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Evidence from Indonesia

by

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Do Banks Respond to Capital Requirement?

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Abstract

Using dynamic panel data models, we examine the effect of capital requirement on banks' behavior in Indonesia. We find inconclusive results. Some banks tend to comply with capital requirement: They increase their capital ratio when their CAR is lower than, or falling towards, the eight percent regulatory minimum. However, most of our results are statistically significant at 20-30% level of significance only. Moreover, our results are mostly driven by private domestic banks and heavily-undercapitalized banks that were closely monitored by regulator in the aftermath of the 1998 crisis. Whether, in normal circumstances, banks in developing countries like Indonesia comply with capital requirement, therefore, remains questionable. This implies that, if regulators in developing countries continue relying on capital regulation, they would also need to improve their supervision capacity, increase the transparency of financial reporting, and strengthen market monitoring of banks.

Keywords: banking crisis, capital requirement, bank regulation, dynamic panel data
JEL classification: C23, G21, G28

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1 Introduction

This paper examines the effect of capital requirement on banks' behavior in Indonesia. We focus on the case of a developing country to see how this regulation fares in an environment where prudential regulation may not be as effective as that in the developed world.

The central question is whether banks in developing countries like Indonesia comply with capital requirement. Do banks increase their capital adequacy ratio (CAR)—the ratio between bank's capital and its risk-weighted assets—when the ratio is lower than, or approaching the regulatory minimum? How do they increase capital ratios: by increasing capital or reducing risk? Do sufficiently capitalized- and undercapitalized banks behave differently?

Regulator imposes capital requirement on banks to control banks' risk-taking. Following the Basel Accord, regulator typically requires banks to hold capital at least 8% of their risk-weighted assets.[1] Banks may or may not invest in high-risk assets; but if they do so, they have to commit sufficient amount of capital on the line.

Banks facing capital requirement, however, may not behave as regulator wants them to. At the outset, risk-based capital requirement could work well if the risk-weightings capture the true banks' business risk. Some argue that asset-risk classifications of the Basel Accord are too coarse so that, to take more risk and maintain capital ratio, banks may shift their portfolios from low-risk to high-risk assets within each risk category. Moreover, if banks' franchise value is low, banks may gamble for resurrection today to comply with the capital requirement tomorrow.[2]

On the other hand, if regulatory penalties are severe and raising capital in-

[1] See Basel (2003) for a detailed description of Basel's risk-based capital requirement.
[2] See Santos (2001) for a theoretical literature review of bank capital regulation.

stantaneously is costly, banks may hold a buffer of excess capital to reduce the probability of having capital ratio falls below the minimum requirement. Whenever banks' capital falls below a threshold, which may still be higher than the minimum requirement, banks increase their capital ratio by raising capital or reducing risk.[3]

To estimate the effect of capital requirement on banks' behavior, we regress banks' capital and risk on an indicator for regulatory pressure and a set of control variables using dynamic panel data models. The coefficient of regulatory pressure dummy—equals one for banks which are under regulatory pressure to comply with the capital regulation and zero otherwise—would then measure how banks, constrained by capital requirement, choose their capital and risk.

We build upon the partial adjustment model developed by Shrieves and Dahl (1992).[4] However, we depart from this literature in three ways. First, we argue that the system of two equations of banks' capital and risk typically estimated in this line of literature are not autonomous. Therefore, estimating the model using simultaneous equation approach is inappropriate. Second, we use panel data analysis so that we could control for banks' heterogeneity better. To the best of our knowledge, except Heid, Porath and Stolz (2004), empirical works in the literature so far have been using pooled data analysis. Third, assuming that banks' business entity remains the same during the period of analysis, and banks would therefore have the same target capital and risk levels, we could eliminate the unobservable banks' internal target capital- and risk levels by differencing. In the literature, these unobservable target levels are approximated by a number of proxies.

We find inconclusive results. Banks tend to comply with capital requirement:

[3] See, for example, Milne and Whalley (2001) and Milne (2002).

[4] For this line of literature, see for example Jacques and Nigro (1997) and Aggarwal and Jacques (1998), which—like Shrieves and Dahl (1992)—examine US' banks. Rime (2001) analyzes banks in Switzerland, while Kleff and Weber (2005) and Heid, Porath and Stolz (2004) look at Germany's banks.

They increase their CAR when the ratio is lower than, or falling towards, the 8% regulatory minimum. Banks whose CAR below 8% do so primarily by raising capital, while banks whose CAR are approaching the 8% minimum from above prefer reducing risk rather than increasing capital.

However, most of our results are statistically significant at 20-30% level of significance only. Moreover, our results are mostly driven by private domestic banks and heavily-undercapitalized banks that were closely monitored by regulator in the aftermath of the 1998 crisis. Whether, in normal circumstances, Indonesian banks comply with capital requirement, therefore, remains questionable.

These results shed light on how banks in developing countries respond to capital requirement. In contrast to the findings in the literature that banks in developed countries comply with capital requirement, we do not find similarly strong evidence of compliance in Indonesia: Statistically, banks that are under pressure from regulator to increase their CAR behave just like adequately capitalized banks. This may imply that, if regulators in developing countries continue relying on capital regulation, they would need to improve their supervision capacity, increase the transparency of financial reporting, and strengthen market monitoring of banks.

This paper proceeds follows: In Section 2 we describe capital requirement in Indonesia. Section 3 presents the methodology. Section 4 describes the data and Section 5 discusses empirical results. In Section 6 we present robustness checks. Section 7 concludes.

2 Capital Requirement in Indonesia

On paper, capital requirement has been the backbone of Indonesia's prudential regulation since 1991 when Indonesia adopted the newly minted Basel Accord. The central bank, Bank Indonesia, which is also the regulator, requires banks to maintain capital at least 8% of risk-weighted assets. Along with other prudential regulations, regulator also imposes prompt corrective action (PCA)—the quantitative-rating system based on banks' capital, asset, management, equity, and liquidity (CAMEL)—on Indonesian banks. [5]

However, in practice, regulator had not always been able to enforce prudential regulations, including capital requirement. Financial crises in the 1990s forced regulator to forbear capital requirement several times. Suharto's administration often interfered and prevented regulator from closing failed-banks. Bogus accounting was the norm, and non-compliance was rarely penalized. Besides, according to public opinions, Bank Indonesia then had yet to acquire experience and technical skills in banking regulation and supervision.

