The Impacts of Strengthening Regulatory Surveillance on Bank Behavior in Microprudential Policy *

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Abstract. This paper studies the impact of the strengthening bank capital regulation on bank heterogeneity in lending, capital accumulation, charter value, and default decisions. In a dynamic model of banks facing idiosyncratic profitability shocks, highly profitable and/or leveraged banks, in the short run, are more responsive to the strengthening capital regulation by decreasing lending and charter value (i.e., market value of capital), which temporarily leads to a credit crunch and a financial instability; however, in the long run, gradual accumulation of regulatory capital leads to the recovery from the credit crunch and the stability of the overall banking system is achieved. To test the short-run implications of our model, we utilize as a natural experiment the introduction of the prompt corrective action (PCA) program in Japan, which went into preliminary implementation in FY 1997 and requested banks to rigorously self assess their assets in order to lessen forbearance. Using difference-in-difference specifications, we find empirical support consistent with the theoretical predictions.

JEL classification: G01, G21, G28.

Keywords: regulatory surveillance; microprudential policy; prompt corrective action; bank capital ratio, capital crunch; financial stability.

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1. Introduction The 2007 through 2009 financial crisis has promoted a debate about bank regulation reforms, because the precrisis microprudential policies failed to function to cope with large financial shocks. The new Basel III regulations scheme a raise in bank capital requirements. In terms of preemptive microprudential policies for the stability of the banking system, there is an active debate about how to implement prompt corrective action (PCA) policies to reduce the costs of government's bank bailouts. This paper theoretically and empirically examines how the strengthening bank capital regulations affect bank behavior by addressing its impact on bank heterogeneity in lending, capital accumulation, charter value, and default decisions. Our study contributes not only to a paucity of theoretical literature analyzing microprudential regulation on bank capital requirements in heterogeneous dynamic models of banking (Corbae and D'Erasmo (2014) and De Nicolò et al. (2014)), but also to empirical literature analyzing its causal impact on bank behavior (see e.g. Bernanke and Lown (1991) and Peek and Rosengren (1995)).

In this paper, we begin by designing an equilibrium model consistently with standard corporate finance setups adapted to the peculiarities of banks (see Flannery (2012)). In these setups, three features characterize our model. First, we explicitly model the strength of financial agency's capital regulatory pressure as the degree of penalty that banks will suffer when they violate the capital regulation and are undercapitalized, while previous studies including De Nicolò et al. (2014) model the capital regulation as prudential one that is not violated. Thus, we analyze a potential role of regulatory surveillance in banks' behavior as well as stabilization of the banking system. Our model allows us to pin down banks' behavior before and after strengthening regulatory surveillance—e.g. introducing the PCA—such that the degree of penalty is set to a particular value. To our knowledges, this paper is the first one to explicitly model the strength of regulatory pressure as the degree of penalty. Second, we consider banks whose regulatory capital are not necessarily constrained to their capital requirements. Banks face idiosyncratic profitability shocks to their assets and equity issuance is costly due to informational asymmetries. In these environments, equity capital plays the role of absorbing losses that occur banks' assets and protects their charter value when negative shocks occur to their assets' valuation. To this end, we model the capital regulation as "occasionally binding" one, albeit previous studies except for Elizalde and Repullo (2007) and Corbae et al. (2014) model it as "always binding" one. Thus, our model allows us to analyze an equilibrium in which banks accumulate capital buffers by retaining their profits beyond a required capital due to their precautionary motives irrespective of whether the capital regulation is introduced or not. In this sense, our model can address the economic capital of banks (see Elizalde and Repullo (2007)). When regulatory surveillance gets stricter, banks increase their capital buffers in order not to violate capital requirements in the future. Based on this observation, we can identify how the introduction of the PCA changes the regulatory pressure by checking capital buffers banks increase after the introduction of the PCA.

Our dynamic heterogeneous model of banking derives the following theoretical insights into the impact of the strengthening bank capital regulations on bank behavior: in the short run, highly profitable banks with high leverage (who are more likely to violate capital requirements) respond to the strengthening capital regulation. They decrease lending more than lowly profitable banks with low leverage since high leverage banks try to meet capital requirements by contracting their lending. Some of them choose default since their charter value (market value of capital) drops below zero. In this way, strengthening surveillance can cause a capital crunch and a financial instability in the short run. However, in the long run, those banks accumulate their regulatory capital to the point in which they are not capital constrained any longer and the financial stability is achieved (banks' default rate of the post-PCA is smaller than that of the pre-PCA). In this way, accumulation of regulatory capital contributes to the stability of the overall banking system.

Next, we test the short-run implications of our dynamic model by utilizing as a natural experiment the introduction of the PCA program in Japan, which went into preliminary implementation in FY 1997—took full effect in April 1998—and requested banks to rigorously self assess their assets in order to lessen forbearance. Several empirical studies focusing on the direct link between explicit regulatory enforcement actions and the shrinkage of bank loans revealed that banks subject to the PCA reduced their loans at a significantly faster rate than those that were not (see Peek and Rosengren (1995) for U.S. case). Woo (2003) and Watanabe (2007) found empirical support for the capital crunch hypothesis in fiscal year 1997, or March 1998, by documenting a positive and statistically significant correlation between new lending growth and bank capital. These papers attributed their results to the fundamental changes in the Japanese financial system that year: an abatement of the moral hazard problem—when the government allowed a string of failures of high-profile financial institutions to take place—due to a substantial strengthening of the supervisory and regulatory framework and heightened scrutiny of the Japanese banks by the financial market (see also Ito and Harada (2005)). However, such attribution of the capital crunch to the strengthening bank capital regulations are not based on a formal theoretical prediction. Our theoretical predictions can establish the more formal lending channel of the strengthening capital regulations in terms of how they affect bank behavior including lending and capital building. Using the bank-firm loan-level matched data as well as the bank-level panel data, we employ difference-in-difference specifications and thereby find that the PCA decreased highly profitable and/or leveraged banks' lending and charter value more substantially among banks, albeit increasing all banks' regulatory capital and decreasing their charter value and loans in consistent with our theoretical predictions.

Our paper is organized as follows. Section 2 develops a microprudential model with heterogeneous banks and then derives theoretical implications regarding the causal impacts of the strengthening bank capital regulations on bank behavior. Section 3 explains our empirical design and dataset based on the PCA in Japan. Section 4 reports the results of our empirical analysis. Section 5 offers conclusions.

2. Theoretical Predictions In this section, we develop a microprudential model, with government's increasing surveillance pressure and bank's decision making including setting of its capital structure and lending.

2.1. **Environment** In the following, we model the banking sector based on De Nicolò et al. (2014) in order to study the relationship between the regulatory pressure of capital requirements and banks' behaviors.

At the end of period $t-1$, a bank with its equity e_t chooses the amount of dividends div_t to pay to the bankers (owners) and how much bank capital

$$n_t = e_t - div_t, \tag{1}$$

to hold in the next period. Notice that e_t is the bank's equity capital before the dividend distribution while n_t is the bank's equity capital after the dividend distribution. At the same time, banks choose how much deposits D_t to gather and make loans L_t so that the following balance sheet constraint is satisfied

$$L_t = n_t + D_t. \tag{2}$$

At the beginning of period t, an idiosyncratic shock z_{t+1} occurs to the quality of credits.[1] Banks facing the credit shocks choose whether they default and exit or repay and continue their businesses. If a bank defaults, its value is zero thanks to limited liability.

