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REVITALISING RESERVE REQUIREMENT IN BANKING MODEL: AN INDUSTRIAL ORGANISATION APPROACH

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ABSTRACT

The objective of reserve requirement as a policy tool is mainly to control money supply in the economy. However, the changes of reserve requirement also affect banks´ interest rates. Thus, the changes will have an effect on banking optimal behaviour in maximising profits. Using the industrial organisation approach, this paper will evaluate the Indonesian banking sector in the course of designing an unconventional reserve requirement policy that link a bank´s reserve requirement ratio to the bank´s loan to deposit ratio. When a bank´s loan to deposit ratio increases, the bank will have a smaller ratio of reserve requirement. This incentive mechanism was implemented to accomplish Bank Indonesia´s intentions of increasing loan growth and reducing the "excess liquidity" in the Indonesian banking sector. The paper reveals that the policy is effective in boosting bank loans and consequently decreasing excess liquidity. It also suggests that the policy could provide another tool for the central bank to impact bank liquidity in order to support financial system stability.

Keywords: Reserve Requirement, Policy, Macro-micro Prudential, Financial System Stability, Incentive, Rate of Remuneration.

JEL Classifications: E43, E52, E58, G21, G28, L16

1. Introduction

In some countries, the central bank does not use reserve requirement as a monetary instrument. Reserve requirement is regarded as "old fashioned" in terms of monetary policy. However, in some other countries, reserve requirement is used extensively by the central bank to manage money supply. The objective of reserve requirement as a policy tool is mainly to influence money supply in the economy. However, changes in reserve requirement can also affect banks' optimal behaviour and interest rates in the profit maximisation effort. In Indonesia, during 2005 – 2008, an unconventional reserve requirement policy design was used to influence lending growth. The policy utilised the reserve requirement ratio to affect banks' loan-to-deposit ratio and was introduced during a period of "excess liquidity" in the Indonesian banking sector. The term of "excess liquidity" in this paper is used by the Indonesian central bank (Bank Indonesia, henceforth BI) and is also called "bank disintermediation"[3] - referring to a problem of perceived low loan-to-deposit ratio (LDR) in the Indonesian banking sector.

The existence of bank disintermediation gives an insight of how the central bank can influence banks in determining portfolio allocations and interest rates through its banking and monetary policies. Therefore, this paper intends to analyse the effectiveness of the reserve requirement policy in addressing the excess liquidity problem in the Indonesian banking sector. However, the causes and existence of the excess liquidity problem will not be discussed in this paper. These two aspects are treated as a given. A bank model will be used to assess the policy to give some recommendations for improving the effectiveness of the policy. The objective of the policy is to influence banks in their performance of the intermediation function – represented by their LDR – optimally based on the macroeconomic, micro-prudential and macro-prudential conditions. The policy provides incentives for banks that have a high LDR and conversely penalise those that have a low LDR. In this sense, a higher reserve requirement ratio will be charged to the banks with a low LDR. While a bank with low LDR increases their LDRs, the reserve requirement ratio decreases. This works the opposite way with a bank with high LDR.

This unconventional reserve requirement policy is interesting because on the one hand, the policy could appear to be ineffective. According to Stiglitz and Greenwald (2003), who built an ideal banking system model based on the mean variance expected utility approach, an increase in the reserve requirement ratio reduces bank deposits as well as bank loans. Therefore, the LDR could go up because of shrinking bank deposits. However, the LDR could remain constant if a decrease in bank loans is in the same proportion with a decrease in bank deposits. LDR could also decrease if bank loans decrease in a greater portion than bank deposits do. As a consequence, the low LDR problem remains unresolved and banks do not provide more lending to the private sector. On the other hand, Bernanke and Blinder (1988) and Agung et al (2001) claim that if a decrease in bank deposits is replaced by other funds that are not subject to reserve requirements, for example by liquidating the bank's portfolios on public bonds or other liquid assets, then the reserve requirement ratio will not reduce bank loans. Accordingly, with the right set up, the reserve requirement ratio could deliver two effects: 1) a decrease in banks' portfolio in public bonds or liquid assets without decreasing bank loans; and 2) an increase of LDR by decreasing bank deposits. In this way,

[3] Bank disintermediation is also used to explain a condition where firms that have access to the bond market will issue private bonds to finance their businesses when the firms' costs of issuing private bonds are lower than the firms' costs of borrowing money from banks. In this case, the private bond becomes a competitor for bank ending.

the reserve requirement policy could resolve the excess liquidity problem in the banking sector. This could take care of the case of the disappearance of bank lending channel, especially when bank disintermediation[4] exists and the borrowers become less bank dependent (Oliner and Rudebusch, 1995). This implies that a decrease in bank deposits due to monetary contraction could be offset by a decrease in public bonds or other liquid assets that are not subject to reserve requirements thus eliminating the necessity for banks to increase their loan rates and reduce their lending.