The turning point of bank regulation in Indonesia was the 1998 financial crisis. Once again, Bank Indonesia forborne prudential regulation. This time however many banks were closed, some were merged, and others had to recapitalize themselves to avoid closing. More importantly, as part of the International Monetary Fund's sponsored economic reforms, a new central banking law was enacted, and this law enabled Bank Indonesia to be more independent.[6]

Since then, Bank Indonesia has strengthened a number of prudential regulations, including a new and more thorough financial reporting system. It also is building its capacity to regulate and supervise banks.

[5] The PCA follows the 1991 US Federal Deposit Insurance Corporation Act.

[6] See Pangestu and Habir (2002) for a brief summary on the 1998 banking crises and the subsequent bank restructuring.

3 Methodology

3.1 Model Specification

The literature following Shrieves and Dahl (1992) models the observed changes in banks' capital and risk as the sum of banks' discretionary adjustment and exogenous shocks to capital and risk as follows:

$$\Delta Capital_{it} = \Delta^{d} Capital_{it} + Ec_{it} \quad (1)$$

$$\Delta Risk_{it} = \Delta^{d} Risk_{it} + Er_{it} \quad (2)$$

where $\Delta Capital_{it}$ and $\Delta Risk_{it}$ are respectively the observed changes in bank i's capital and risk in period t respectively; $\Delta^{d} Capital_{it}$ and $\Delta^{d} Risk_{it}$ are bank i's discretionary changes in capital and risk in period t; and Ec_{it} and Er_{it} are exogenous shocks to banks i's capital and risk in period t.

To recognize that banks may not be able to adjust their desired capital and risk instantaneously, Shrieves and Dahl (1992) assume that the discretionary changes in banks' capital and risk are proportional to the difference between banks' target capital and risk levels and their corresponding values in the previous period, i.e.:

$$\Delta^{d} Capital_{it} = \beta_1 \left(Capital^{*}_{it} - Capital_{it-1} \right) \quad (3)$$

$$\Delta^{d} Risk_{it} = \beta_2 \left(Risk^{*}_{it} - Risk_{it-1} \right) \quad (4)$$

where $Capital^{*}_{it}$ and $Risk^{*}_{it}$ are bank i's target capital and risk levels respectively.

Substituting these two equations into Equations (1) and (2), the equations for the observed changes in banks' capital and risk then become

$$\Delta Capital_{it} = \beta_1 \left(Capital^{*}_{it} - Capital_{it-1} \right) + Ec_{it} \quad (5)$$

$$\Delta Risk_{it} = \beta_2 \left(Risk^{*}_{it} - Risk_{it-1} \right) + Er_{it} \quad (6)$$

The observed changes in banks' capital and risk are therefore a function of target capital or risk level, lagged capital or risk, and some exogenous variables. The coefficient β is the speed of adjustment—it measures how fast banks adjust their current capital or risk to the corresponding target level.

They then derive regression models for observed changes in capital and risk from the capital equation, Equation (5), and risk equation, Equation (6). First, the banks' target capital and risk levels, $Capital^*_{it}$ and $Risk^*_{it}$, are not observed, and have to be approximated. Second, appealing to the theoretical literature that banks may choose capital and risk simultaneously, they put a measure of risk on the right hand side of the capital equation and capital on the right hand side of the risk equation. Third, banks that are under regulatory pressure to comply with the capital requirement may be forced to increase capital or reduce risk more than adequately capitalized banks. To capture this idea, they introduce an indicator for regulatory pressure Reg_{it-1}as an additional explanatory variable. It equals one if bank i at time $t-1$ is under regulatory pressure and zero otherwise.

They then specify the working regressions as follows:

$$\Delta Capital_{it} = \alpha_{01} + \alpha_1 Reg_{it-1} - \beta_1 Capital_{it-1} + \gamma_1 \mathbf{x}_{it} + \xi_1 \Delta Risk_{it} + \epsilon_{it} \quad (7)$$

$$\Delta Risk_{it} = \alpha_{02} + \alpha_2 Reg_{it-1} - \beta_2 Risk_{it-1} + \gamma_2 \mathbf{x}_{it} + \xi_2 \Delta Capital_{it} + \xi_{it} \quad (8)$$

which are usually estimated using simultaneous equation methods.

We depart from this approach in three ways. First, we recognize that banks determine the combination of $Capital_{it}$ and $Risk_{it}$ simultaneously. However, because the equations are not autonomous, introducing $\Delta Capital_{it}$ and $\Delta Risk_{it}$ in the right hand sides of Equation (7) and (8), respectively, is not appropriate.[7] These equations would be meaningless because there is no way to examine what happens to changes in banks' capital, $\Delta Capital_{it}$, if bank i is under regulatory pressure (Reg_{it-1} equals one) holding the change in banks' risk, $\Delta Risk_{it}$, constant. Starting from

[7]According to Wooldridge (2002), this inappropriate use of simultaneous equation models is quite common in the empirical literature.

Equations (5) and (6), our capital and risk equations are therefore as follows:

$$\Delta Capital_{it} = \alpha_1 Reg_{it-1} + \beta_1 \left(Capital^*_{it} - Capital_{it-1}\right) + \gamma_1 \mathbf{x}_{it} + \delta'_i + \lambda_t + \epsilon_{it} \quad (9)$$

$$\Delta Risk_{it} = \alpha_2 Reg_{it-1} + \beta_2 \left(Risk^*_{it} - Risk_{it-1}\right) + \gamma_2 \mathbf{x}_{it} + \mu'_i + \nu_t + \xi_{it} \quad (10)$$

where $\Delta Capital_{it}$ and $\Delta Risk_{it}$ are the observed changes in bank i's capital and risk in period t respectively; Reg_{it-1} is a dummy variable equals one if bank i in period $t-1$ is under regulatory pressure to comply with the capital requirement; $Capital^*_{it}$ and $\Delta Risk^*_{it}$ are bank i's target capital and risk levels in period t respectively; $\mathbf{x}_{it}$ is a vector of characteristics of bank i at time t; δ'_i and μ'_i are bank i's fixed effects, and λ_t and ν_t are time-effects at time t; the error term ϵ_{it} and ξ_{it} are bank time-varying errors, assumed to be distributed independently of δ'_i and λ_t and μ'_i and ν_t respectively.