When making these choices, banks are subject to several constraints. In order to continue their business, banks must hold a positive amount of capital at the beginning of the period

$$n_t \geq 0. \tag{3}$$

Furthermore, banks are subject to the capital requirement,

$$\Phi_t \equiv \frac{n_t}{L_t} \geq \phi, \tag{4}$$

where Φ_t is the capital to the loans ratio and ϕ is the required capital ratio by policies. If this capital requirement is not satisfied, the bank incurs pecuniary costs PC, which amounts to

$$PC(\Phi_t) = \begin{cases} 0 & \text{if } \Phi_t \geq \phi, \\ \tau(\Phi_t - \phi)^2 & \text{if } \Phi_t < \phi. \end{cases}$$

This costs can be interpreted as penalty for violating the capital requirement by the regulatory authority. This cost is larger if the banks' capital ratio is deviated from the required level more as is expressed by a quadratic function of deviation $\Phi_t - \phi$. Hence, the amount

[1] In De Nicolò et al. (2014), this credit shock is an aggregate (systemic) shock. In this paper, however, this shock is treated as an idiosyncratic shock that makes banks different with each other.

of dividends div_t distributed to the bankers can be expressed as

$$div_t = e_t - n_t - PC(\Phi_t) \tag{5}$$

instead of the case without penalties, equation (1).

The bank's equity e_{t+1} at the end of the next period can be expressed as

$$e_{t+1} = E(L_t, D_t, z_{t+1}) = z_{t+1} f(L_t) - R^d D_t - k, \tag{6}$$

where $f(\cdot)$ is the revenue function of loans that satisfies $f(0) = 0$,$f > 0$,$f' > 0$, and $f'' < 0$ following De Nicolò et al. (2014), R^d is deposit rate, and k is the fixed cost of operating in the loan market. Credit shocks z_{t+1} are i.i.d across banks and follow an AR(1) process;

$$\log z_{t+1} = (1 - \rho)\ \overline{\log z} + \rho\ \log z_t + \epsilon_{t+1},$$

where $\epsilon_t \sim N(0, \sigma^2)$. In the later, we discretize this process by using the method of Tauchen (1986).

In period t, the bank's objective function is the expected discounted value of dividends

$$E_t \sum_{i=0}^{\infty} \beta^i \Theta(div_{t+i}), \tag{7}$$

where the expectation operator is for the process of credit shocks z_t, β is the bankers' discount factor, and $\Theta(\cdot)$ is the function for bank's dividend policy

$$\Theta(d) = \begin{cases} d & \text{if } d \geq 0, \\ d(1+a) & \text{if } d < 0. \end{cases} \tag{8}$$

Note that negative d is not dividends, but equity issuance (recapitalization) which is assumed to be costly as in Cooley and Quadrini (2001), Hennessy and Whited (2007), and Corbae and D'Erasmo (2014). The parameter a expresses how costly recapitalization is.

2.2. **Bank's Policy and Stationary Equilibrium** In this subsection, we describe bank's decision making and then define the corresponding stationary equilibrium.

2.2.1. **Bank Decision Making** At the end of the period t, a bank with equity capital e_t and idiosyncratic shock z_t solves the following problem

$$V(e_t, z_t) = \max_{div_t, L_t, D_t, n_t, \Phi_t} \Theta(div_t) + \beta \sum_{z_{t+1}} P(z_t|z_{t+1}) \max \left\{ \underbrace{V(e_{t+1}, z_{t+1})}_{\text{Repay}(x=0)}, \underbrace{0}_{\text{Default}(x=1)} \right\}, \quad (9)$$

subject to equations (2), (3), (4), (5), and (6), where $V(e_t, z_t)$ is the value of the bank and $P(z_t|z_{t+1})$ is the transition matrix of credit shocks from z_t to z_{t+1}. We define the default policy $x(e_t, z_t, z_{t+1})$ contingent on the realized credit shock z_{t+1} as

$$x(e_t, z_t, z_{t+1}) = \begin{cases} 0 & \text{Repay and Continue,} \\ 1 & \text{Default and Exit.} \end{cases} \quad (10)$$

Bank's other policies are expressed as the solutions of the above bank's decision problem;

$$div_t = div(e_t, z_t), \quad (11)$$

$$L_t = L(e_t, z_t), \quad (12)$$

$$D_t = D(e_t, z_t), \quad (13)$$

$$n_t = n(e_t, z_t), \quad (14)$$

$$\Phi_t = \Phi(e_t, z_t). \quad (15)$$

2.2.2. **Entrance of New Banks and Stationary Distribution** Let the distribution of credit shocks for entrants be denoted as $\psi(z)$. We assume $\psi(z)$ is an invariant distribution implied by the transition matrix $P(\cdot|\cdot)$. New entrants have zero equity capital, and they initially have to use costly external finance to raise capital. Let the mass of banks in the state (de, z_i) just after entry and exit occurs be denoted by $\zeta_t(de, z_i)$, and the mass of new entrants be denoted by B (see Figure 1 for the timing).[2] By using the policy functions

[2] We assume entry dynamics is invariant to the policy changes for simplicity in the later part. This can be justified by thinking that Japanese banking industry is strongly regulated and new entry to the banking sector hardly occurs. One of the possible extensions of the model is to endogenize the mass of new entrants by imposing the free entry condition as in Hopenhayn (1992).

above, we can express the law of motion of the distribution $\zeta_t(de, z_i)$ as

$$\zeta_{t+1}(de', z_j) = \int \sum_i P(z_i|z_j) \cdot \zeta_t(de, z_i) \cdot \mathrm{I}\{x(e, z_i, z_j) = 0\} \cdot \mathrm{I}\{de' \ni E(L(e, z_i), D(e, z_i), z_j)\} + B \cdot \mathrm{I}\{de' \ni 0\} \cdot \psi(z_j), \tag{16}$$

where $\mathrm{I}\{\cdot\}$ is an indicator function and $E(L, D, z)$ is the function in equation (6). The first term of the right hand side represents the distribution of incumbent banks and the second term represents new entrants. A stationary distribution is a distribution ζ^* satisfying $\zeta_{t+1} = \zeta_t = \zeta^*$ (invariant distribution).

2.2.3. **Definition of Stationary Equilibrium** In the following quantitative analysis, we solely focus on the stationary equilibrium. Given a capital requirement policy parameter ϕ, penalty for violation τ, banks' revenue function $f(\cdot)$, the process of credit shocks z_t, deposit rate R^d, and a mass of new entrants B, a stationary equilibrium of the banking industry is a set of

1. policy and value functions for banks $\{x(e, z, z'),\ div(e, z),\ L(e, z),\ D(e, z),\ n(e, z),\ \Phi(e, z)$, and $V(e, z)\}$ those satisfy banks' problem,
2. stationary distribution of banks $\zeta^*(e, z)$ implied by the above policy functions.

2.3. **Calibration and Model Implications** In this subsection, we illustrate the results of the calibration and simulation of the model to derive theoretical and cross-sectional predictions about strengthening regulatory surveillance.

2.3.1. **Credit Shock** First, we calibrate the dynamics of credit shock. Following De Nicolò et al. (2014), the shock process is proxied by the return on bank assets (ROA) before taxes; hence, z in the previous section corresponds to ROA. The sample period is fiscal years 1975-1996 until just before the preliminary implementation of the PCA in FY 1997—took full effect in April 1998—to Japanese commercial banks. We estimate the following AR(1) process of ROA_{it} for bank i in period t:

$$\log\mathrm{ROA}_{it} = (1 - \rho)\log\mathrm{ROA}_0 + \rho\log\mathrm{ROA}_{it-1} + \gamma_i + u_{it}, \tag{17}$$

where γ_i is bank fixed effects, and u_{it} is i.i.d. and distributed $N(0, \sigma)$. The result is shown in Table 1. Then, we apply the method of Tauchen (1986) to the AR(1) process in equation (17) in order to obtain a finite state Markov process $P(z_t|z_{t+1})$.