Many approaches can be used to analyse the reserve requirement policy. The mean-variance expected utility approach does very well in empirical works because the approach uses time series data and considers some risks involved in the model. However, the mean-variance expected utility approach is more difficult to construct when the objective function involves many constraints such as banking or monetary policies, banks' customers' demand for loans or supply of deposits, and so on. It is also difficult to have reliable results when the data is not available or has many of the usual problems, such as structural breaks, multicollinearity, etc. As a consequence, the analysis of bank behaviour based on this approach is not flexible. Freixas and Rochet (1997) pinpoint some problems that relate to this approach.

As each theory has special characteristics, none of the theory of bank behaviour dominates other theories. Therefore, this paper uses an alternative approach to overcome this inflexible problem in studying bank behaviour. This alternative approach is called the Industrial Organisation Approach which considers a bank as a firm that maximises its objective function, namely profit function, directly from the revenue and cost functions given some constraints. Researchers who study bank behaviour using this approach are not as many as researchers of the Mean-variance Expected Utility Approach. The seminal papers based on this approach are pioneered by Klein (1971) and Monti (1972). The approach of Industrial Organization is simple but sufficiently powerful to address many issues related to the daily operations of banks. Freixas and Rochet (1997) and Matthews and Thompson (2008) mention that the Industrial Organization Approach can deal with a rich set of models for tackling different issues, such as monetary policy, market failure and some aspects of banking policy.[5] Therefore, the Industrial Organization Approach is more suitable for the analysis of the comparative statics of bank behaviour for this paper. One of models of bank behaviour based on the Industrial Organization Approach is also known as the Monti Klein Model.

The rest of this paper is organised as follows. Section 2 presents reserve requirement policies implemented by BI to cope with the excess liquidity problem in the Indonesian banking sector. Section 3 describes the benchmark model of banking using a conventional reserve requirement policy. The new policy is then introduced into the model. Short analyses are also presented in this Section. Sensitivity analyses of the model are discussed in Section 4 followed by the reserve requirement policy analysis in the Indonesian banking sector during 2005 – 2008 in Section 5. The final section concludes.

[4] Refer to previous footnote for its definition.

[5] Besides the two approaches above, there are other approaches that are frequently used to determine bank's portfolio allocation. They are known as the Value at Risks and Safety First approaches. These approaches involve the probability of every asset of banks over a period of time. However, these approaches are also not flexible enough to be used for investigating the effect of a new policy on bank behaviour.

2. The Reserve Requirement Policy in Indonesian Banking Sector

The excess liquidity problem in the Indonesian banking system appeared during 2000 - 2007 (Sabirin (2002), Zulverdy et al (2004) and Asih (2005) among others).[6] Banks rather place their money in Bank Indonesia Certificates (henceforth SBI)[7] and public bonds than provide more lending to the private sector. To deal with the problem, BI introduced two policies. The first policy relates to the reserve requirement for commercial banks which was released in June 2004. According to the policy, all commercial banks were required to increase their reserves at the central bank following the new reserve requirement ratios. The policy stated that the ratios of reserve requirement be increased from 5% to 6% for banks that have third party funds between Rp 1 trillion and Rp 10 trillions, to 7% for banks that have third party funds between Rp 10 trillions and Rp 50 trillions, and to 8% for banks that have third party funds more than Rp 50 trillions. Banks that have third party funds less than Rp 1 trillion would retain the same reserve requirement ratio of 5%. Furthermore, the policy also stated that BI would pay an interest rate of 3% for banks' excess reserves resulting from the policy (the rate of remuneration, Anderson (2008)) or on top of the originally 5% reserve requirement.

According to Asih (2005), there were only 4 banks that had third party funds over Rp 50 trillion but their share of total third party funds was more than 50% while more than 50% of the total number of banks had less than Rp 1 trillion of third party funds, which was less than a 3% share of all third party funds in the Indonesian banking sector (Table 1). Effectively, the aggregated reserve requirement ratio rose by 2.2675% in the weighted average of total third party funds. Therefore, the ratio of reserve requirement increased from 5% to 7.2675% for all third party funds.

Table 1
Group of Commercial Banks[8]

Group of Banks	Number of Banks	Share of Total Third Party Funds
> Rp 50 trillions	4	52.69%
Between Rp 10 – 50 trillions	12	26.19%
Between Rp 1 – 10 trillions	47	18.01%
< Rp 1 trillion	66	3%
Total	**129**	**100%**

