z-score $Z_{it} = \left(ROA_{it} + Capital\,ratio_{it}\right)/\sigma ROA_{it}$, lending rate=interest income on loans/loans and bills discounted, size=ln(total assets), capital ratio=equity/assets, asset diversification=securities/assets, liquidity=liquid assets/total assets, revenue diversification=non-interest incomes/operating income, market capitalisation is in natural logarithm. Est.: estimate, S.e.: standard error, Obs: number of observations. ***,**,*: significance at 1%, 5%, 10% level.