2.3.2. **Equity Issuance Cost and penalty by Capital Regulation** Next, we jointly calibrate the parameters, fixed cost (k), equity issuance cost (a), and penalty cost when they break capital requirement (τ). Let us denote the penalty costs before and after the strengthening bank capital regulation as τ_0 and τ_1 respectively ($\tau_0 < \tau_1$). We assume other parameters (economic conditions) did not change before and after the strengthening regulatory surveillance.

Table 2 shows how capital surplus (defined as capital ratio net required level) changes before and after the strengthening capital supervision: the preliminary implementation of the PCA in FY 1997 and the full effect in FY 1998. Note that because penalty from breaking requirements are weak before the strengthening of capital supervision, banks have relatively lower capital surplus (about 1%). After the capital supervison strengthens (and penalty becomes stricter), they accumulate their capital surplus gradually by retaining their profits and it reaches about 4% (much higher than 1% for the pre-strengthening). Our model assume that after the capital supervison strengthens, banks become unable to break capital requirememnts ($\tau_1 = \infty$). This means if their capital ratio is under regulatory required level, they should issue new equity (recapitalize) for which they should pay extra cost (a) in order to satisfy requirements. Under this assumption, we can calibrate fixed cost (k), equity issuance cost (a), and the penalty before the introduction of the PCA (τ_0) by targeting the banks' default rate, capital surplus after the introduction of the PCA, and the capital surplus before the introduction of the PCA, respectively. Tables 1 and 3 show model parameters and target moments.

2.3.3. **Banks' Value Functions and Policy Functions** Figures 2 to 6 show banks' value functions and policy functions for capital ratio, dividends, loan, and default decisions. There are two state variables, namely, equity capital e_t at the end of the period t, and the credit shock z_t. Hence, value functions and policy functions are functions of these two state variables. We discretize credit shocks z_t into 11 states (z_1,z_2,....,z_{11}) . z_1 is the worst (smallest) credit shock and z_{11} is the best (largest) credit shock. We show only the relevant value and policy functions for those states.

Figure 2 shows banks' value becomes smaller after the capital supervision strengthens; that is, penalty becomes stricter. This reduction is larger when banks have better credit shocks and smaller equity capital. For those banks, capital requirements are more likely to bind and damages from stricter penalty are larger. Banks' value can be interpreted as their charter value or market value of capital. Hence, this means strengthening supervision damages banks' charter value and increases their default incentives, which leads to a financial instability as we will see in short.

Figure 3 shows banks' decisions of capital ratio. When banks have good credit shocks (z_{11}), they break capital requirements before the bank capital supervision strengthens. They start to hold the smallest capital ratio they are required ($\phi = 0.08$) after the capital supervision strengthens. For banks with relatively worse credit shocks (z_8), capital requirements are not binding before the strengthening supervision. They start to accumulate more capital buffer after the supervision strengthens because they prevent the constraint from binding in the future. For those banks with worst credit shocks (z_1), their capital policy does not change even after the strengthening supervision of bank capital because they accumulate enough capital buffer before the strengthening supervision.

Figure 4 shows dividend policies before and after the bank capital supervision strengthens. Negative dividends means equity issuance. Before the bank capital supervision strengthens, banks with good credit shocks (z_{11}) tend to distribute their profits as dividends. As a result, they break capital requirements as shown in Figure 3. After the bank capital supervision strengthens, they retain their profits and accumulate their capital buffer in order to satisfy capital requirements (which corresponds to the plateau in the figure) in Figure 3. After they accumulate enough capital buffers, they start to distribute their dividends.

Figure 5 shows how policies of loans change before and after the bank capital supervision strengthens. Banks contract their credit supplies more seriously when they face better credit shocks and smaller equity capital. This is because for those banks capital requirements are more likely to bind and it is less costly for them to reduce their credit supplies rather than to issue new equity capital in order to satisfy capital requirements. Banks with worst credit shocks (z_1) hardly change their credit supplies because capital requirements are non-binding for them.

Figure 6 shows default policies of banks. Those banks with best credit shocks (z_{11}) never default because they have significant charter value (notice that their value in Figure 2 are greater than zero) in all the region of equity e_t we consider here. For other banks (z_1, z_8), their default thresholds shift toward right direction, which means they are more likely to default after the bank capital supervision strengthens. After the supervision strengthens, their charter value becomes smaller (as shown in Figure 2) so that they have less incentive to continue their businesses. This means just after the bank capital supervision strengthens, banking sector becomes temporarily vulnerable since banks' charter value is damaged and some of them prompt to default.

By contrast, in the long run, banks accumulate their capital buffers and become more stable than the pre-strengthening period. The first row of Table 4 shows default rate of banks in the steady state before and after the bank capital supervision strengthens. Apparently, default rate in the steady state decreases from 1% to 0.8% after the bank capital supervision strengthens.

2.3.4. **Stationary Distribution of Capital Ratio** Figure 7 shows stationary distribution of capital ratio before and after the bank capital supervision strengthens. Because of weaker penalties, many banks break capital regulation ($\phi = 0.08$) before the bank capital supervision strengthens. After the strengthening supervision in the PCA, many banks accumulate their capital and all banks satisfy capital regulation because penalty becomes quite large ($\tau_1 = \infty$).

2.4. **Theoretical Predictions and Cross-Sectional Insights** Based on the results for calibration thus far—to motivate our empirical analysis conducted in the next section—we can summarize cross-sectional insights about the causal impacts of the strengthening bank capital supervision on bank behavior as follows: 1) highly profitable and/or leveraged banks, in the short run, are more likely to respond to the strengthening capital regulation such that they more decrease charter value and lending, while all banks accumulate regulatory capital and decrease charter value and lending; 2) however, in the long run, such accumulation of regulatory capital leads to the stability of the overall banking system.

3. Experimental Design and Data Set In this section, we start by reviewing the prompt corrective action (PCA) program in Japan to utilize the PCA as a natural experiment to test our theoretical predictions about the causal impacts of the strengthening bank capital supervision on bank behavior. Then, we introduce a difference-in-difference specification for three bank outcome variables: regulatory capital ratios, franchise values, and bank loans.

3.1. **PCA in Japan: Increase in Regulatory Pressure in FY 1997** In this section, we review the PCA program in Japan to motivate empirical analyses in the following sections.

The Japanese authorities established under the "Law to Ensure Financial Institution Soundness" the PCA framework, loosely modeled after the American framework. The PCA, which was to take full effect in April 1998, went into preliminary implementation in FY 1997. The PCA has two main components.

First, it introduces a self-assessment process that holds the banks themselves responsible for valuing their assets on a prudent and realistic basis, according to well-defined guidelines. These procedures also require that the banks' own findings (including the necessary provisioning for loan losses and capital ratios) be subject to review by external auditors and inspection and monitoring by the bank examiners.

Second, the PCA also specifies the thresholds of the regulatory capital ratio under which the regulators can force the banks to take remedial actions. These remedial actions range from reduction of branches to reduction of dividends and liquidation in the case of insolvency. Also in FY 1997, the authorities announced the construction of the Financial Supervisory Agency (FSA) to take over the role of banking supervision from the Ministry of Finance. The FSA was granted autonomy and independence in order to allow the supervisors to operate more effectively. The FSA started its operation in April 1998.[3]

[3] Kanaya and Woo (2001) discusses evidence of regulatory forbearance that was made possible by the weakness in the regulatory framework before FY 1997. For example, the regulatory authorities, which had

By removing the possibility of discretionary forbearance on the part of bank supervisors, the PCA represented a significant strengthening of the existing regulatory framework at the time. As emphasized in in Woo (2003), Watanabe (2007), and Sekine and Watanabe (2018), combined with the creation of the FSA whose independence gave it a credibility which the Ministry of Finance lacked, the PCA could cause the weakly capitalized banks to take the capital adequacy requirement more seriously; consequently, it could trigger the credit crunch by these banks.