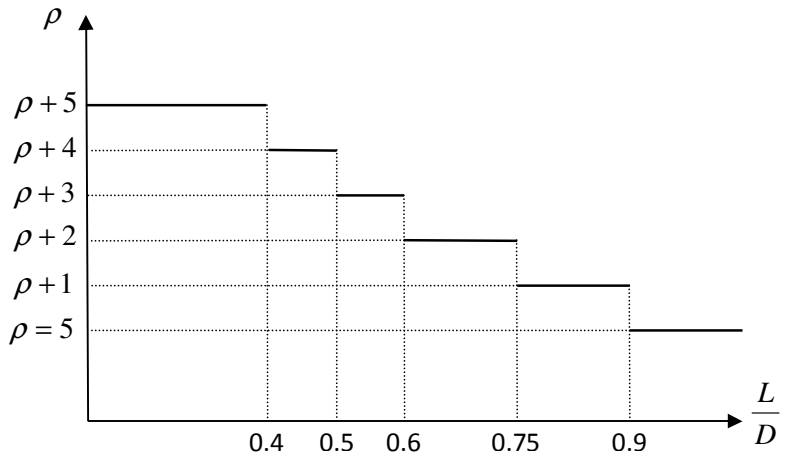
In September 2005, BI introduced the second policy that revised the first policy of reserve requirement for commercial banks. For the second policy, the reserve requirement ratio depended on both the third party funds and banks' LDR. The ratios of reserve requirement that relate to the third party funds did not change from those of the first policy, but the ratios of reserve requirement would increase if banks had lower LDR than a certain percentage number. According to the second policy, a bank has to place more funds in BI as

[6] See also the Bank of Indonesia Annual Reports from 2000 to 2007. See also Kompas newspaper printed edition on 30 April 2007 and website http://www.kompas.com.
[7] In conducting monetary policy, BI uses SBI, short for "Sertifikat Bank Indonesia" or Bank Indonesia Certificate (instead of public bonds) to influence the money supply through open market operations. However, SBI and public bonds have the same characteristics. In the model developed later, this paper will only use public bonds which is assumed to represent SBI and public bonds, as a monetary tool.
[8] As of May 2005. Data is taken from Table 2 in Asih (2005).

required reserves if the bank has lower LDR than the limit. In other words, the higher the bank's loans to deposits ratio, the smaller the amount of money that the bank must place as required reserves given constant bank's deposit volumes, and vice versa.

According to the second policy, the reserve requirement ratios would increase by 1% for banks whose LDR is between 75% and 90%, increase by 2% for banks that have LDR between 60% and 75%, increase by 3% and 4% for banks that have LDR between 50% and 60%, and between 40% and 50%, respectively. Finally, the reserve requirement ratios are to increase by 5% for banks that have LDR below 40%. Moreover, the interests paid by BI for banks' excess reserves resulting from the second policy (or the excess reserve on top of the originally 5% reserve requirement) are to increase from 3% to 5.5%. These staggered ratios of reserve requirement and LDR relationship are depicted in Figure 1 below.

Figure 1
Staggered Ratios of Reserve Requirement Policy



The objective of the second policy is to provide banks with an incentive for increasing their LDRs, so as to increase bank lending to the private sector and thus mop up excess liquidity. The policy is also aimed to penalise banks that have demonstrated poor performances in their intermediation function.

3. The Model

In this Section, two models are developed with the first, the Benchmark Model, representing a bank's optimal decision in portfolio allocations and interest rates when the central bank imposes a conventional reserve requirement. The second model describes a bank's optimal decision in portfolio allocations and interest rates when the central bank imposes the reserve requirement policy that relates the reserve requirement ratio to the bank's LDR.

3.1 Benchmark Model with a Conventional Reserve Requirement Policy

Using the Industrial Organisation Approach, we model bank behaviour following Freixas and Rochet (1997). It is assumed that the model has a constant equity, an exogenous policy interest rate r (as a benchmark interest rate) and a concave profit function in order to simplify the model. In this profit maximisation problem, a monopolistic bank's objective is to

choose loans L, liquid asset M, and deposits D to maximise its profits. The bank's maximisation problem can be written in mathematical expression as:

$$Max \quad \pi = Lr_L + Mr - Dr_D \tag{1}$$

subject to:

$$L + M + R = D \tag{2}$$
$$D = a + br_D \tag{3}$$
$$L = c - dr_L \tag{4}$$
$$R = \rho D \tag{5}$$

where $R \equiv$ reserve requirement, $r_L \equiv$ loan rates, $r_D \equiv$ deposit rates and $\rho \equiv$ ratio of reserve requirement.

Equation (1) defines the bank's profit maximisation in which we assume that fixed costs and the costs of managing loans and deposits are equal to zero. Besides simplification of the model, this assumption is intended to avoid any complication notation in the model. Equation (2) is a simple balance sheet of the bank. Equation (3) represents the bank's customers' supply of deposits. Parameter b is positive representing the responsiveness of the bank's customers' supply of deposits to a change in the bank's deposit rates. Parameters a could be defined as external factors that affect the bank's customers' decisions to deposit their money in the bank. These external factors could include income, economic growth, inflation, or others. This equation implies that an increase in deposit rates will encourage the bank's customers to increase deposits.