Second, taking advantage of the panel structure of our data, we could control for time-invariant banks' characteristics more explicitly by introducing banks' fixed effects in addition to the vector of control variables $\mathbf{x}_{it}$.

Third, rather than approximating banks' target levels by a number of proxies, we assume that, during the period of our analysis, after controlling for banks' characteristics, banks' business entity remains the same and therefore banks would have the same target capital and risk levels. Target capital and risk levels then become time-invariants $Capital^*_i$ and $Risk^*_i$ respectively, and therefore submerge into banks' fixed effects, respectively δ'_i and μ'_i. The capital and risk equations become:

$$\Delta Capital_{it} = \alpha_1 Reg_{it-1} - \beta_1 Capital_{it-1} + \gamma_1 \mathbf{x}_{it} + \delta_i + \lambda_t + \epsilon_{it} \quad (11)$$

$$\Delta Risk_{it} = \alpha_2 Reg_{it-1} - \beta_2 Risk_{it-1} + \gamma_2 \mathbf{x}_{it} + \mu_i + \nu_t + \xi_{it} \quad (12)$$

where the fixed effects δ_i and μ_i replace $(\delta'_i + \beta_1 CAP^*_i)$ and $(\mu'_i + \beta_2 CAP^*_i)$ respectively.

To facilitate standard estimation, we modify Equation (11) and (12) by adding CAP_{it-1} to both sides of Equation (11) and $RISK_{it-1}$ to both sides of Equation (12). Our specification then simplifies into standard dynamic panel data models, i.e.:

$$Capital_{it} = \alpha_1 Reg_{it-1} + (1-\beta_1)\, Capital_{it-1} + \gamma_1 \mathbf{x}_{it} + \delta_i + \lambda_t + \epsilon_{it} \quad (13)$$

$$Risk_{it} = \alpha_2 Reg_{it-1} + (1-\beta_2)\, Risk_{it-1} + \gamma_2 \mathbf{x}_{it} + \mu_i + \nu_t + \xi_{it} \quad (14)$$

We proceed as follows: First, to see how banks choose capital ratio, the combination of both *Capital* and *Risk*, we estimate a similar regression in which we use capital ratio, CAR, as the dependent variable as follows:

$$CAR_{it} = \alpha_3 Reg_{it-1} + (1-\beta_3)\, CAR_{it-1} + \gamma_3 \mathbf{x}_{it} + \varphi_i + \psi_t + \omega_{it} \quad (15)$$

where $CAR = Capital \ / \ Risk$.

Then, to examine how banks comply with the capital requirement, by increasing capital or reducing risk, we estimate Equations (13) and (14). Unlike past works, we do not use simultaneous equation models, however. Rather, we estimate the capital and risk equations separately without controlling for risk and capital, respectively, in each equation.

3.2 Hypotheses

We take as the null hypotheses that banks under regulatory pressure behave like those which are not. We therefore state our main hypothesis as follows:

H1 : *Regulatory pressure to comply with the capital requirement does not affect banks' capital decision.*

H2 : *Regulatory pressure does not affect banks' risk decision.*

Our primary interest is therefore the significance and magnitude of the αs—the coefficients of REG_{it-1} in Equations (13-15). Large positive α_1 and α_3, and negative α_2 would be against our hypothesis, i.e. banks that are under regulatory pressure to comply with the capital requirement would raise more capital or reduce more risk compared to adequately capitalized banks.

We also expect $(1-\beta)$, the coefficient of lagged dependent variable, to be positive. From these estimates we could then get the speed of capital- and risk adjustment, β. Positive estimates of speed of adjustment suggest that banks adjust its capital and risk towards its own target capital- and risk levels over time. The larger the β, the faster banks adjust their capital or risk toward the target levels.

Among banks' characteristics in the vector of control variables $\mathbf{x}_{it}$ are banks' size and income. Larger banks may need to raise larger capital and reduce larger risk ceteris paribus. The more profitable banks may be able to raise larger capital and reduce more risk, though these banks could afford higher risk too.

3.3 Method of Estimation

We estimate the basic regressions in Equations (13-15) using dynamic panel data technique, i.e. both Arellano and Bond (1991)'s first-differenced GMM estimator and Blundell and Bond (1998)'s system GMM estimator.

To eliminate the individual effects, we first take the first-difference of the models. Then we instrument all endogenous- and pre-determined variables by a set of instrumental variables.

Arellano and Bond (1991) suggest that we use entire lagged of endogenous- and pre-determined variables as instruments and then estimate the model using Generalized Method of Moments (GMM). Because the number of period (T) in our sample is 19 and the number of group (N) is about 130, should we use the entire lag, the number of instruments would be large. To avoid having biased estimates because of too many instruments, we therefore present the results using two- and three lagged of endogenous variables and one- and two lagged of pre-determined variables only.

Because the lagged level may be poor instruments for first difference, Blundell and Bond (1998) further propose adding the lagged-differences of endogenous and pre-determined variables as instruments. For the same reasons like the above, we present the results of system GMM using two- and three lagged of endogenous variables and one- and two lagged of pre-determined variables only. Because the two-step estimates of standard errors may be severely downward-biased, we use the finite-sample correction of covariance matrix derived by Windmeijer (2005).

We also present the results of fixed effect and OLS for our basic specifications to see whether the coefficients of lagged dependent variable of GMM estimators are biased.