3.2. **Hypothesis and Difference-in-Difference Specification** As discussed in the above subsection, previous literature pointed out that the preliminary implementation of the PCA in FY 1997 increased regulatory pressure on Japanese banks. Based on the short-run implications of our dynamic model (see subsection 2.4), we empirically address the following three questions,

1. Did the increased regulatory pressure in FY 1997 lead to an increase in banks' regulatory capitals? If the answer is yes, did the capital increase depend on banks' holding of regulatory capitals and profitability of the pre-1997 period, or FY 1996?

2. Did the increased regulatory pressure in FY 1997 lead to a decrease in banks' franchise values? Furthermore, as predicted by our dynamic model, did lowly capitalized and/or profitable banks face more decreases in franchise values?

3. Did the increased regulatory pressure in FY 1997 cause a decrease in bank lending. Furthermore, as predicted by our dynamic model, did lowly capitalized and/or profitable banks face more decreases in bank lending?

To examine the causal impacts of the the increased regulatory pressure in FY 1997, we use difference-in-difference specifications. More concretely, we introduce the following

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the power to delicense banks, usually intervened only after banks had become insolvent. As shown by Skinner (2008), Japanese banks also used deferred tax assets to compensate for capital losses arising from unrealized losses on their stock holdings. They were able to do so because the government allowed them to account for their deferred tax assets as Tier I capital in 1998. Bank managers subjectively estimated their total deferred tax assets at their own discretion. The regulatory forbearance policy had allowed Japanese banks to engage in a "patching up" of their capital ratios before FY 1997 (see, e.g., Shrieves and Dahl (2003) and Nakashima and Takahashi (2018)).

difference-in-difference specification for the bank-level panel date

$$
\begin{aligned}
\mathrm{y}_{it} \;=\;& a_0 \;+\; a_1\mathrm{BUFFER}_{it-1} \;+\; a_2\mathrm{ROA}_{it-1} \;+\; a_3\mathrm{BUFFER}_{it-1} * \mathrm{ROA}_{it-1} \\
&+ a_4 t_{FY1997} \;+\; a_5\mathrm{BUFFER}_{it-1} * t_{FY1997} \;+\; a_6\mathrm{ROA} * t_{FY1997} \\
&+ a_6\mathrm{BUFFER}_{it-1} * \mathrm{ROA}_{it-1} * t_{FY1997} \;+\; a_7\mathrm{CONTROLS}_{it-1} \;+\; v_i + \; \varepsilon_{it},
\end{aligned} \tag{18}
$$

where the dependent variable, y_{it}, indicates bank i's four outcome variables for the two sample periods $t =$ FYs 1996 and 1997; that is, regulatory capital adequacy ratios, regulatory capital buffers, the market capital ratios, and the growth rate of the total amount of loans outstanding. Regulatory capital buffers are defined as the difference between bank's reported capital adequacy ratios and its regulatory target ratio (8% for international banks and 4% for domestic banks). We use the bank market capital ratio as a proxy of bank franchise values (Sarin and Summers (2016)). The bank market capital ratio is defined as the market value of a bank's equity divided by the market value of its total assets, where the market value of a bank's total assets is defined as the sum of the market value of its equity and the book value of its total liabilities. We calculate the market value of equity by multiplying the end-of-year stock price by the number of shares.

Observable explanatory variables, BUFFER_{it-1} and ROA_{it-1}, denote one-period-lagged values of the regulatory capital buffers and return on assets for bank i, respectively. These two variables are supposed to capture the adequacy of bank capital and profitability at the pre-1997 period, or FY 1996. $\mathrm{CONTROLS}_{it-1}$ denote one-period-lagged values of other control variables: logarithmic values of total assets SIZE_{it-1}, the indicator variable regarding whether bank i has overseas branches $\mathrm{OVERSEA}_{it-1}$, and Tobin's q TOBINQ_{it-1}. Tobin's q is defined as the ratio of the market value of bank i to its book value, where the market value is defined as the sum of the market value of its equity and the book value of its total liabilities. μ_i denotes bank i's time-invariant fixed effects and t indicates time dummies. ε_{it} is the stochastic disturbance term.

As for the use of the bank-firm loan-level matched data, we introduce the following difference-in-difference specification for the bank loan equation,

$$\begin{aligned}\Delta\text{LOAN}_{it}^{j} \;=\;& a_0 \;+\; a_1\text{BUFFER}_{it-1} \;+\; a_2\text{ROA}_{it-1} \;+\; a_3\text{BUFFER}_{it-1} * \text{ROA}_{it-1} \\ &+ a_4\text{BUFFER}_{it-1} * t_{FY1997} \;+\; a_5\text{ROA} * t_{FY1997} \\ &+ a_6\text{BUFFER}_{it-1} * \text{ROA}_{it-1} * t_{FY1997} \;+\; a_7\text{CONTROLS}_{it-1} \\ &+ a_8\text{RELATIONS}_{it-1}^{j} \;+\; v_i + u_{jt} \;+\; \varepsilon_{it}^{j}, \qquad (19)\end{aligned}$$

where the dependent variable, $\Delta\text{LOAN}_{it}^{j}$, indicates the growth rate of the total amount of loans outstanding between bank i and domestic listed firm j for the two sample periods $t =$ FYs 1996 to 1997.

The loan-level equation (19) additionally includes as control variables one-period lags of two relationship variables $\text{RELATIONS}_{it-1}^{j}$: lending exposure LEXP_{it-1}^{j} and borrowing exposure BEXP_{it-1}^{j}. The lending exposure is defined as loans from bank i to firm j divided by the total loans of bank i. The borrowing exposure is defined in the same manner, as loans from bank i to firm j divided by the total borrowings of firm j. v_i denotes bank i's time-invariant fixed effects to control for its time-invariant unobservables, while u_{jt} denotes firm j's time-varying fixed effects, or $\text{YEAR}_t * u_j$ with time dummies (YEAR_t), to control for the borrowing firm's total demand factors at each sample period t. ε_{it}^{j} is the stochastic disturbance term.

Again note that to control for borrower-side factors in the bank loan equation (19) with u_{jt}, we employ the fixed-effects approach proposed by Khwaja and Mian (2008) and Jiménez et al. (2012; 2014). The fixed-effects approach assumes that all potential borrower-side factors are embodied in time-varying firm unobservables, which are captured by time*firm fixed effects (u_{jt}).[4]

3.3. **Estimation Method** To estimate the difference-in-difference specification (18) with the two-way fixed effects, we employ the conventional within estimation method for

[4] Hosono and Miyakawa (2014), Nakashima (2016), and Nakashima et al. (2019) employed this fixed-effects approach with Japanese loan-level matched data. Hosono and Miyakawa (2014) and Nakashima et al. (2019) identified the effects of unconventional monetary policies on bank loan supply, while Nakashima (2016) examined the effects of Japan's public capital injections on bank lending.

the bank panel date of the sample period t = FYs 1996 and 1997.

As for estimation of the bank loan equation (19) with the three-way fixed-effects, our matched lender–borrower sample is based on a continuation of the lending relationship. According to the literature on relationship banking, the continuation of a bank–firm relationship depends on both the bank's and the firm's characteristics (Ongena and Smith (2001) and Nakashima and Takahashi (2019)). In other words, we must address the survivorship bias that may arise from nonrandom assortative matching between banks and firms. To correct for survivorship bias, we employ Heckman's (1979) two-stage regression technique. In the first stage, we conduct a probit regression of relationship survival. Then, in the second stage, we employ the estimate method developed by Abowd et al. (1999) and Andrews et al. (2008) for the regression of the difference-in-difference specification of the bank loan equation (19) with the three-way fixed-effects.[5]

Our probit regression includes one-period lags of four banks' characteristics such as the market leverage ratio, six firms' characteristics such as the interest coverage ratio, and three relationship factors such as the duration of the relationship between lender i and borrowing firm j. We estimate the probit regression for the continuation of bank–firm relationships and then estimate the second-stage regression of the bank lending equation with the inverse Mills ratio. To take into account the possibility that the coefficients of the variables in the probit model are time-varying, as pointed out by Nakashima and Takahashi (2019), we conduct a estimation of the probit model year by year: that is, t = FYs 1996 and 1997. The details of the estimation results are shown in Appendix.