Equation (4) describes the bank's customers' demand for loans. Parameter d has a positive value representing responsiveness of the bank's customers' demand for loans to a change in the bank's loan rates. Parameter c represents some external factors that could affect the bank's customers' decisions on borrowing funds from the bank with similar interpretation as described above. This equation says that an increase in loan rates reduces the bank's customers' willingness to borrow money from the bank for financing their businesses and activities. Equation (5) is a simple reserve requirement equation where the bank's reserves in the central bank are a certain portion of the bank's total deposits.

Let $\mathcal{L}$ be a Lagrangian function of the bank's maximisation problem. The first order necessary conditions of Lagrangian function for maximum are:

$$\frac{\partial \mathcal{L}}{\partial L} = r_L + \lambda_1 + \lambda_3 = 0 \tag{6}$$
$$\frac{\partial \mathcal{L}}{\partial r_L} = L + \lambda_3 d = 0 \tag{7}$$
$$\frac{\partial \mathcal{L}}{\partial M} = r + \lambda_1 = 0 \tag{8}$$
$$\frac{\partial \mathcal{L}}{\partial D} = -r_D - \lambda_1 + \lambda_2 - \lambda_4 \rho = 0 \tag{9}$$
$$\frac{\partial \mathcal{L}}{\partial r_D} = -D - \lambda_2 b = 0 \tag{10}$$
$$\frac{\partial \mathcal{L}}{\partial R} = \lambda_1 + \lambda_4 = 0 \tag{11}$$
$$\frac{\partial \mathcal{L}}{\partial \lambda_i} = 0, \quad for\ i = 1, \dots, 4 \tag{12}$$

where λ_i, for $i = 1, \dots, 4$ are Lagrange multipliers respectively for the bank's balance sheet, customers' supply of deposits, demand for loans and reserve requirement. The set of optimal solutions for the bank's maximisation above is:

$$D^* = \frac{1}{2}\big(a + br(1-\rho)\big) \quad (13)$$

$$L^* = \frac{1}{2}(c - dr) \quad (14)$$

$$R^* = \frac{\rho}{2}\big(a + br(1-\rho)\big) \quad (15)$$

$$M^* = \frac{1}{2}\big(a(1-\rho) - c + r(b(1-\rho)^2 + d)\big) \quad (16)$$

$$r_D^* = \frac{1}{2b}\big(-a + br(1-\rho)\big) \quad (17)$$

$$r_L^* = \frac{1}{2d}(c + dr) \quad (18)$$

Equations (13) and (17) show that the bank's optimal solution on deposit volumes and interest rates depend only on the policy interest rates positively and the parameters of the bank's customers' supply of deposits function. Neither the loan volumes nor interest rate or the parameters of the bank's customers' demand for loan function has any influence on the bank's optimal solution on deposit volumes. Similarly, Equations (14) and (18) describe that the policy interest rate affecting bank's optimal solution on loan volumes negatively and on interest rates positively. They also depend on the parameters of the bank's customers' demand for loan function. Neither the deposit volumes nor interest rates or the parameters of the bank's customers' supply of deposits function have any influence on the bank's optimal solution on loan volumes. These relationships are similar to the standard analysis of bank behaviour in the Monti Klein model that can be found in Freixas and Rochet (1997) or Matthew and Thompson (2008). From these equations, we can see that reserve requirement optimally reduces bank deposit volumes and interest rates, but it does not have any effect on bank loan volumes and interest rates.

Furthermore, the reserve requirement volume in Equation (15) depends on the policy interest rate and the parameters of the bank's customers' supply of deposits function. The bank's optimal solution on liquid assets in Equation (16) will not only depend on the policy interest rate and the parameters of the function of bank's customers' supply of deposits, but also the parameters of the function of bank's customers' demand of loans. From Equation (16), we can also see that the reserve requirement ratio reduces the bank's optimal solution on liquid assets.

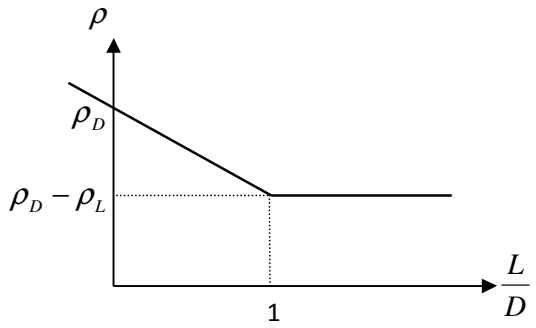
3.2 Model with the Reserve Requirement Policy

We will now introduce the model that reflects the policy relating the reserve requirement ratio to the LDR. Equation (5) above will be adjusted in order to comply with the policy. It is assumed that the bank will optimise the placement of its funds as reserves in the central bank. This means that the bank will not place any excess reserves unless it is obligated by policy. Let ρ be a ratio of reserve requirement that relates to bank's LDR. It is assumed that the relationship has a continuous function[9] and the reserve requirement ratio has the lowest value of LDR reaching one or above[10]. This parameter ρ will depend negatively on bank's LDR. The adjustment of reserve requirement ratio can be depicted in Figure 2 below:

[9] Instead of staggered or discreet function, continuous function is chosen to simplify the model.