4 Data

We use the quarterly financial statement of Indonesian banking industry provided by the Bank Indonesia's Department of Banking Statistics. The dataset consists of quarterly financial reports of about 130 banks over more than four-year period since the fourth quarter of 2000 to the second quarter of 2005. It covers all commercial banks in Indonesia, and, because Indonesia's capital markets are still quite small, this data represents a large portion of Indonesia's financial industry. It excludes, however, the typically small Indonesia's saving and loan institutions (*Bank Perkreditan Rakyat*).[8]

[8] A few banks do not submit financial reports for a number of quarters. These missing observations however are a small proportion of our sample and therefore would not affect our results much. At the time we process the dataset, some banks have not reported their financial statement for the last quarter in our sample, the second quarter of 2005.

This financial statement provides detailed financial information about each bank. In particular, it provides banks' assets and liabilities as well as their capital, risk-weighted assets, and CAR which are important in analyzing the effect of capital requirement on bank behavior.

There are six types of bank ownership. Our sample for the year of 2001, for example, includes 5 state-owned banks, 35 large private-domestic banks, 37 small private-domestic banks, 26 regional-development banks, 18 joint-venture banks, and 11 foreign-owned banks.[9] State-owned banks are among the largest, followed by large private-domestic banks and small private-domestic banks. The largest eight banks have 80% of Indonesia's banking assets. Except state banks and a few large-private domestic banks, most other banks are quite small.

Despite the apparent heterogeneity of banks, for our basic specifications, we keep all banks in our sample. Later, to see the robustness of our results, we focus on some more homogenous groups of banks.

4.1 Capital and Risk

As a measure of capital, we use the amount of capital banks reports in their financial statement (*Capital*).[10] In the literature, capital ratios—capital to assets ratio or capital to risk-weighted asset ratio—are more popular. However, because we want to examine whether banks under regulatory pressure would increase capital, we think *Capital* is better than capital ratios. Besides, we also control for banks' size using the value of banks' assets in our regressions. Moreover, we also estimate a regression in which we use banks' CAR as the dependent variable.

[9] Large private-domestic banks may trade foreign currencies while small private-domestic banks may not. Regional development banks are owned by provincial governments, and therefore are like state banks though they are typically small. Joint venture banks are joint ventures between domestic- and foreign owners. Foreign banks are owned by foreign investors.

[10] Bank Indonesia's definition of capital follows Basel Accord (Basel, 2003).

As a measure of risk, we use banks' risk-weighted assets (*Risk*).[11] Obviously, risk-weighted assets are not a perfect measure of banks' risk. First, it assumes that the risk-weightings correctly capture the risk of different types of assets. Secondly, as some people have argued, the weightings are too coarse so that using *Risk* as a measure of risk ignores banks' preference putting their assets in the most risky assets in each asset category.

Unfortunately, our data does not give us a better measure of banks' risk, and, for that matter, capital. At least, we believe that *Capital* and *Risk* are highly correlated with the true banks' capital and risk, respectively. Moreover, regulator also uses these two measures to enforce capital requirement. This paper would then offer a look into how banks respond to capital requirement the regulator imposes on them.

4.2 Regulatory Pressure

We use two types of measures for regulatory pressure *Reg*. The simplest one is PCA measure of regulatory pressure, *RegPCA*, an indicator equals one if banks' CAR is less than the minimum capital requirement set by regulator and zero otherwise.[12] The coefficient of this variable captures how much banks would increase or decrease their capital compared to adequately capitalized banks should the bank's CAR falls below the minimum requirement.

The second one is the probabilistic measure of regulatory pressure, *RegPROB*. This measure takes into account that banks' CAR is volatile. Therefore, to avoid failing to meet the legal requirement, banks may set a higher minimum CAR threshold for themselves. We define *RegPROB* equals one if banks' CAR is below some

[11] Again, we do not use risk ratio, the ratio of risk-weighted assets to total assets, for the same reason that we do not use capital ratio.

[12] Normally, the minimum capital requirement is 8%. However, in the aftermath of the crises until 2001, central bank requires 4% minimum capital requirement for some banks.

bank-specific minimum threshold and zero otherwise. We set the threshold to be one standard deviation of banks' CAR over the period of analysis above the legal requirement.

4.3 Control Variables

The rest of the variables are **x**, a vector of banks' specific characteristics. They are banks' assets ($Size$) as measure of banks' size, banks' profits ($Income$) as a measure of banks' ability to raise capital through retained earnings, and some dummies for bank types (state-owned, private, foreign-owned, and joint-venture banks).

[**INSERT TABLE 1 HERE**]

A set of bank fixed effects and time effects would complete our model. These bank fixed effects would control for banks' time-invariant characteristics, including banks' target capital and risk levels, $Capital^*$ and $Risk^*$. The time effects would control for factors that may affect all banks in each period such as macroeconomic shocks and other changes in business environment.

In some specifications, especially for robustness checks, we also introduce a dummy for public banks ($TPublic$) and a dummy for banks sold to strategic investors ($TSold$). We also use lagged risk-weighted assets ($Risk_{t-1}$) in the capital equation and lagged capital ($Capital_{t-1}$) in the risk equation.

5 Results

5.1 CAR Equation

Table 2 presents the results for regressions in which we use CAR as the dependent variable. Regressions using PCA measure of regulatory pressure, $RegPCA$, are on the left panel; those using probabilistic measure, $RegPROB$, are on the right panel.

The four columns in each panel report system GMM, first-differenced GMM, fixed effect and OLS estimators, respectively. The coefficients of lagged dependent variable CAR_{t-1} of the system GMM are as we expect from a consistent GMM estimator: They are smaller than those of the OLS and bigger than those of the fixed effect. However, the coefficient of CAR_{t-1} of the first-differenced GMM is well below that of fixed effect. Therefore, we should not rely too much on the estimates in Columns (2) and (6).

The coefficient of $RegPCA$ in Column (1), though statistically significant at 30% level of significance only, is economically large. It suggests that undercapitalized bank, whose CAR is lower than 8% by the end of last period and is under regulatory pressure to comply with the capital requirement, would increase its CAR by eight percentage points.