3.4. **Dataset** Our data come from two sources. First, bank-level panel data are from Nikkei Digital Media Inc. The data are annual and based on financial statements reported by Japanese banks for the full year (ending in March of calender year $t + 1$) of their fiscal year (hereafter FY) t, with our regression samples covering the period from FY 1996 to FY 1997. For our analysis, we include loans from Japanese city, trust, regional and mutual banks. The sample size for our analysis is 232 with 116 Japanese banks listed on any

[5] This estimation method gives consistent and unbiased parameter estimates not only for time-varying observables, but also unobserved fixed effects. See Abowd et al. (1999) and Andrews et al. (2008) for more details.

Japanese stock exchange. Table 4 provides summary statistics for our bank-level panel data.

The second source of data is matched bank-firm loan data from the Corporate Borrowings from Financial Institutions Database compiled by Nikkei Digital Media Inc. The data are annual and report short-term loans (with a maturity of one year or less) and long-term ones (with a maturity of more than one year) from each financial institution for every listed company on any Japanese stock exchange, which we sum to obtain total amount of loans outstanding. Our loan measure comprises all loans received from each financial institution for about 2,500 firms per year. When combining the bank-level panel data, we use the fiscal year-end reports by banks on March 31.

Our difficulty in working with the loan-level data was sorting through bank mergers and restructuring in our data. We thoroughly recorded all the date of bankruptcies and mergers that took place in Japanese banking sector. Whenever a bank ceases to exist in out data because of a bankruptcy, firms cease reporting that financial institution as a source of loans. If we could not find any information on a bankruptcy or a merger, we filled in the zero loan data in our data. On the other hand, if we could find evidence of a bankruptcy or a merger and firms reported loans coming from a restructured bank as coming from the prior bank, we recoded these loans as coming from the restructured bank. In order to calculate the loan growth of a restructured bank, we trace all the banks that predated it. Thus, if banks A and B merged in year t to form bank C, bank C's loans in year $t-1$ would be set equal to the sum of the loans of banks A and B, and the growth rate of bank C's loans in year t would be calculated accordingly.

The loan-level data cover about 110 banks, about 2,500 listed firms and about 20,000 relations per year. Our data set does not include all SMEs but covers approximately 70% of the total loans of the Japanese banking sector for our sample period from FY 1996 through FY 1997. The number of observations is 42,907. Table 5 provides summary statistics for our loan-level matched data.

4. Empirical Results In this section, we report estimation results. Tables 6 to 8 show results for difference-in-difference regressions (18) and (19).

Table 6 reports results for the causal impacts on banks' regulatory capital building.

t_{FY1997} has significantly positive coefficients, indicating that the preliminary implementation of the PCA in FY 1997, or the increasing regulatory capital pressure in FY 1997, caused Japanese banks' building of regulatory capital, as also observed in Table 2. This result does not depend on the use of the level (the left column) and the buffer of regulatory capital (the right column) as the outcome variable. Also note that the interaction term, $\text{BUFFER}_{it-1} * t_{FY1997}$, has significantly negative coefficients, implying that high leveraged banks—banks with low regulatory capital ratios—were more likely to be engage in capital building in the increasing regulatory capital pressure in FY 1997.

Table 7 shows estimated impacts on banks' market capital ratios, which is a proxy of banks' franchise value. t_{FY1997} has a significantly negative coefficient. This implies that the preliminary implementation of the PCA in FY 1997 drove down banks' franchise value. In addition, $\text{BUFFER}_{it-1} * t_{FY1997}$ has a positive coefficient, $\text{ROA}_{it-1} * t_{FY1997}$ has a negative coefficient, and $\text{BUFFER}_{it-1} * \text{ROA}_{it-1} * t_{FY1997}$ has a positive coefficient, indicating that high leveraged and/or profitable banks were more likely to face a decrease in their franchise value. These results for banks' market capital ratios are consistent with our theoretical prediction.

Table 8 reports estimated impacts on bank lending behavior obtained using the bank-level specification (the left column) and the loan-level specification (the right column). In the bank-level specification, t_{FY1997} has a significantly negative coefficient. This implies that the preliminary implementation of the PCA in FY 1997, or the increasing regulatory capital pressure, reduced bank credit. Furthermore, $\text{BUFFER}_{it-1} * t_{FY1997}$ has a positive coefficient, $\text{ROA}_{it-1} * t_{FY1997}$ has a negative coefficient, and $\text{BUFFER}_{it-1} * \text{ROA}_{it-1} * t_{FY1997}$ has a positive coefficient, indicating that high leveraged and/or profitable banks were more likely to cut their credit in the increasing regulatory capital pressure in FY 1997. Also note that $\text{BUFFER}_{it-1} * \text{ROA}_{it-1}$ has a negative coefficient, which implies that high leveraged-profitable banks were more likely to lend in FY 1996 before the increasing regulatory pressure; however, the increasing regulatory pressure in the PCA has a more substantially negative impact on lending by such high leveraged-profitable banks.

Summing up our empirical results, the preliminary implementation of the PCA in FY1997, or the increasing regulatory capital pressure in Japan, decreased high leveraged and/or profitable banks' lending and charter value more substantially among banks, albeit increasing all banks' regulatory capital and decreasing their charter value and loans in consistent with our theoretical predictions.

5. Conclusion This paper studies the impact of the strengthening bank capital regulation on bank heterogeneity in lending, capital accumulation, charter value, and default decisions. In a dynamic model of banks facing idiosyncratic credit quality shocks, high leveraged and/or profitable banks, in the short run, are more likely to respond to the strengthening capital regulation. They decrease charter value and lending more than low leveraged and/or profitable banks, while all banks accumulate regulatory capital and decrease charter value and lending; however, in the long run, gradual accumulation of regulatory capital leads to the stability of the overall banking system.

To test the short-run implications of our model, we utilize as a natural experiment the introduction of the prompt corrective action (PCA) program in Japan, which went into preliminary implementation in FY 1997—took full effect in April 1998—and requested banks to rigorously self assess their assets. Using difference-in-difference specifications, we find that the PCA decreased high leveraged and/or profitable banks' lending and charter value more substantially among banks, albeit increasing all banks' regulatory capital in consistent with our theoretical predictions.

Appendix: Estimation Results for Relation Survival Probability In Subsection 3.3, we included the inverse Mills ratio in the bank loan model to control for survival bias. In this Appendix, we show the estimation results of the probit model, which is used to calculate the inverse Mills ratio.

As the literature on relationship banking pointed out, the continuation of a bank–firm relationship depends on both the bank's and the firm's characteristics. Our probit regression includes one-period lags of banks' market leverage ratio (MARCAP_{it-1}), return on assets (BROA_{it-1}), size (BSIZE_{it-1}), and the number of firm that have lending–borrowing relationships with bank i (NUMBB_{it-1}). Firm characteristics include one-period lags of firms' book leverage ratio (FBLEV_{jt-1}), return on assets (FROA_{jt-1}), interest coverage ratio (FICR_{jt-1}), size (FSIZE_{jt-1}), and the number of banks that have relationships with firm

j (NUMBF_{jt-1}). To control for the firm-level attributes, we also include dummy variables for the industries to which firms belong. In addition to the bank–firm characteristics, our probit regression includes one-period lags of bank i's lending exposure to firm j (LEXP^j_{it-1}), firm j's borrowing exposure to bank i (BEXP^j_{it-1}), and the duration of the relationship between lender i and borrowing firm j (DURAT^j_{it-1}) as relationship factors. We conduct rolling estimation of the probit model year-by-year to incorporate time-varying effects of each variable. This year-by-year estimation means that we do not need to include time dummies.

