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Have lower interest rates tightened capital regulation? Empirical analysis using data of regional banks

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Abstract

The purpose of this article is to explore the relationship between bank capital regulation and interest rates. We develop a model that assumes a regional monopoly in bank lending under Basel III-like capital regulation. Our model assumes that banks have the means to relax capital regulation. However, we show that in a very low interest rate environment, the effectiveness of some mitigation measures is weakened. Therefore, our banking model predicts that very low interest rates will reduce the ability of banks to control capital adequacy ratios. The findings from our empirical analysis are consistent with this prediction. Our analysis also suggests that yields on zero-risk weighted assets, such as sovereign bonds and reserve deposits, affect the health of banks. In a very low interest rate environment, our findings suggest that more flex- ible capital regulation by the monetary authority is increasingly important in light of macroprudential policies. The policy implication of this paper is that it presents a new macroprudential policy that promotes regional eco- nomic growth by making the capital regulations of Japan's regional banks more flexible.

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1 INTRODUCTION

The period of the low interest rate environment is over. Central banks around the world are raising interest rates sharply to combat global inflation. Looking back, the low interest rate environment that had persisted in advanced economies since the global financial crisis was a rare phenomenon. In Japan, however, the low interest rate environment persists even today. The purpose of this article is to show that there is a risk that a low interest rate environment will tighten banking regulations and threaten the soundness of banks, and to examine countermeasures. The structure of this article is as follows. Section 2 reviews previous studies on the low-interest rate environment. Section 3 examines the effects of capital regulation using a simple banking model. Section 4 illustrates the mechanism by which a low interest-rate environment strengthens banking regulation. Section 5 confirms the impact of low interest rates on the soundness of banks through empirical analysis. The final section concludes and provides suggestions for future research.

2 PREVIOUS RESEARCH

Since the global financial crisis, interest rates in advanced economies declined against the backdrop of monetary easing policies by central banks. Many central bank economists have explained that the decline in global interest rates is primarily driven by lower economic growth rates and natural interest rates (Del Negro *et al.* (2019), Holston *et al.* (2017), Borio *et al.* (2017)). In addition, economists at the Bank for International Settlements (BIS) have shown that low interest rates deprive monetary policy of effectiveness (Borio and Gambacorta (2017), Claessens *et al.* (2018)). Rubio and Yao (2020) also note that strict capital regulation in a low interest rate environment can severely undermine economic stability. Brunnermeier and Koby (2018) demonstrate that accommodative monetary policy can be counterproductive, making bank lending contractionary.

Thus far, however, there have been few studies focusing on the relationship between bank capital regulation and the low interest rate environment. One exception is Rubio and Yao (2020) which assumes that banks' assets consist only of loans, but their analysis should take into account the diversification of banks' assets and the complexity of capital regulations, so further analysis is required.

This study examines the impact of lower interest rates on the strength of banks' capital requirements. The hypotheses of this paper are as follows. Although the Basel Banking Regulation imposes strict capital regulation, banks have the means to ease the regulation. However, a low interest rate environment weakens the effectiveness of this easing and engenders risks that could undermine the financial soundness of banks.

3 BANKING MODEL UNDER CAPITAL REGULATION

The purpose of this section is to set up a banking model subject to capital regulation. The typical Japanese lending market consists of between one and three banks that serve multiple companies as borrowers in each prefecture. Therefore, the assumption of a traditional regional monopoly of the lending market is likely to be realistic for Japan. The primary deposit D_0 and the initial capital C_0 are given. The deposit interest rate is constant in r_L. The bank holds two types of assets: loan L and reserve R. The loan cost function is denoted by $\Phi(L)$ and the partial derivative coefficient of L is assumed to be constant at β. In other words, $\partial\Phi(L)/\partial L{=}\beta$. The interest rate on loans and reserves shall be denoted by r_L and r_R, respectively, where

r_L is non-negative and r_R is zero. In this simple model, lending is the only source of profit for banks. The reserve requirement ratio is constant at α. In addition, the bank does not pay dividends but retains all profits obtained by deducting expenses and interest on deposits from the interest on loans. As a result, banks accumulate capital. The total demand of the borrower is expressed as the decreasing function $D(r_L)$ of r_L, and $r_L(L)$ is the inverse demand function. Based on these assumptions, the bank's profit maximization is as follows:

$$\max_L r_L(L)L - \Phi(L) - r_D D \tag{3.1}$$

$$s.\ t.\ L + R = D + C. \tag{3.2}$$

The left side of equation (3.2) indicates the bank's assets, and the right side indicates debt and equity. Funds procured through deposits and capital are managed through loans and reserves. Banks lend L_{max} to maximize profits. When a bank implements an L_{max} loan, if the funds raised $(1-\alpha)D+C_0$ are insufficient, the bank must raise its monetary deposits. The deposit at this time is D_{max} (the interest rate is raised in r_D). The profit is $r_L(L_{max})L_{max}-\Phi(L_{max})-r_D D_{max}$, and, from the assumption of retained earnings, this profit becomes capital. The level of L_{max} depends on the borrower's demand curve. Figure 1 shows the simple lending market in the model. In Figure 1, MC is marginal cost, and MR is marginal revenue. Figure 2 shows the relationship between bank capital and lending. When the loan amount is zero, the capital is the given amount, C_0 (C_0=$\Theta(0)$). When the loan amount is L_{max}, the capital amount is maximized, C_{max}. When the loan amount increases beyond L_{max}, the capital amount decreases. $\Theta(L)$ signifies a function regarding capital. Now let's assume that the bank is subject to capital regulation. Capital regulation such as the Basel Banking Regulation requires banks to have a minimum capital amount for risk-weighted assets. This capital regulation requires banks to secure at least a certain percentage of their risk-weighted assets. The ratio of capital to risk-weighted assets is called the capital adequacy ratio (CAR, which is denoted by γ). In this model, the only risk-weighted asset is loans. CAR can be expressed as follows:

$$\gamma = \frac{C}{L}. \tag{3.3}$$

If the minimum CAR stipulated by the capital regulation is γ_{min}, and the loans and capital at this time are expressed in L_{basel} and C_{basel}, respectively, the following is obtained.

$$\Theta(L_{basel}) = C_{basel} \tag{3.4}$$

$$\gamma_{min} = \frac{C_{basel}}{L_{basel}}. \tag{3.5}$$

The above implies that in the case of L_{basel} loans, CAR will be the minimum level required by regulations. In other words, if the loans exceed L_{basel}, the CAR will fall below the minimum CAR, making it impossible to lend above L_{basel} in order to comply with regulations. The following illustrates the effect that capital adequacy regulations have on banks' lending. Capital adequacy regulations are the most basic and powerful banking regulations. Under the Basel regulations, the minimum CAR required for international banks subject to Basel regulations (hereafter "banks subject to international standard") is 10.5%, and for domestic or regional banks subject to domestic regulations (hereafter "banks subject to domestic standard") it is 4.0%. In order for the minimum CAR to be met, it is assumed that the bank sets a safety margin and a higher capital adequacy target. When the target CAR and the safety margin ratio are expressed as γ_{target} and γ_{margin}, respectively, the relational expression with the minimum CAR (γ_{min}) is as follows:

$$\gamma_{target} = \gamma_{min} + \gamma_{margin}. \tag{3.6}$$

The capital corresponding to the loan L_{max}, which maximizes the bank's profit, is referred to as C_{max}, and the CAR is referred to as γ_{max}. If the target CAR is lower than the γ_{max} at the time of maximum profit, the bank will execute the loan L_{max} to achieve the γ_{max} as long as the minimum CAR stipulated by the regulations is met. On the other hand, if the target CAR is set at a level higher than γ_{max}, the loan L_{max} will be excessive, so it is necessary to restrain lending to L_{target}. This is expressed by the following formula:

$$L = \begin{cases} L_{max} & \gamma_{target} < \gamma_{max} \\ L_{target} & \gamma_{target} \geq \gamma_{max}, \end{cases} \tag{3.7}$$

$$\frac{C_{max}}{L_{max}} = \gamma_{max}, \quad \frac{C_{target}}{L_{target}} = \gamma_{target}.$$

Figure 3 illustrates the function of the capital regulation. The minimum CAR is fixed for both banks subject to international standard and domestic standard. On the other hand, the safety margin or safety margin rate varies from bank to bank. Conservative banks, or banks that anticipate contingent losses, will set a high target CAR with a large margin of safety. In addition, loans and disbursements will decrease if the minimum CAR is raised.