[10] This assumption is to simplify the model. According to the second policy, the reserve requirement ratio will reach the lowest value when the loan to deposit ratio reaches 0.9 or above. Changing from one to another value would be easy to do later.

Figure 2
The Adjusted Ratio of Reserve Requirement



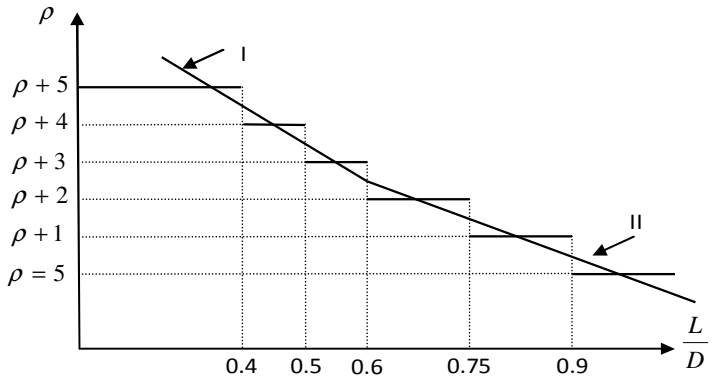
In Figure 2, adjusted reserve requirement ratio (ρ) goes up if $^{L}/_{D}$ falls. This relationship implies that along with the increasing of bank's LDR, the adjusted reserve requirement ratio decreases until the point when the bank's loans to deposits ratio reaches unity. Mathematically, this relationship can be written as:

$$\rho = \rho_D - \rho_L \frac{L}{D} \qquad (19)$$

In the adjusted reserve requirement ratio, ρ_D and ρ_L are defined as the reserve requirement ratios on deposits and loans, respectively. The reserve requirement ratio on deposits can be interpreted as a maximum ratio of reserve requirement if the bank has a zero loan volume (an extreme condition), while the ratio of reserve requirement on loans can be interpreted as a discount ratio[11] when the bank has a higher LDR. The lowest adjusted reserve requirement ratio that the bank can achieve is $\rho_D - \rho_L$, where the bank's LDR is equal to one.[12] Here, the level of incentive and disincentive will be determined by the values of ρ_L. Required reserves can be seen as a cost for banks and the increase of the adjusted reserve requirement ratio ρ will potentially reduce banks' profits. Therefore, an increase in the bank's LDR when the reserve requirement ratio on loans ρ_L is high, will reduce the adjusted reserve requirement ratio ρ faster as compared to an equivalent increase in the bank's LDR when the reserve requirement ratio on loans ρ_L is low. In this case, the bank will have more incentives to increase its LDR. Conversely, the bank will suffer more penalties from decreasing its LDR when ρ_L is high. Therefore, an increase in ρ_L will reduce the required reserves of banks in the central bank given any LDR. This implies that the incentive and disincentive mechanisms exert a greater influence.

[11] It is called as a discount ratio because it is a subtraction of the reserve requirement ratio on deposits.
[12] See footnote no 10. Bank's loan to deposit ratio could be greater than one. In this case, the adjusted ratio of reserve requirement is also equal to P_D-P_L.

Figure 3
Incentive and Punishment Mechanisms



For the case of Indonesia, Figure 3 intuitively shows that the incentive and disincentive mechanism is larger when the bank's LDR falls below 60% as compared to that above 60%. The threshold of 60% of loan to deposit axis is picked as a critical point because the range of staggered ratio below 60% is 10% and the range of staggered ratio above 60% is 15%. This condition can be confirmed by curve I that has a steeper slope compared to the slope of curve II. For simplification, these two curves are drawn considering the average of the LDR at every stage of the reserve requirement ratio. Mathematically, the two curves I and II can be represented in the respective equations as follows:

$$\rho = \begin{cases} 13.5 - 10\dfrac{L}{D}, & for \quad \dfrac{L}{D} \leq 0.6 \\ 10.375 - 5\dfrac{L}{D}, & for \quad \dfrac{L}{D} > 0.6 \end{cases}$$

If we multiply Equation (19) by D and substitute it into Equation (5), then the reserve requirement function will have a new form as:

$$\rho D = \rho_D D - \rho_L L$$

$$R = \rho_D D - \rho_L L \qquad (20)$$

Regarding the bank's excess reserves resulting from the policies, the excess reserves can be formulated as:

$$x_{rev} = \rho_D - \rho_L \frac{L}{D} - \bar{\rho} \qquad (21)$$

$$x_{rev} D = \rho_D D - \rho_L L - \bar{\rho} D \qquad (22)$$

where $\bar{\rho}$ is the standard reserve requirement when the second policy does not exist and $\rho_D - \rho_L \frac{L}{D} \geq \bar{\rho}$. Therefore, the bank's maximisation problem in Equation (1) can be altered by