Table A shows the estimation results and indicates that a higher borrowing and lending exposure and a longer duration of relationships are associated with a higher probability of the continuation of relationships. Furthermore, firms with higher profitability tend to continue their relationships with lending banks. A lower firm's interest coverage ratio implies a higher probability of the continuation of the relationship, which suggests that firms with a high dependence on debt funding tend to continue their relationships with banks. We should also note that higher bank leverage was associated with a lower probability of the continuation of relationships in the late 1990s. This suggests that in the late 1990s, a capital crunch occurred in terms of relationship termination, as pointed out by Nakashima and Takahashi (2019). Overall, dependence on debt finance and higher firm profitability, and higher borrowing and lending exposure are associated with higher probability of relationship continuation.

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Table 2: Summary of Capital Surplus
(Capital Ratio Net Required Level)

Fiscal Year	Mean (%)	Number of Banks
1994	.91079137	139
1995	1.1691304	138
1996	.97183823	136
1997	3.142406	133
1998	3.391	130
1999	4.4944776	134
2000	4.0996297	135

Table 1: Model Parameters

Parameter		Value	Target (Source)
Deposit Rate	R^d	0	DeNicolo et al. (2014)
Discount Factor of Bankers	β	0.95	Cost of Bank Capital 5% (DeNicolo et al. (2014))
Revenue Function of Loans	$f(x)$	$x^{0.9}$	DeNicolo et al. (2014)
Capital Requirement	ϕ	0.08	Basel Accords
Persistency of i.d. Shock	ρ	0.76	Panel Data on ROA (FYs 1975-1996)
Std. Dev. of i.d. Shock	σ	0.15	panel data on ROA (FYs 1975-1996)
Mean of i.d. Shock	$\overline{\log z}$	0.27	Panel Data on ROA (FYs 1975-1996)
Fixed Cost	k	1.03	Annual Bank's Default Rate 1%
Equity Issuance Cost	a	0.38	Capital Surplus after PCA 4%
Punishment before PCA	τ_0	30	Capital Surplus before PCA 1%
Punishment after PCA	τ_1	∞	Assumption

Table 3: Model and Target Moments

Moment	Target	Model
Default Rate of Banks (%)	1	0.8
Capital Surplus after PCA (%)	4	4.5
Capital Surplus before PCA (%)	1	1.1

Table 4: Default rate for the steady state

	Before PCA ($\tau = \tau_0$)	After PCA ($\tau = \infty$)
Default Rate of Banks (%)	1.2	0.8

Table 4: Summary Statistics for Bank-level Data:
Fiscal Years 1996 - 1997

Variables		Total Sample					Fiscal Year 1996					Fiscal Year 1997				
		Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Outcome Variables	Regulatory Capital Ratio_{it}	232	8.235	2.373	0.660	13.61	116	7.826	2.568	2.850	13.61	116	8.648	2.092	0.660	13.56
	BUFFER_{it}	232	2.092	1.914	-5.010	9.480	116	1.070	1.145	-5.010	5.610	116	3.123	1.983	-3.340	9.480
	Market Capital Ratio_{it}	232	4.595	1.966	0.010	13.98	116	4.810	1.900	0.745	10.71	116	4.037	2.015	0.011	13.98
	ΔLOAN_{it}	232	0.050	0.044	-0.298	0.235	116	0.062	0.042	-0.297	0.235	116	0.038	0.045	-0.184	0.123
Control Variables	ROA_{it-1}	232	-0.137	1.078	-16.22	0.436	116	-0.058	0.522	-2.186	0.436	116	-0.214	1.427	-16.21	0.262
	SIZE_{it-1}	232	14.62	1.355	11.94	18.17	116	14.60	1.352	11.94	17.80	116	14.63	1.362	11.98	18.17
	OVERSEA_{it-1}	232	0.982	0.182	0.000	1.000	116	0.100	0.159	0.000	1.000	116	0.091	0.198	0.000	1.000
	TOBINQ_{it-1}	232	101.9	2.373	97.93	115.2	116	102.5	2.833	98.83	115.2	116	101.3	1.619	97.93	107.9

Notes: See Subsection 3.2 for the definition of each variable.

Table 5: Summary Statistics for Loan-level Data: Fiscal Years 1996 - 1997

Variables		Total Sample					Fiscal Year 1996					Fiscal Year 1997				
		Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Dependent Variable	$\Delta LOAN^j_{it}$	42907	0.178	2.252	-0.999	276.2	21453	0.209	1.987	-0.999	100	21454	0.147	2.498	-0.996	276.2
Factor of bank i	$BUFFER_{it-1}$	42907	1.720	1.544	-5.010	9.480	21453	1.129	1.131	-5.010	5.610	21454	2.332	1.670	-3.340	9.480
	ROA_{it-1}	42907	-0.178	0.529	-16.21	0.649	21453	-0.020	0.368	-2.186	0.436	21454	-0.344	0.614	-16.21	0.649
	$SIZE_{it-1}$	42907	16.71	1.275	11.53	18.17	21453	16.67	1.259	11.53	17.95	21454	16.75	1.289	11.98	18.17
	$OVERSEA_{it-1}$	42907	0.173	0.136	0.000	1.000	21453	0.178	0.132	0.000	1.000	21454	0.169	1.40	0.000	1.000
	$TOBINQ_{it-1}$	42907	104.0	3.355	97.93	123.8	21453	105.3	3.827	98.76	123.8	21454	102.8	2.230	97.93	123.8
Relationship Factor of lender i and borrower j	$LEXP^j_{it-1}$	42907	0.600	2.660	0.000	100.0	21453	0.623	2.724	0.000	92.30	21454	0.578	2.596	0.000	100.0
	$BEXP^j_{it-1}$	42907	10.12	12.80	0.002	100.0	21453	9.698	12.37	0.002	100.0	21454	10.51	13.17	0.003	100.0

Notes: See Subsection 3.2 for the definition of each variable.

Table 6: Estimated Impacts on Regulatory Capital Ratio

	Level	Buffer
BUFFER_{it-1}	0.257	0.123
	(0.188)	(0.331)
ROA_{it-1}	-0.614	-0.260
	(0.506)	(0.893)
$\text{BUFFER}_{it-1} * \text{ROA}_{it-1}$	0.764**	0.123
	(0.346)	(0.289)
t_{FY1997}	1.253***	2.674***
	(0.190)	(0.335)
$\text{BUFFER}_{it-1} * t_{\text{FY1997}}$	-0.321***	-0.450**
	(0.119)	(0.210)
$\text{ROA}_{it-1} * t_{\text{FY1997}}$	-0.585	0.670
	(0.576)	(1.017)
$\text{BUFFER}_{it-1} * \text{ROA}_{it-1} * t_{\text{FY1997}}$	-0.586	0.670
	(0.576)	(1.017)
SIZE_{it-1}	3.523	3.957
	(3.450)	(6.084)
OVERSEA_{it-1}	-0.485	-0.436
	(0.788)	(1.390)
TOBINQ_{it-1}	0.056	0.223*
	(0.073)	(0.129)
Constant	-50.81	-81.10
	(54.40)	(95.93)
N	232	232

Notes: This table shows results for the difference-in-difference regression (18). ***, **, * indicate 1%, 5% and 10% levels of significance, respectively. Robust standard errors are in parentheses.