Figure 1: Monopoly lending market

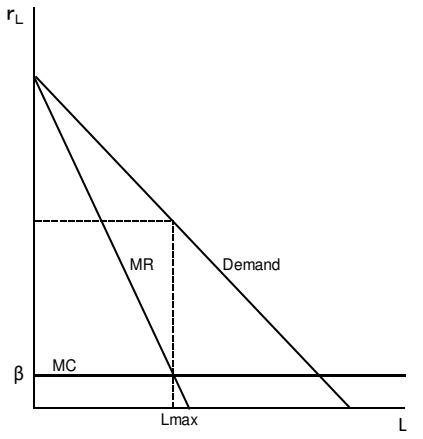


Figure 2: Capital and lending of the bank

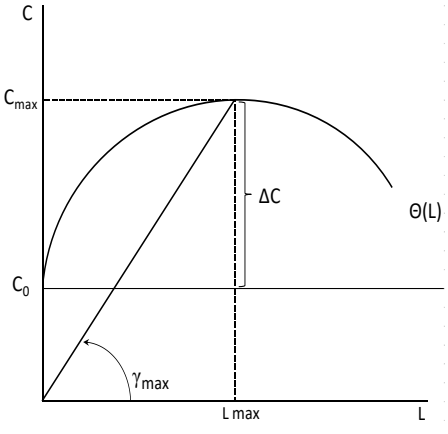


Figure 3: The impact of capital regulation

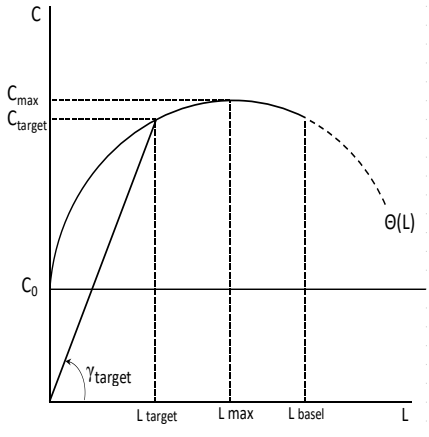
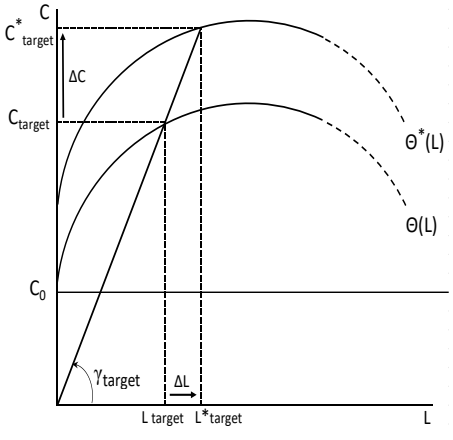


Figure 4: The recapitalization effect



4 MITIGATION OF CAPITAL REGURATION

This section shows that there are measures that banks can use to mitigate the lending restraint effect of capital regulation, for example by holding sovereign bonds. Because sovereign bonds have zero risk weight, they are not included as risk-weighted assets. The interest rate on sovereign bonds is denoted as r_B, and the interest income of $r_B B$ is earned for holding sovereign bond B. We assume that the deposit rate is very low and $r_D < r_B$ holds. Prior to holding sovereign bonds, banks have loans at L_{target} ($<L_{max}$), capital at C_{target} ($<C_{max}$), and capital adequacy ratios at γ_{target} ($>\gamma_{max}$). When sovereign bonds are issued, banks use the interest rate differential between deposit rates the sovereign bond rates ($r_B - r_D > 0$) to raise deposits and purchase sovereign bonds. Funds are raised at the interest rate r_D to purchase sovereign bonds, and the profits on sovereign bonds ($r_B B - r_D \Delta D$) are retained and become capital (Δ indicates a change in the balance). The reason that the deposits raised are not used for lending is that if the loans exceed L_{target}, risk-weighted assets will increase, and the CAR will fall below the target level. Sovereign bonds enable banks to enjoy the profits ($r_B B - r_D \Delta D$) without reducing their CARs. This effect increases as the interest rate differential between sovereign bonds and deposits increases. Banks then retain profits from holding sovereign bonds, which are added as capital. The additional profits associated with holding sovereign bonds are expected to promote capital accumulation, which is expected to have the effect of increasing lending. This movement is shown by the following equations (4.1), (4.2), and (4.3).