[**INSERT TABLE 2 HERE**]

The coefficients of $RegPROB$ in Column (5), on the other hand, is statistically significant at 10% level of significance and quite large economically. It suggests that banks whose CAR are lower than their own CAR threshold last period would increase their CAR by three percentage points.

The estimates in the left panel indicate that, to immediately comply with the 8% capital requirement, undercapitalized banks simply have to raise their CAR more than adequately capitalized banks. The estimates in the right panel show that banks whose CAR is falling towards the minimum requirement increase their CAR by smaller percentage points.

The coefficients of CAR_{t-1} in Columns (1) and (5) suggest that the speed of CAR adjustment, β_3, is significant both statistically and economically. Banks on average cut the difference between previous period CAR and target CAR by about

10% per quarter, which means banks typically halve the CAR gap within two years.

The coefficients of $Size$ and $Income$ are positive and negative, respectively, though they are insignificant, both statistically and economically. Controlling for other explanatory variables, including previous period capital as well as individual- and time effects, the larger- and the more profitable banks do not seem to increase their CAR faster.

Hansen tests for overidentifying restrictions in Columns (1) and (5) do not reject the null hypothesis that our instruments are valid. As we expect, the tests for serial correlation reject the null hypothesis of no first-order serial correlation of residuals of the first-differenced equation, but do not reject the null hypothesis that there is no second-order serial correlation.

5.2 Capital Equation

We now examine how banks increase their CAR: by increasing capital or reducing risk.

Table 3 presents the results for the capital equation. Regressions using $RegPCA$ are on the left panel; those using $RegPROB$ are on the right panel.

The coefficients of lagged dependent variable $Capital_{t-1}$ of the system GMM are as we expect from a consistent GMM estimator; those of the first-differenced GMM are not, however.

The coefficient of $RegPCA$ in Column (1) is statistically significant at 20% level of significance; economically it is also large. It suggests that undercapitalized banks whose CAR is lower than 8% by the end of last period comply with the capital requirement by increasing their capital by Rp 300 million on average, about 41% of the mean of all banks' capital.

[**INSERT TABLE 3 HERE**]

The coefficients of $RegPROB$ on the right panel, on the other hand, are close to zero and statistically insignificant.

The first set of estimates indicates that, to immediately comply with the 8% capital requirement, an undercapitalized bank simply has to raise capital more than adequately capitalized banks. The second set of estimates shows that banks whose CAR are falling towards the minimum requirement, as far as capital decision is concerned, behave like any other banks. These banks may be under regulatory pressure too, but they do not have to raise capital to increase capital ratio. Instead, they may opt for other means like reducing risk, especially when raising capital is very costly.

The coefficients of $Capital_{t-1}$ in Column (1) suggests that the speed of capital adjustment, β_1, is significant both statistically and economically. Banks on average cut the difference between previous period capital and target capital by about 13%, which means banks typically halve the capital gap within a year and a half.

The coefficients of $Size$ and $Income$ are positive and statistically significant. The larger the bank is, the more it needs to raise capital; the more profitable the bank is, the more easily it could increase capital. However, controlling for other explanatory variables, including previous period capital as well as individual- and time effects, the impacts of $Size$ and $Income$ on banks' capital decision is small. For every Rp 1 billion increase of banks' $Size$ (assets) or $Income$, banks raise their capital by a few million rupiahs only.

The two system GMM specifications pass the tests for overidentifying restrictions and for serial correlation.

5.3 Risk Equation

Table 4 presents the risk equation. The coefficients of lagged dependent variable $Risk_{t-1}$ of the OLS, fixed effect and system GMM are about the same, while that of first-differenced GMM is well below that of fixed effect. Though we should take the results of this risk equation with care, we console to the fact that the coefficients of $Capital_{t-1}$ of the system GMM are between that of OLS and that of fixed effect.

[**INSERT TABLE 4 HERE**]

The coefficient of $RegPCA$ in Column (1) is negative, though statistically insignificant. It suggests that an undercapitalized bank, as far as risk decision is concerned, behaves like adequately capitalized banks.

The coefficients of lagged dependent variable $Risk_{t-1}$ on the right panel suggest that the system GMM is better. The coefficient of $RegPROB$ of the system GMM is negative, though it is statistically significant at 30% level of significance only. These estimates show that a bank whose CAR is falling towards the minimum requirement last period may reduce risk about Rp 100 million to comply with the capital requirement, about 3% of the mean of all banks' risk-weighted assets.

The first set of estimates indicates that, to comply with the 8% capital requirement, undercapitalized banks do not rely much on reducing risk. They prefer raising capital as we show in Table 3. On the other hand, the second set of estimates suggest that banks whose CAR is falling towards the minimum requirement may do just the opposite: They prefer reducing risk, not raising capital.[13]

[13] Do note that, unlike in the capital equation, in this risk equation we introduce the dummy for public banks, $TPublic$, which is equals one for banks that have gone public and zero otherwise. We include $TPublic$ because using only $Size$ and $Income$ as control variables leads to very similar coefficients of lagged dependent variable $Risk_{t-1}$ of the OLS, fixed effect and system GMM. Our estimates in the capital equation on the other hand are about the same whether we include or $TPublic$ not.

The coefficients of $Risk_{t-1}$ in all system GMM specifications suggest that the speed of risk adjustment, β_2, is statistically significant in all two system GMM specifications. Unlike the speed of capital adjustment, they are very small, however. Banks on average cut the difference between previous period risk and target risk by about 3% per quarter, which means banks typically halve the capital gap within almost six years.

The coefficients of $Size$ and $Income$ are positive and are statistically significant. Like those in the capital equation, they are not economically significant, however. Nonetheless, these estimates suggest that the larger or the more profitable the bank is, the larger the risk it could afford.

The system GMM in Columns (1) and (5) pass the usual diagnostic tests, except Hansen test for regression in Column (5).