Table 7: Estimated Impacts on Market Capital Ratio

	Market Capital Ratio
BUFFER_{it-1}	0.230
	(0.145)
ROA_{it-1}	0.207
	(0.388)
$\text{BUFFER}_{it-1} * \text{ROA}_{it-1}$	-0.339
	(0.258)
t_{FY1997}	-0.452***
	(0.147)
$\text{BUFFER}_{it-1} * t_{\text{FY1997}}$	0.251***
	(0.093)
$\text{ROA}_{it-1} * t_{\text{FY1997}}$	-0.719*
	(0.376)
$\text{BUFFER}_{it-1} * \text{ROA}_{it-1} * t_{\text{FY1997}}$	0.543**
	(0.237)
SIZE_{it-1}	1.359
	(2.584)
OVERSEA_{it-1}	0.356
	(0.612)
TOBINQ_{it-1}	0.249**
	(0.057)
Constant	-41.58
	(40.93)
N	232

Notes: This table shows results for the difference-in-difference regression (18). ***, **, * indicate 1%, 5% and 10% levels of significance, respectively. Robust standard errors are in parentheses.

Table 8: Estimated Impacts on Bank Lending in Bank- and Loan-Level Specifications

	Bank-level Spec.	Loan-level Spec.
BUFFER_{it-1}	-0.856	-0.922
	(0.625)	(0.616)
ROA_{it-1}	-0.655	-0.325
	(1.629)	(1.262)
$\text{BUFFER}_{it-1} * \text{ROA}_{it-1}$	-2.529**	-3.490***
	(1.108)	(0.810)
t_{FY1997}	-0.503**	
	(0.232)	
$\text{BUFFER}_{it-1} * t_{\text{FY1997}}$	0.464	0.810**
	(0.400)	(0.405)
$\text{ROA}_{it-1} * t_{\text{FY1997}}$	-3.148*	-3.354***
	(1.885)	(1.012)
$\text{BUFFER}_{it-1} * \text{ROA}_{it-1} * t_{\text{FY1997}}$	2.816***	3.232***
	(1.017)	(0.682)
SIZE_{it-1}	17.28	11.66***
	(11.08)	(2.415)
OVERSEA_{it-1}	-0.303	3.000
	(2.628)	(3.162)
TOBINQ_{it-1}	1.130***	2.844***
	(0.247)	(0.100)
LEXP^{j}_{it-1}		-0.064
		(0.090)
BEXP^{j}_{it-1}		0.078***
		(0.012)
Inverse Mills Ratio^{j}_{it}		-0.801***
		(0.142)
Constant	-372.8***	-221.4**
	(175.4)	(111.4)
N	232	42907

Notes: This table shows results for the difference-in-difference regressions (18) and (19). ***, **, * indicate 1%, 5% and 10% levels of significance, respectively. Robust standard errors are in parentheses.

Table A: Results for the Survivorship Model of Bank–Firm Relationships

Fiscal Year	1996	1997
MARCAP_{it-1}	-0.0590^{***}	-0.0222^{*}
	(-6.03)	(-1.69)
BSIZE_{it-1}	0.212^{***}	0.0997^{**}
	(5.16)	(2.17)
BROA_{it-1}	0.128^{***}	0.0539^{**}
	(4.97)	(2.54)
FLEV^{j}_{t-1}	0.0145^{***}	0.000600
	(5.97)	(0.24)
FSIZE^{j}_{t-1}	0.106	0.364^{***}
	(1.31)	(3.91)
FROA^{j}_{t-1}	0.00908^{***}	0.00101
	(3.34)	(0.62)
FICR^{j}_{t-1}	0.00000177^{**}	-0.000000292
	(2.34)	(-0.22)
DURAT	0.0127^{***}	0.00977^{***}
	(7.79)	(6.20)
EXPL^{j}_{it-1}	0.000290	0.0732^{***}
	(0.05)	(6.44)
EXPB^{j}_{it-1}	0.0142^{***}	0.00871^{***}
	(12.92)	(8.71)
NUMBL_{it-1}	0.299^{***}	0.231^{***}
	(9.54)	(7.43)
NUMBB^{j}_{t-1}	-0.187^{***}	-0.00246
	(-4.35)	(-0.05)
N	21453	21454

Notes: This table shows the estimation results of the model with industry fixed effects. The dependent variable is the survival dummy variable, which equals one if the borrower–lender relationship continues in year t and zero otherwise. See also Appendix for details on our variable definition. We also include five-year moving average values of the firm ROA, interest coverage ratio, book leverage ratio, and size to control for time-varying firm fixed effects. The estimated coefficients are not shown in the table. *, **, and *** denote significance at levels of 0.10, 0.05, and 0.01, respectively. t statistics are in parentheses.