$$\Delta C = r_B B - r_D D \tag{4.1}$$

$$L + \Delta L = \frac{C + \Delta C}{\gamma_{target}} \tag{4.2}$$

$$B + L_{target} + \Delta L + R = C + \Delta C + D + \Delta D \tag{4.3}$$

Equation (4.1) shows the increase in capital associated with sovereign bond holdings, equation (4.2) shows the increase in loans, and equation (4.3) shows the bank's balance sheet taking into account sovereign bond holdings and increased lending. Figure 4 illustrates the recapitalization and lending increase from sovereign bond holdings. The recapitalization effect associated with sovereign bond ownership is expressed as an upward shift in the function $\Theta(L)$. This allows banks to increase their loans while maintaining their CARs at the target level γ_{target}. In addition, measures to relax capital regulation other than sovereign bond holdings include reserves deposited by banks with the central bank, loans to the government, and loans with good guarantees. Fees related to settlement, foreign exchange, M&A, asset management, consulting, etc. are also sources of income that do not involve risk-weighted assets.

On the other hand, during periods of low interest rates, more flexible capital regulation could encourage lending. If the financial authorities reduce the minimum CAR, the banks ' target CAR will also be lowered, and lending can be expected to increase. There is little discretion for individual financial authorities on important details such as the minimum capital adequacy ratio levels and the measurement of risk-weighted assets agreed to by the Basel Committee on Banking Supervision (BCBS), which is composed of the financial authorities of major countries. However, there is only one capital requirement within the capital regulations that can be adjusted by financial authorities at their own discretion. That is the counter-cyclical buffer (CCyB) introduced in Basel Ⅲ. The CCyB is adjusted by each country's financial authorities according to their economic conditions and is variable. Each financial authority has the discretion to determine the capital requirements sought in the CCyB between 0% and 2.5% of risk-weighted assets. The aim is to curb the amplitude of the business cycle by encouraging banks to build up capital and curb

lending during boom periods and to release capital and stimulate lending during recessions. However, although the CCyB framework has been introduced in Japan, it has been maintained at 0% since its introduction. Therefore, the CCyB cannot be launched for the purpose of lowering the minimum CAR. In addition, most banks in Japan are engaged mainly in domestic business, and since domestic banks are not covered by Basel Ⅲ, the CCyB is not applied in the first place. Therefore, we propose that the regulation be reviewed. For banks subject to international standard to which Basel Ⅲ applies, the CCyB can be adjusted from -2.5% to +2.5%. It is conceivable that the regulation could be revised in order to be adjusted within a wider range. On the other hand, banks subject to domestic standard, such as regional banks, can be regulated at the discretion of the financial authorities of their own countries, allowing for more flexible supervision than banks subject to international standard. Specifically, it is possible to change regulations on an individual basis in response to downward pressure on earnings due to capital constraints. For example, while maintaining the current minimum CAR of 4%, it is conceivable to flexibly operate the minimum CAR according to the earnings situation with the 1% portion being CCyB. By adjusting CCyB individually based on the economic environment surrounding each regional bank, the financial authorities are able to strike a balance between regional revitalization and prudence. Meanwhile, in Japan, the financial authorities are supporting the role of regional banks in revitalizing regional economies, and if CCyB is introduced to banks subject to domestic standard, it will be possible to operate in line with this policy. Applying a negative CCyB to banks subject to international standard and setting CCyB to 1% of the capital of banks subject to domestic standard will both provide flexibility to bank capital requirements without raising the minimum capital adequacy ratio from the current level. In this way, CCyB can be useful as a policy tool. The importance of utilizing CCyB as macroprudential policy is the same as that discussed in Rubio and Yao (2020). Table I summarizes measures to ease capital controls that lead to increased lending.