6 Robustness Checks

In Tables 5 and 6, we explore the robustness of our results to some changes in the basic specifications. Panel A of Table 5 shows the results in which we introduce lagged capital into the risk equation and lagged risk into the capital equation.[14] We find that banks whose CAR are below the minimum 8% tend to increase their capital while those whose CAR are falling towards the minimum requirement tend to reduce risk. These show that controlling for banks' risk in the capital equation and banks' capital in the risk equation does not change our basic results. The coefficients are not statistically significant at conventional level, however.

[**INSERT TABLE 5 HERE**]

[14] It should be noted that, unlike previous works in this line of literature, we introduce lagged values of capital and risks as additional explanatory variables, not their current values.

Panel B shows estimates of specifications in which we allow for heterogeneous responses. Previously we restrict all banks, whatever their types, responding to regulatory pressure in the same way. To allow different type of banks to respond differently, we introduce interactive dummies between the type of ownership dummy and the regulatory pressure dummy. The capital equation, for example, becomes as follows:

$$\begin{aligned} Capital_{it} &= \sum_{j} \alpha_j Type_{ijt-1} * Reg_{ijt-1} + (1-\beta_1)\,Capital_{it-1} \\ &\quad + \gamma_1 \mathbf{x}_{it} + \delta_i + \lambda_t + \epsilon_{it} \end{aligned} \tag{16}$$

where $Type_{ij}$ is a dummy equals one if bank i has type of ownership j and zero otherwise.

For the capital equation, in Column (1) the coefficient of $Type * RegPCA$ is statistically significant for large private-domestic banks only. Large private-domestic banks appear to respond strongly to the capital requirement: Undercapitalized banks raise capital by Rp 1.8 billion within one quarter. The coefficients of $Type * RegPROB$ in Column (2) are significant at 20% level of significance for state-owned and joint-venture banks only. They are negative, however.[15]

For the risk equation, in Column (3) the coefficients of $Type * RegPCA$ are statistically insignificant. The coefficients of $Type * RegPROB$ in Column (4) are quite significant statistically for state-owned and regional-development banks. For the former, it is positive however, while for the latter it is economically small.

For the CAR equation in Column (5), similar picture appears: Most of the positive effects of regulatory pressure on CAR come from undercapitalized large

[15] Table 6 presents the results for the system GMM for capital-, risk-, and CAR equations. There is no state-owned and foreign-owned banks which are under regulatory pressure if we use $RegPCA$ and therefore their interactive terms in Columns (1), (3) and (5) drop out of the regressions. Moreover, the interactive terms for joint-venture banks are dropped due to collinearity. All bank types present in regressions using $RegPROB$ in Columns (2), (4) and (6).

private-domestic banks. Small private-domestic- and regional-development banks seem to behave like other adequately capitalized banks.

The coefficients of $Type * RegPROB$ in Column (6) are statistically significant for state-owned and joint-venture banks while they are significant at 20% level for small private-domestic- and regional-development banks. Many of them are negative, however. The results in Column (6) suggest that, allowing heterogeneous responses, many of state-owned and joint-venture banks appear to have too high capital ratios, and therefore tend to reduce their CAR even though, by our definition, they are under regulatory pressure.

Panel C shows the estimates if we restrict our sample into all banks except state-owned and foreign-owned banks. For the most part, our results are quite robust, though many are not significant statistically at conventional level of significance.

In Table 6 we focus on more homogenous sample of banks and at the same time explore the robustness of our results if we allow regulatory pressure to non-linearly affect banks' capital and risks. We also examine what happens if we allow different types of banks to have different speed of adjustment.

[**INSERT TABLE 6 HERE**]

In Panel A, we allow banks who are significantly undercapitalized to behave differently by introducing another dummy, $CAR4$ that equals one if banks' CAR below 4 and zero otherwise. We find that these heavily undercapitalized banks respond the strongest to the capital requirement: primarily by raising capital, and to lower extent by reducing risk. Controlling for $CAR4$, $RegPCA$ continues being quite significant statistically, though economically it becomes smaller. Using the sample of private domestic banks only, for example, it equals 0.024, which is much lower than 0.443, the coefficient of $CAR4$.

In Panel B, we allow undercapitalized banks to have different speed of adjustment than adequately capitalized ones. We add an interactive term between the regulatory pressure and the lagged dependent variable such as the following:

$$\begin{aligned} Capital_{it} &= \alpha_1 RegPCA_{it-1} + (1-\beta_0)\, RegPCA_{it-1} * Capital_{it-1} \\ &\quad + (1-\beta_1)\, Capital_{it-1} + \gamma_1 \mathbf{x}_{it} + \delta_i + \lambda_t + \epsilon_{it} \end{aligned} \qquad (17)$$

We find that undercapitalized banks have larger speed of capital adjustment. On the other hand, the speed of risk adjustment for both undercapitalized- and adequately capitalized banks appears to be quite the same. Overall, controlling for different speed of capital- and risk adjustment, the coefficients of $RegPCA$ continue to be quite robust.

We also do other robustness checks. First, we introduce a dummy for public banks ($TPublic$) and a dummy for banks sold to strategic investors ($TSold$) into the basic regressions. Overall, the coefficients of regulatory pressure $RegPCA$ and $RegPROB$ continue to be quite large. Second, we drop the observations during the time when regulator imposes 4% minimum capital requirement temporarily. Third, we also estimate the model using different number of lagged variables as instruments in the GMM specifications. Fourth, to reduce the number of instruments in the GMM estimators, we reestimate the regressions using yearly data only. Overall, our basic results are quite robust.[16]

7 Concluding Remarks

There is some evidence that banks comply with the capital requirement: They increase their CAR when the ratio is lower than, or approaching, the 8% regulatory

[16] The results are available from authors upon request.

minimum. Banks whose CAR below 8% do so primarily by raising capital, while banks whose CAR is falling towards the minimum requirement prefer reducing risk rather than increasing capital.

However, some caveats are in order. First, most of our results are statistically significant at 20-30% level of significance only.