$$Max \quad \pi = Lr_L + Mr - Dr_D + r_R x_{rev} D$$

or

$$Max \quad \pi = Lr_L + Mr - Dr_D + r_R \rho_D D - r_R \rho_L L - r_R \bar{\rho} D \qquad (23)$$

where r_R is the interest rate of excess reserves paid by the central bank to the bank (rate of remuneration) and it becomes an added profit for the bank. Including the excess reserves in the model is almost similar to the model of Cosimano (1987). The differences are (i) Cosimano's model uses the dynamic framework and (ii) Cosimano uses the total reserves instead of the excess reserves. It is assumed that r_R is less than the policy interest rates r and is also less than the bank's interest rates on deposits. Otherwise, the bank will have a chance of an arbitrage condition by borrowing from the interbank market or raising bank deposits and putting the money in the central bank.

With these two adjustments, the model with the reserve requirement policy can be derived similarly with the benchmark model using the Lagrangian approach. The bank's optimal solutions on portfolio allocations and interest rates can be written as follows:

$$D^* = \frac{1}{2}\left(a + br(1-\rho_D) + br_R(\rho_D - \bar{\rho})\right) \quad (24)$$

$$L^* = \frac{1}{2}\left(c - dr + d\rho_L(r - r_R)\right) \quad (25)$$

$$R^* = \frac{1}{2}\left[\rho_D\left(a + br(1-\rho_D) + br_R(\rho_D - \bar{\rho})\right) - \rho_L\left(c - dr + d\rho_L(r - r_R)\right)\right] \quad (26)$$

$$M^* = \frac{1}{2}\left((1-\rho_D)\left(a + br(1-\rho_D) + br_R(\rho_D - \bar{\rho})\right) - (1-\rho_L)\left(c - dr + d\rho_L(r - r_R)\right)\right) \quad (27)$$

$$r_D^* = \frac{1}{2b}\left(-a + br(1-\rho_D) + br_R(\rho_D - \bar{\rho})\right) \quad (28)$$

$$r_L^* = \frac{1}{2d}\left(c + dr - d\rho_L(r - r_R)\right) \quad (29)$$

As we assume that $r - r_R > 0$ and comparing Equation (24) to Equation (13) and comparing Equation (28) to Equation (17), the bank's optimal solutions on deposit volumes and interest rates are higher when the reserve requirement policy is imposed by the central bank. These conditions imply that the policy influence the bank to collect more deposits from its customers. As a consequence, the bank increases its deposit rates to encourage its customers to increase deposits. Comparing Equation (25) to Equation (14), we can see that the bank's optimal solution on loan volumes is also higher. Thus, an increase in deposit volumes will be balanced by an increase in loan volumes. As a result, the bank's optimal solution on loan rates is lower to encourage bank's customers to borrow more from the bank. This condition is confirmed by comparing Equation (29) to Equation (18). As both optimal solutions on loans and deposits are higher when the policy imposed, the bank's optimal solution on liquid assets is ambiguous as this depends on how much bank loans increase as compared to the increase in bank deposits. Therefore, sensitivity analyses are needed to explore the impact of the policy on bank's optimal solution for liquid assets. The comparison between the benchmark model and the model with the policy are presented in Table 2.

Table 2
The Differences Between Benchmark and Modified Models

Variables	Differences
Loans	$\frac{1}{2} d\rho_L (r - r_R)$
Deposits	$\frac{1}{2} br_R (\rho_D - \bar{\rho})$
Liquid Assets	$\frac{1}{2}\left(br_R (\rho_D - \bar{\rho}) - d\rho_L (r - r_R)\right)$
Reserves	$\frac{1}{2} br_R \rho_D (\rho_D - \bar{\rho})$
Loan rates	$-\frac{1}{2} \rho_L (r - r_R)$
Deposit rates	$\frac{1}{2} r_R (\rho_D - \bar{\rho})$

4. Sensitivity Analyses

The sensitivity analyses are carried out for a more comprehensive understanding of the impact of the reserve requirement policy on bank behaviour, especially portfolio allocations and interest rates. We will differentiate the bank's optimal solutions in Equations (24) to (27) with respect to the reserve requirement ratio on deposits and loans as well as the rate of remuneration. The results are presented in Table 3 below.[13]

Table 3
Sensitivities of Bank Portfolios and Loan-to-Deposit Ratio

	ΔL	ΔD	ΔR	ΔM	$\Delta \frac{L}{D}$
$\Delta\rho_D$	**0**	**-**	**-**	**-**	**+**
$\Delta\rho_L$	**+**	**0**	**-**	**-**	**+**
Δr_R	**-**	**+**	**+**	**++**	**-**

L = loans; ***D*** = deposits; ***M*** = liquid assets; $\boldsymbol{r_R}$ = rate of remuneration