Table I: Mitigation measures against capital regulation

Mitigations	Effect
Holding sovereign bonds	Recapitalizing (Saving RWA)
Increase of fees and commissions	Recapitalizing (Saving RWA)
Issuance of stock	Recapitalizing directly
Reduction in dividend	Recapitalizing directly
Enhancing interest-bearing reserve	Recapitalizing (Saving RWA)
Increasing the flexibility of regulation	Deregulation directly

5 EMPIRICAL ANALYSIS

From the banking model in the previous section, the following predictions can be derived. (1) Sovereign bond-related profits raise and help maintain CARs at high levels; (2) The low interest rate environment weakens the capital enhancement effect of holding sovereign bonds, so the variation (standard deviation) in CARs among banks increases; and (3) in particular, the higher the dependence on sovereign bond-related earnings, the more difficult it is to control the CAR and the more likely it is to deviate from the industry average.

To test these predictions, this article uses financial data of individual banks from Nikkei NEEDS Financial Quest (FQ). Nikkei NEEDS-FQ uses longitudinal datasets from individual banks. Since capital regulation-related data such as CAR have been available since fiscal 1999, the sample data in this report covers the period from fiscal

Figure 5: Capital adequacy ratio

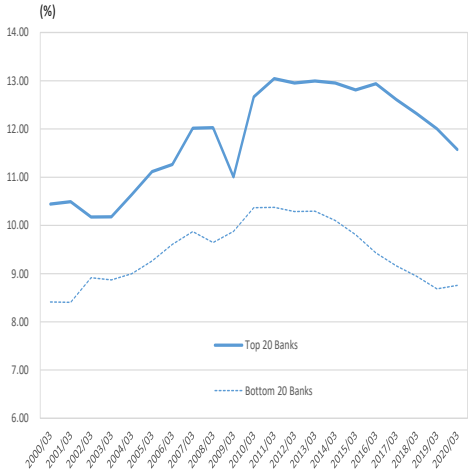
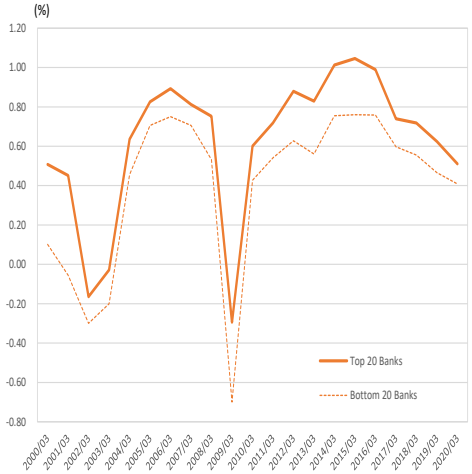


Figure 6: RORA



1999 to fiscal 2019. Sovereign bond-related income includes interest and trading gains and losses. Trading gains and losses can be captured in the income statement, but interest is mixed in with the dividends of all the securities. Therefore, interest and dividends on securities as a whole less dividends on stocks are considered to be interest on sovereign bonds. In addition, Nikkei NEEDS-FQ cannot grasp the stock dividend data of about half of the banks in Japan. In this study, we examined the financial statements of individual banks and constructed panel data. Banks without data on stock dividends were removed from the sample, and ultimately panel data on 60 regional banks was prepared. Linear interpolation was performed for missing values. The interest rate is based on the yield on the 5-year government bond, taking into account the maturity of the bank's assets and liabilities. To test the predictions, we first calculated sovereign bond-related revenues for all 60 sample banks and created groups of the top 20 and bottom 20 banks in terms of their share of sovereign bond-related revenues. Table II shows the key data for the average of 60 rows, the top 20 rows, and the bottom 20 rows.