Second, our results are mostly driven by private domestic banks; other undercapitalized banks appear to respond to the capital requirement like adequately capitalized banks. This may be because, during the period of analysis, regulator monitored large private-domestic banks intensively. Moreover, some of these banks were bailout by the government in the aftermath of the 1998 crises and their managers perhaps were under political pressure to perform. A few of these banks' book in fact turned red again during the period of analysis and the government had to recapitalize them one more time.

Third, furthermore, our results are also primarily driven by heavily-undercapitalized banks whose CAR is lower than 4%. Once we control for regulatory pressure for heavily-undercapitalized banks, the effect regulatory pressure on banks whose CAR is lower than 8% but larger than 4% becomes less significant economically.

These results shed light on how banks in developing countries respond to capital requirement. In contrast to the findings in the literature that banks in developed countries comply with capital requirement, we do not find similarly strong evidence of compliance in Indonesia: Statistically, banks that are under pressure from regulator to increase their CAR behave just like adequately capitalized banks.

Bear in mind, however, that the findings in the past works may not be accurate due to the simultaneous equation estimation of non-autonomous equations. Moreover, we cannot say that banks in developing countries would respond to capital requirement like those in the developed world. Barth, Caprio and Levine (2006) for example, using cross-country data analysis, show that strengthening the discretionary powers of prudential supervisors in countries with weak institutional environments leads to, among others, banks that are less sound.

Therefore, whether, in normal circumstances, Indonesian banks comply with capital requirement remains questionable. The good news is that banks do respond to the capital requirement, however weakly. The challenge is that, if regulators in developing countries continue relying on capital regulation, they would need to improve their supervision capacity, increase the transparency of financial reporting, and strengthen market monitoring of banks.

It would be interesting to see how Indonesian banks respond to capital requirement in the future when Indonesian economy has fully recovered, banking industry stabilized, and regulator stopped its intensive supervision and monitoring. Because many developing countries implement capital requirement as the key instrument in prudential supervision of their banks, it would also important to look into whether developing countries, whose regulators are less independent and their supervision capacity is weaker, could really enforce capital requirement and induce banks to limit risk taking.

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	Unit	Observations	Mean	Standard Deviation
Capital	Rp billion	2,468	0.73	2.37
Risk Weighted Assets	Rp billion	2,468	3.36	9.86
CAR		2,469	23.40	16.79
RegPCA		2,458	0.02	0.13
RegProb		2,458	0.18	0.38
Size	Rp billion	2,509	8.07	26.77
Income	Rp billion	2,340	21.44	77.36

Table 1: Summary Statistics

Dependent Variable: CAR_t								
	GMM		**FE**	**OLS**	**GMM**		**FE**	**OLS**
	SYS	**DIFF**			**SYS**	**DIFF**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$RegPCA_{t-1}$	8.019	18.586	10.675	10.327				
	(7.725)	(9.859)	(4.737)	(7.475)				
$RegPROB_{t-1}$					3.038	1.274	-2.123	0.899
					(1.705)	(2.795)	(1.331)	(0.821)
CAR_{t-1}	0.908	0.594	0.714	0.918	0.902	0.541	0.700	0.917
	(0.046)	(0.094)	(0.063)	(0.018)	(0.047)	(0.115)	(0.062)	(0.018)
$Size_t$	-0.029	0.282	-0.236	-0.049	-0.023	0.144	-0.243	-0.047
	(0.029)	(0.305)	(0.164)	(0.029)	(0.030)	(0.256)	(0.166)	(0.026)
$Income_t$	0.011	0.031	0.022	0.017	0.009	0.027	0.022	0.016
	(0.010)	(0.022)	(0.016)	(0.011)	(0.010)	(0.023)	(0.016)	(0.010)
AR(1)	-2.95	-2.64			-2.96	-2.47		
AR(2)	-0.65	-0.80			-0.66	-0.85		
Hansen	[0.132]	[0.019]			[0.116]	[0.163]		
Observations	2,165	1,980	2,165	2,165	2,165	1,980	2,165	2,165

Note: The estimators are system GMM, first-differenced GMM, fixed effect and ordinary least squares. GMM results are one-step estimates. GMM regressions include lagged dated *t-2* and *t-3* as instruments. All regressions include bank fixed effects and time effects. Robust standard errors are in parentheses.
AR(1) and AR(2) are tests for first-order and second-order serial correlation, respectively. Hansen is a test of the overidentifying restrictions for the GMM estimators; it uses the minimized value of the corresponding two-step GMM estimators. The p-values are in the brackets.

Table 2: CAR Equation

Dependent Variable: Capital$_t$								
	GMM		**FE**	**OLS**	**GMM**		**FE**	**OLS**
	SYS	**DIFF**			**SYS**	**DIFF**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RegPCA$_{t-1}$	0.295	0.316	0.331	0.296				
	(0.231)	(0.278)	0.240	(0.247)				
RegPROB$_{t-1}$					-0.008	-0.024	-0.002	0.002
					(0.023)	(0.027)	(0.012)	(0.006)
Capital$_{t-1}$	0.873	0.745	0.848	0.916	0.875	0.748	0.840	0.911
	(0.058)	(0.145)	(0.075)	(0.039)	(0.063)	(0.143)	(0.084)	(0.046)
Size$_t$	0.008	0.072	0.012	0.006	0.008	0.068	0.012	0.006
	(0.002)	(0.035)	(0.007)	(0.001)	(0.002)	(0.033)	(0.007)	(0.001)
Income$_t$	0.003	0.006	0.003	0.002	0.003	0.006	0.003	0.002
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
AR(1)	-1.92	-1.80			-1.92	-1.79		
AR(2)	0.99	0.80			1.00	0.82		
Hansen	[0.096]	[0.003]			[0.055]	[0.042]		
Observations	2,165	1,980	2,165	2,165	2,165	1,980	2,165	2,165

Note: The estimators are system GMM, first-differenced GMM, fixed effect and ordinary least squares. GMM results are one-step estimates. GMM regressions include lagged dated *t-2* and *t-3* as instruments. All regressions include bank fixed effects, time effects and TPublic. Robust standard errors are in parentheses.
AR(1) and AR(2) are tests for first-order and second-order serial correlation, respectively. Hansen is a test of the overidentifying restrictions for the GMM estimators; it uses the minimized value of the corresponding two-step GMM estimators. The p-values are in the brackets.