Figure 1: **Balance Sheet and Timeline for a Bank**

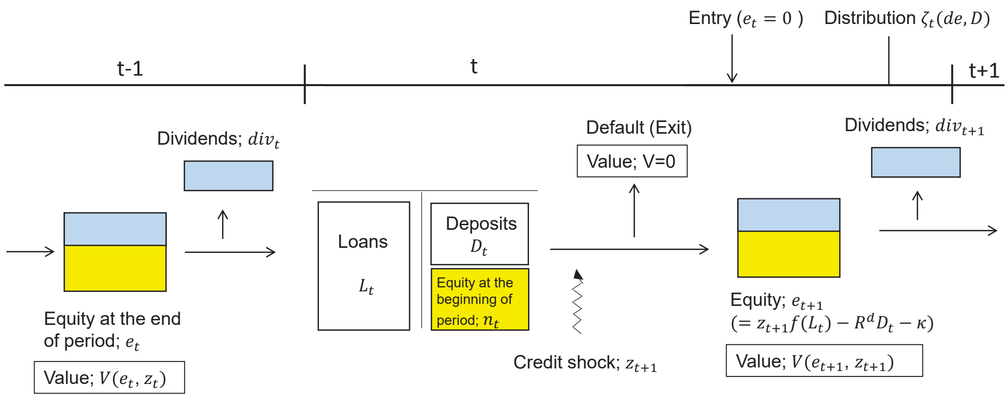

Figure 2: **Value Functions**

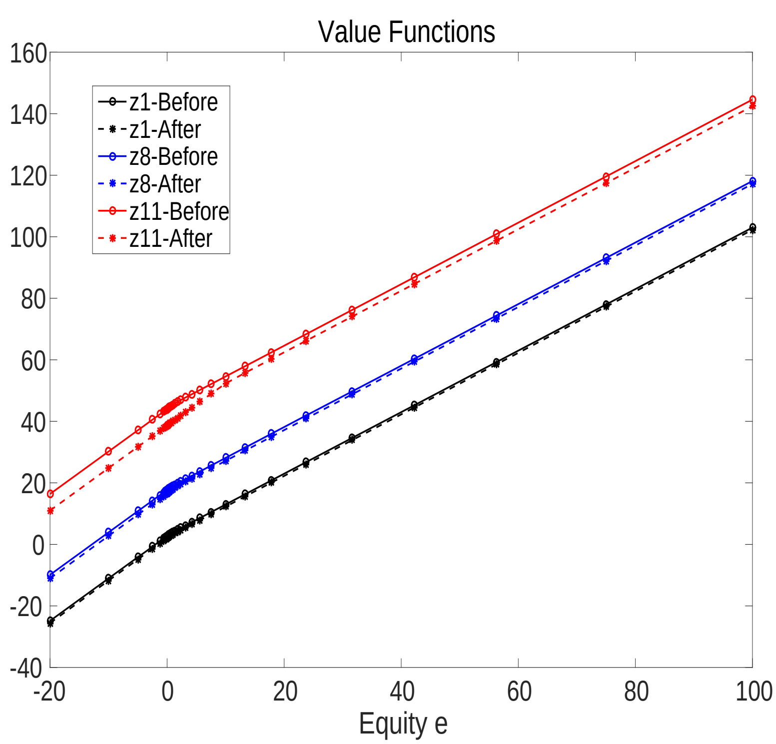

Figure 3: **Capital Ratio Decisions**

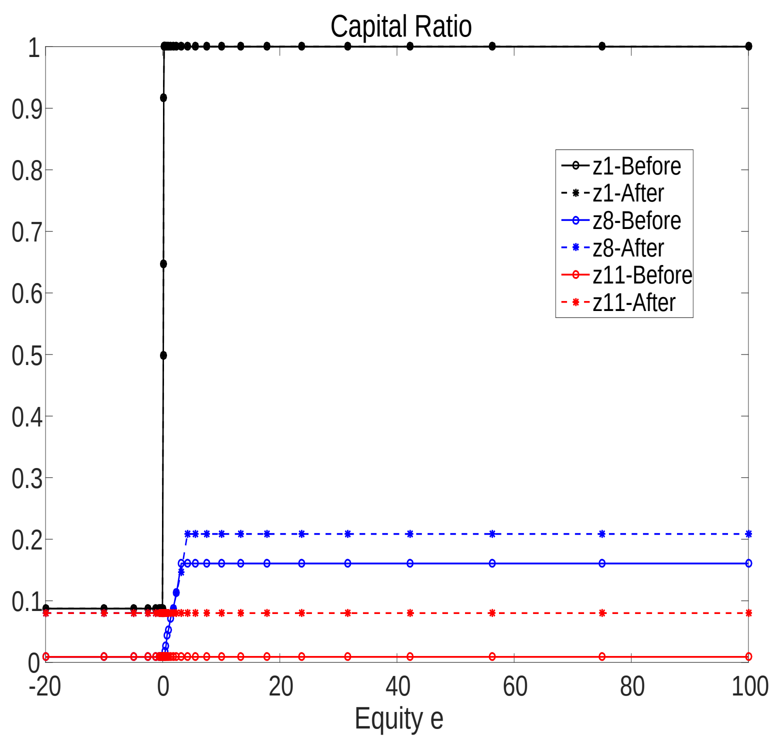

Figure 4: **Dividend Decisions**

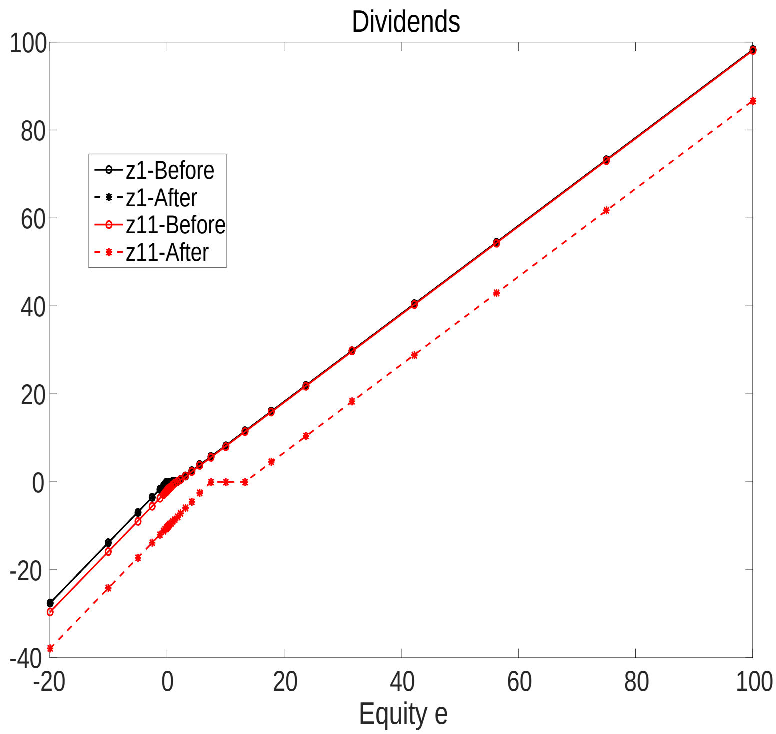

Figure 5: **Loan Decisions (Log)**

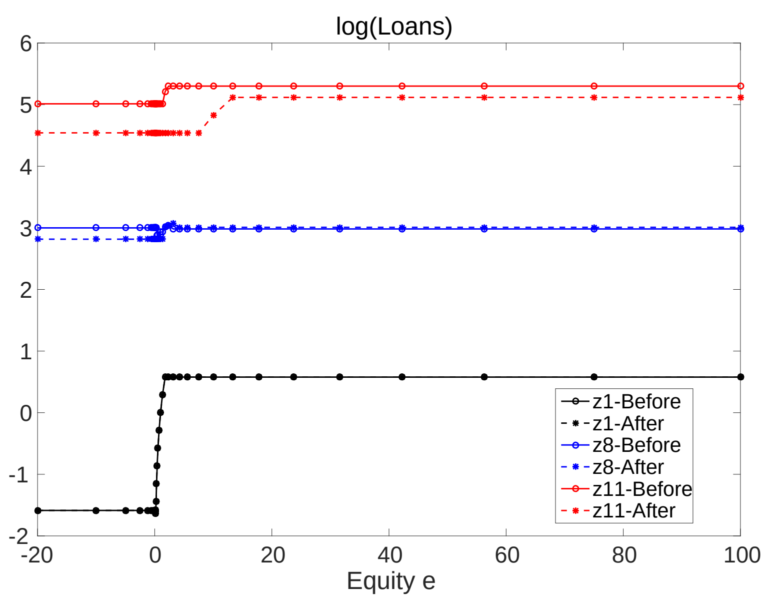

Figure 6: **Default Decisions**

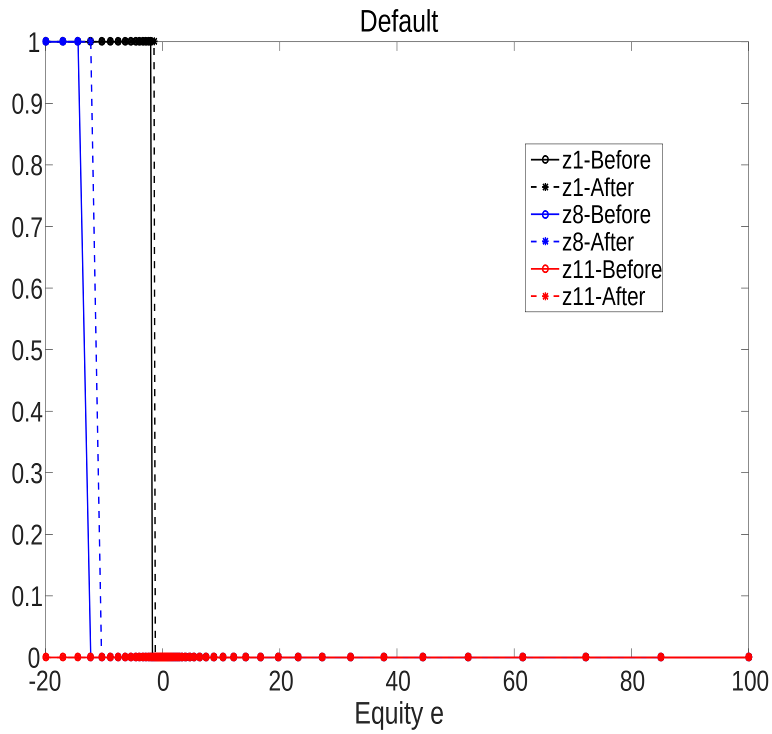

Figure 7: **Stationary Distribution of Capital Ratio Before and After Strengthening Capital Surveillance**