There is a difference in CARs between the top 20 and bottom 20 banks. The average CAR of the top 20 banks is 11.82%, and the average of the bottom 20 banks is 9.43%. When the difference in the means is tested, it indicates that there is a difference at the significance level of 5%. The test results are consistent with prediction (1) that that higher revenues associated with sovereign debt will help banks control and maintain higher CARs. Furthermore, there is also a difference between the top 20 and the bottom 20 banks in the rate of return on ordinary income net of risk-weighted assets (RORA). In fact, a test of the difference in RORA means indicates that there is a difference at the 10% significance level. Therefore, the top 20 banks in terms of sovereign bond-related income are healthy (high CAR) and profitable (high RORA). If low interest rates weaken the effect of mitigating capital regulation, it will be more difficult for banks to control their CARs, and the standard deviation of CARs is expected to increase. Figure 7 shows a negative correlation between CARs and interest rates, especially at low interest rates where the yield on five-year government bonds is less than 0.5%.

Next, we categorized the CARs data as whether they were obtained in a low interest rate environment or not. Table III shows the dispersion of CARs in low interest rate environments with interest rates below 0.5 percent and CARs in non-low interest rate environments. The test for the difference in variance in both CARs indicates that there is a difference at the 5% level of significance. Therefore, prediction (2) of this article, that the standard deviation of equity capital increases in a low interest rate environment, can be said to be supported by data analysis.

If the low interest rate environment weakens the effect of mitigating capital reg-

Table II: Summary stastics

	Mean	S. D.	Minimum	Maximum	Period
Bank variables (all 60 banks)					
Interest revenue of sovereign bond	9,787	1,393	7,920	13,342	FY 1999-2019
Net profit on sales of sovereign bond	98	1,452	-4,327	2,193	FY 1999-2019
Sovereign bond-related earnings	9,800	1,673	4,688	12,552	FY 1999-2019
Revenue share of sovereign bond-related earnings	19.25	4.05	5.91	24.07	FY 1999-2019
Capital adequacy ratio (CAR)	10.45	0.76	9.34	11.55	FY 1999-2019
Bank variables (top 20 banks)					
Interest revenue of sovereign bond	15,294	2,109	13,054	21,308	FY 1999-2019
Net profit on sales of sovereign bond	403	1,998	-5,883	3,129	FY 1999-2019
Sovereign bond-related earnings	15,573	2,556	6,824	20,017	FY 1999-2019
Revenue share of sovereign bond-related earnings	27.24	5.33	8.28	33.09	FY 1999-2019
Capital adequacy ratio (CAR)	11.82	1.03	10.17	13.04	FY 1999-2019
Bank variables (bottom 20 banks)					
Interest revenue of sovereign bond	4,741	1,124	2,756	7,612	FY 1999-2019
Net profit on sales of sovereign bond	-351	1,000	-3,417	1,468	FY 1999-2019
Sovereign bond-related earnings	4,433	1,285	1,322	6,156	FY 1999-2019
Revenue share of sovereign bond-related earnings	11.68	3.64	1.23	16.87	FY 1999-2019
Capital adequacy ratio (CAR)	9.43	0.65	8.41	10.37	FY 1999-2019
Market variables					
5-year sovereign yield	0.46	0.45	-0.21	1.28	FY 1999-2019

Note: The unit of interest revenue of sovereign bond, net profit on sales of sovereign bond, and sovereign bond-related earnings is in millions of JPY. The unit of the other variables is the percentage.
Source: Prepared by author based on financial statements of banks

Figure 7: S.D. of CAR (all banks)