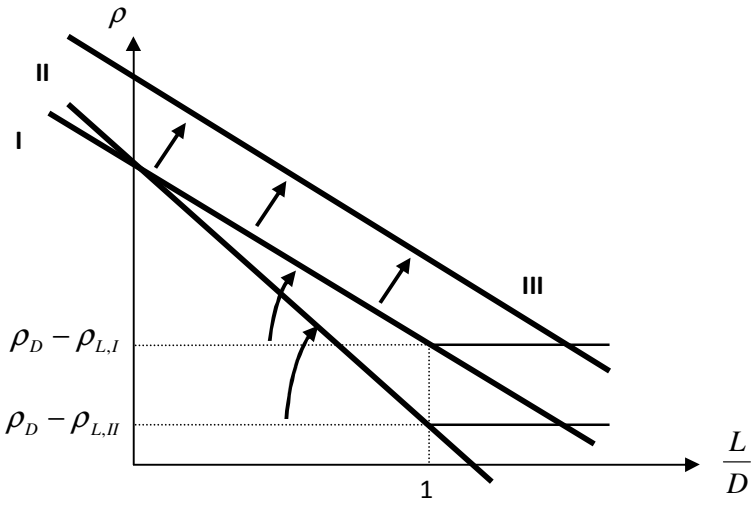
With regard to the pure reserve requirement (first row on Table 3), an increase in the reserve requirement ratio on deposits reduces the bank's optimal solution on deposit volumes without altering the bank's optimal solution on loan volumes. As a result, the bank's optimal solution on reserves decreases while bank's LDR goes up. The increasing reserve requirement ratio on deposits will also lead the bank to reduce its optimal solutions on liquid assets, as the rate of remuneration is less than the policy interest rate.

With regard to the incentive/disincentive reserve requirement (second row on Table 3), an increase in the reserve requirement ratio on loans raises the bank's optimal solution on

[13] This table is modified and taken from Gunadi (2009).

loan volumes without changing the bank's optimal solution on deposit volumes. As a consequence, the bank's LDR increases. Increasing reserve requirement ratio on loans also makes the bank decrease its optimal solution for liquid assets.

Figure 4
Pure and Incentive/Disincentive Mechanism of Reserve Requirement Ratios



These changes of pure and incentive reserve requirements imply that the increasing ratio of reserve requirement on deposits is similar to a shifting of the curve of reserve requirement ratio to the right, i.e. from curve I to curve III in Figure 4. Curves I and III have similar slope values but different intercept values. Meanwhile, increasing reserve requirement ratio on loans is similar to an increase in the slope of the curve of the reserve requirement ratio, i.e. from curve I to curve II. These conditions imply that a shift of the curve of the reserve requirement ratio to the right (upward) and an increasing of the slope of the curve of reserve requirement ratio will lead the bank to increase its LDR.

Table 3 also shows that incorporating the rate of remuneration or the interest rate on the bank's excess reserves in the central bank (third row) will decrease the bank's optimal solution on loan volumes. In contrast, the rate of remuneration raises the bank's optimal solution on deposit volumes. This implies the bank will collect more deposits from its customers to gain more profits which will lead to the raising of the bank's reserves. Increases in its liabilities side should be balanced by increases in the asset side of the bank's balance sheet. Thus, the bank will have more liquid assets and reserves in the central bank. As a result, the bank's optimal solution on liquid assets goes up and the bank will end up with a lower LDR.

5. Analysis of Indonesian Reserve Requirement Policies in 2005 - 2008

As mentioned earlier, BI launched two policies to increase the banks' LDR. There were three simultaneous changes on the model's parameters from these two policies. First, BI increased the reserve requirement ratio on deposits (pure reserve requirement) by 2.2675% on weighted average. Second, BI linked the reserve requirement ratio to the banks' LDR. Last, BI paid the bank for its excess reserves in the central bank at a rate of 5.5% per year.

The model shows that increasing the reserve requirement ratio on deposits by BI is an appropriate policy because it definitely increased banks' LDR. With regard to the reserve

requirement ratio on loans, the effect of the regulation can be greater when the bank's LDR is less than 60% or as reflected by curve I in Figure 3, compared to that when the ratio is greater than 60%, or curve II in the same Figure. This is an effect caused by the magnitudes of slope and intercept of the curves of the reserve requirement ratio. These conditions can be seen from the magnitude of slope of curve I, which is greater than the magnitude of slope of curve II that has about 10 and 5 on average, respectively. The model shows that a steeper slope of the reserve requirement ratio curve will create a greater effect for increasing banks' LDR. Therefore, the setup will allow for the optimal deliberation of reserve requirement policy in order to gain banks' optimal solution on loan volumes and to shift the banks' liquid assets to loans.