Table 3: Capital Equation

Dependent Variable: $Risk_t$								
	GMM		**FE**	**OLS**	**GMM**		**FE**	**OLS**
	SYS	**DIFF**			**SYS**	**DIFF**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$RegPCA_{t-1}$	-0.022	0.167	0.124	-0.029				
	(0.023)	(0.424)	(0.113)	(0.032)				
$RegPROB_{t-1}$					-0.097	-0.141	-0.069	-0.053
					(0.090)	(0.141)	(0.036)	(0.033)
$Risk_{t-1}$	0.984	0.853	0.938	0.991	0.984	0.847	0.938	0.991
	(0.030)	(0.094)	(0.036)	(0.025)	(0.030)	(0.101)	(0.036)	(0.025)
$Size_t$	0.015	0.367	0.105	0.015	0.015	0.378	0.105	0.015
	(0.004)	(0.059)	(0.014)	(0.003)	(0.004)	(0.060)	(0.015)	(0.003)
$Income_t$	0.004	0.009	0.004	0.003	0.004	0.009	0.004	0.003
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
AR(1)	-1.97	-1.73			-1.96	-1.71		
AR(2)	-0.22	-0.55			-0.23	-0.57		
Hansen	[0.091]	[0.001]			[0.000]	[0.030]		
Observations	2,165	1,980	2,165	2,165	2,165	1,980	2,165	2,165

Note: The estimators are system GMM, first-differenced GMM, fixed effect and ordinary least squares. GMM results are one-step estimates. GMM regressions include lagged dated *t-2* and *t-3* as instruments. All regressions include bank fixed effects and time effects. Robust standard errors are in parentheses.
AR(1) and AR(2) are tests for first-order and second-order serial correlation, respectively. Hansen is a test of the overidentifying restrictions for the GMM estimators; it uses the minimized value of the corresponding two-step GMM estimators. The p-values are in the brackets.

Table 4: Risk Equation

Dep. Variable	$Capital_t$		$Risk_t$		CAR_t	
	(1)	(2)	(3)	(4)	(5)	(6)
A. Include lagged Capital and Risk in Risk- and Capital equations, respectively						
$RegPCA_{t-1}$	0.264		-0.002			
	(0.205)		(0.071)			
$RegPROB_{t-1}$		-0.019		-0.095		
		(0.020)		(0.099)		
B. Introduce separate indicators of regulatory pressure for each type of banks						
Reg_{t-1}*Type						
State		-0.239		0.367		-31.339
		(0.194)		(0.186)		(2.081)
Large private	1.839	0.032	-0.057	-0.101	28.177	-0.886
	(0.201)	(0.047)	(0.466)	(0.195)	(4.885)	(6.393)
Small private	0.002	-0.029	0.003	-0.059	5.404	6.246
	(0.010)	(0.026)	(0.017)	(0.094)	(8.676)	(4.832)
Development	-0.012	0.006	-0.022	-0.172	-0.599	2.079
	(0.012)	(0.018)	(0.022)	(0.104)	(1.639)	(1.388)
Joint venture		-0.174		0.001		-9.250
		(0.070)		(0.108)		(3.988)
Foreign		0.144		0.351		-3.517
		(0.166)		(0.358)		(3.133)
C. Use the sample of all banks except state- and foreign banks						
$RegPCA_{t-1}$	0.235		-0.008		6.678	
	(0.166)		(0.079)		(7.778)	
$RegPROB_{t-1}$		-0.004		(0.061)		1.220
		(0.029)		(0.047)		(1.495)

Note: The estimator is system GMM. The results are one-step estimates of regressions that include lagged dated t-2 and t-3 as instruments. All regressions include lagged dependent variable, Size, Income as well as bank fixed effects and time effects. Regressions in Panel A include lagged Capital and lagged Risk in Capital- and Risk equations, respectively. In Panel B, odd-numbered regressions use RegPCA as measure of regulatory pressure, while even-numbered regressions use RegPROB. Robust standard errors are in parentheses. The number of observations vary between 1,924 to 2,165.

Table 5: Robustness Checks 1

Dep. Variable	Capital$_t$				Risk$_t$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Introduce an indicator for banks whose CAR is lower than 4%								
CAR<4	0.434	0.443	1.832	-0.012	-0.019	-0.036	-0.115	-0.019
	(0.341)	(0.344)	(0.218)	(0.013)	(0.145)	(0.136)	(0.452)	(0.009)
RegPCA$_{t-1}$	0.021	0.024		0.012	0.000	(0.001)		0.018
	(0.015)	(0.017)		(0.010)	(0.015)	(0.026)		(0.010)
B. Introduce an interactive term between RegPCA and lagged Capital or lagged Risk								
Capital$_{t-1}$	0.863	0.868	0.882	0.935				
	(0.062)	(0.069)	(0.059)	(0.010)				
RegPCA$_{t-1}$*Capital$_{t-1}$	-0.556	-0.553	-22.212	0.123				
	(0.054)	(0.063)	(0.691)	(0.013)				
Risk$_{t-1}$					0.977	0.976	0.969	0.816
					(0.044)	(0.047)	(0.051)	(0.039)
RegPCA$_{t-1}$*Risk$_{t-1}$					-0.011	-0.020	0.116	0.075
					(0.024)	(0.072)	(0.519)	(0.046)
Sample	1	2	3	4	1	2	3	4

Note: The estimator is system GMM. The results are one-step estimates of regressions that include lagged dated t-2 and t-3 as instruments. All regressions include lagged dependent variable, Size, Income as well as bank fixed effects and time effects. Robust standard errors are in parentheses.

Samples 1 includes all banks except state banks and foreign banks; Sample 2 private-domestic banks only; Sample 3 large private-domestic banks only; Sample 4 small private domestic banks. The number of observations for Samples 1-4 are 1,925, 1,224, 581, and 643, respectively.

Table 6: Robustness Checks 2