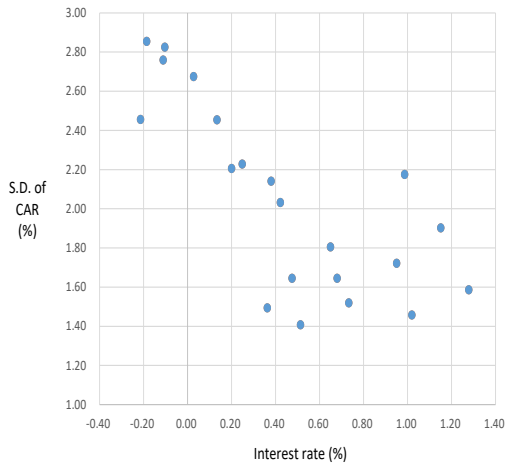


Figure 8: Difference in S.D. of CAR

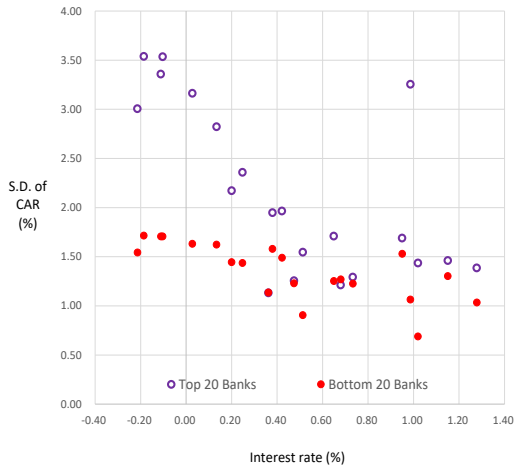


Table III: Variance of CARs

	Low interest rate	Not low interest rate
Observations	720	540
Variance	6.019	3.287

Note: A low interest rate environment is defined as a period in which the five-year sovereign bond yield is under 0.5 percent.
Source: Prepared by author based on financial statements of banks

ulation, banks that rely on sovereign bond-related earnings will have more difficulty controlling their capital. In this case, the negative correlation between the standard deviation of CARs and interest rates of the top 20 banks in terms of the share of sovereign bond-related returns is expected to be stronger than that of the bottom 20 banks. Figure 8 shows the negative correlation between the standard deviation of CARs and interest rates for the top 20 banks and the bottom 20 banks. In a low interest rate environment where 5-year Treasury yields are less than 0.5%, it is clear that the negative correlation between the top 20 banks is stronger than in the bottom 20 (the top 20 banks have a steeper negative slope). This difference can be said to support prediction (3). Therefore, the empirical analysis supports the three predictions based on the banking model under capital regulation.

6 CONCLUSIONS

This article uses a simple bank model to examine the effects of capital regulation on lending and the measures banks have to mitigate these effects. Although capital regulation restrains bank lending, banks have measures to mitigate the effects of regulation and can control their CARs while lending. However, a low interest rate environment weakens the mitigating effect of capital regulation through sovereign bond holdings. The results of the empirical analysis support the predictions based on our banking model. As interest rates become negative, the standard deviation of banks' CARs increases. The results of the empirical analysis suggest that a prolonged low interest rate environment risks undermining the health of the banking system. Banks' control of CAR can be compared to driving a car on a snowy road. Even on snowy roads, if drivers have snow tires and an anti-lock braking system, drivers can drive a car safely. However, if the road surface freezes completely, their equipment ceases to function and it is difficult to drive safely. Capital controls was snowy roads, and frozen roads was low interest rates.

Interpreting the results of the empirical analysis from a normative perspective, low interest rates and large standard deviations in banks' CARs can have asymmetrical effects on economic entities. For governments, corporations, and mortgage users who are borrowers of funds, low interest rates are desirable, and standard deviations of CARs between banks are not a major problem, but, for depositors, low interest rates mean less interest income, and large standard deviations in CARs mean that the safety of their deposits is threatened. The current Japanese economy is likely to impose significant costs on depositors. For banks as well, the decline in profitability and difficulty in controlling CARs due to low interest rates are management issues that may destabilize the financial system in the long term, which is not desirable.

The results of the analysis this article should be verified by a more sophisticated model. A more refined model may fit the data better.

Future research suggested by this article will may be able to address the issue of what can be done from a macroprudential perspective to prevent accommodative monetary policy from having a stronger effect on capital regulation thereby restrain-

ing bank lending. This article also suggests that a good combination of monetary and macroprudential policies could have synergistic effects. A combination of monetary policy that steepens the yield curve through central bank yield curve control (YCC) and macroprudential policy in which the monetary authority lowers the CCyB could be a powerful policy to encourage bank lending in a low interest rate environment.

The purpose of this article is to present the effectiveness of the flexible application of regulation, in addition to YCC, with respect to banks subject to domestic standard. The starting point for this analysis was the perception that macroprudence could be used not only to strengthen regulation, but also to achieve sustainable economic growth, after experiencing a prolonged environment of very low interest rates, declining local economies, and the Covid-19 pandemic. Of course, the author would like to reiterate that it is not simply about deregulation. It is hoped that such pro-growth prudential policies will be investigated by further empirical research.

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