Moreover, curve I also has a bigger intercept than the curve II. This implies that the bank will reduce loans when its LDR is below 60% compared to when its LDR is above 60%. The model also demonstrates that curve I with its larger intercept will give a greater effect of increasing the bank's LDR and decreasing the bank's optimal solutions on liquid assets (including Bank Indonesia Certificate). Therefore, curve I is more effective for increasing the bank's LDR. These conditions imply that in the case where the bank's LDR is greater than 60%, the bank's optimal solutions on deposit volumes and liquid assets will decrease and the bank's optimal solution on loan volumes will increase. However, the changes of these assets will not be as much if the bank's LDR is less than 60%.

According to Indonesian banking data,[14] the Indonesian banking sector's LDR is around 73.2% - which is on the curve II. Thus, the reserve requirement ratio is around a weighted average of 6.715%, meaning that there will be a big reduction in banks' portfolio of liquid assets. However, there will be a slower reduction of banks' liquid assets and also a slower increase of banks' asset on loans. In other words, the condition will cause a decrease in the acceleration of the LDR growth in the Indonesian banking sector, although it is still high. If BI wants to motivate banks to reduce their liquid assets and increase their loans so that banks' LDR rises, then BI should increase the magnitudes of the slope and intercept of curve II. Conversely, BI has to decrease the magnitudes of slope and intercept of curve II if it wants to slow down the reduction of banks' liquid assets and loans.

However, slowing down the increase of the LDR could be one of BI's strategies for the Indonesian banking system. A deceleration of LDR growth is sometimes needed to a 11 excessive loans from banks to the private sector. There will be a trade-off in the timing of the slowing of increasing LDR. If the central bank comes in too early to decelerate the increasing LDR, the economy may suffer from reduced loans and increased liquidity. In contrast, if the central bank is too late in slowing down the increasing LDR, the economy would also suffer from inflation and insufficient liquidity. Therefore, the timing for slowing down an increasing LDR is quite critical and would make for interesting future research. The ability of the (new) LDR-linked reserve requirement policy as a tool for delivering countercyclical impact on the banking system is one of the unique features of the policy. Therefore, this policy can be considered as a macro-prudential tool.

The last impact of the reserve requirement policy is the 5.5% interest paid by BI for banks' excess reserves. The model suggests that paying the interest will increase the banks' optimal solution on liquid assets and deposits while decreasing banks' optimal solution on loans. As a result, banks' LDR falls. These conditions imply that the reserve requirement policy is counterproductive to BI's objective of increasing banks' LDRs. Accordingly, the

[14] As of December 2008, Bank Indonesia.

model suggests that the policy of paying interest on banks' excess reserves in BI should be abolished in order to achieve the optimum effect of the reserve requirement policy of increasing the LDR of the Indonesian banking sector.

6. Conclusion

We analysed the effectiveness of the reserve requirement policy that relates the reserve requirement ratio to banks' LDR. A simple model based on the Industrial Organisation Approach was developed to assess the impact of the policy on bank behaviour in determining optimal portfolio allocations and interest rates. The model showed that increasing the reserve requirement ratios on LDR will not only decrease the banks' optimal solutions on deposit volumes but would also increase their optimal solutions on loan volumes. Therefore, the effect is very significant. The increase of the reserve requirement ratio on deposits is similar to a shifting of the curve of the reserve requirement ratio to the right, while the increase of the reserve requirement ratio on loans is similar to raising the magnitude of the slope of the reserve requirement ratio curve. Therefore, in the case of a low LDR, the significant effects of the reserve requirement regulation would be to increase the magnitude of slope of the curve and to push the curve to the right by raising both the reserve requirement ratios on deposits and loans.

Based on the model's results, we conducted sensitivity analyses for the changes of the reserve requirements ratios on deposits and loans as well as the rate of remuneration. These sensitivity analyses show that the positive changes of reserve requirements ratios can increase banks' LDR.

The evaluation on the reserve requirement policy reveals that BI is on the right path for increasing banks' LDR in the Indonesian banking sector. The two reserve requirement policies are effective for dealing with the problem. However, the effect of the regulations can be optimised by adjusting the incentive and disincentive embedded in the policy design. The model also shows that the regulation of paying an interest for banks' excess reserves should be abolished to maximise the effect of the reserve requirement regulation of increasing banks' LDR.

There are two issues that we think are important regarding the policy and the model. First, the reserve requirement policy could be hazardous if banks have a high LDR and therefore still have the incentive to provide more lending to the private sector. There are no tools in the regulation that have the capacity to reduce or stop excessive loan growth. The LDR-linked (incentive) reserve requirement is equipped with this feature, making it a macro-prudential tool. Therefore, it is very important to study how excessive loan growth can be avoided in the system.[15] Second, bank deposits are naturally dominated by short term deposits. It will indeed be very commendable if the incentive mechanism in lending is also accompanied by a restructuring of the maturity of deposits as banks will have less liquidity risks if they have a bigger share of longer-term deposits. These two issues will be our further research for improvement of the policy. In essence, the policy can be used as an instrument to strike a balance between monetary stability and financial stability. It can also be used to apply macro-micro prudential measures on the banking system.

[15] We will discuss the issue in our forthcoming paper.

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