Revitalizing Reserve Requirement in Banking Model: An Industrial Organization Approach[1]

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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 behaviour in optimal way to maximize the banks' profits. Using the industrial organization approach, this paper will evaluate Indonesian banking sector during an unconventional reserve requirement policy that related a bank´s ratio of reserve requirement to the bank´s loan to deposit ratio. When the bank´s loan to deposit ratio increases, the bank will have a smaller ratio of reserve requirement. This incentive mechanism was due to the Indonesian central bank´s intentions to increase loan growth and to reduce a high "excess liquidity" in Indonesian banking sector. The paper reveals that the policy is effective to boost bank loans and consequently to decrease excess liquidity. It also suggests that the policy could give another tool for the central bank to affect banks´ liquidity in order to support financial system stability.

Keywords: reserve requirement, policy, macro-micro prudential, financial system stability, incentive, rate of remuneration.

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

1. Introduction

In some countries, the central bank does not use reserve requirement for monetary instrument. Reserve requirement is regarded as an old fashion in monetary policy. However, in some other countries, reserve requirement is used extensively by the central bank to control money supply. 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' behaviour and interest rates in optimal way to maximize their profits. In Indonesia during 2005 – 2008, an unconventional reserve requirement policy was used to influence lending growth. The policy related the reserve requirement ratio to bank's loan to deposit ratio. The policy was introduced due to an "excess liquidity" problem in Indonesian banking sector. The term of "excess liquidity" in this paper refers to a term that is used in Indonesian central bank (Bank Indonesia, henceforth BI). It is also called bank

[1] The views expressed in this working paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of Bank Indonesia. All errors and omissions are the authors'.

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disintermediation[3] that means a perceived low loan to deposit ratio problem in 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 analyze the effectiveness of the reserve requirement policy to address the excess liquidity problem in Indonesian banking sector and this paper does not discuss the causes and the existence of excess liquidity problem. These two aspects are treated as given and a model of bank will be used to assess the policy and to give some recommendations for improving the effectiveness of the policy. The objective of the policy is to give an incentive for the banks that have a high loan to deposit ratio and a punishment for the banks that have a low loan to deposit ratio. In this sense, a higher reserve requirement ratio will be charged to the banks with a low loan to deposit ratio. Along with increasing their loan to deposit ratios, the reserve requirement ratio will decrease. Therefore, banks are encouraged to give more loans to private sector in order to increase their loans to deposits ratio.

This unconventional reserve requirement policy becomes interesting because on one side the policy seems to be ineffective. According to Stiglitz and Greenwald (2003) who built an ideal banking system model based on mean variance expected utility approach, an increase in the reserve requirement ratio reduces bank deposits as well as bank loans. Therefore, loan to deposit ratio could go up because of shrinking bank deposits, but loan to deposit ratio could also not change if a decrease in bank loans has the same proportion with a decrease in bank deposits or it could decrease if a decrease in bank loans has a greater portion than a decrease in bank deposits. As a consequence, the low loan to deposit ratio problem remains unsolved and banks do not give more lending to private sector. On the other side, Bernanke and Blinder (1988) and Agung et al (2001) claim that if a decrease in bank deposits is offset by other funds that are not subject to reserve requirements, or by a decrease in bank's portfolios on public bonds, then the reserve requirement ratio will not reduce the bank loans. As a consequence, the reserve requirement ratio could decrease the banks' portfolio on public bonds without decreasing bank loans and could increase loan to deposit ratio by decreasing bank deposits. Therefore, the reserve requirement policy could solve the excess liquidity problem in the Indonesian banking sector. In addition, when bank disintermediation[4] exists and the borrowers become less bank dependent, the bank lending channel could disappear (Oliner and Rudebusch, 1995). This implies that a decrease in bank deposits due to monetary contraction could be offset by decreases in public bonds that are not subject to reserve requirements and banks would not necessarily increase their loan rates and reduce their lending.

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

Many approaches can be used to analyze the reserve requirement policy. The mean-variance expected utility approach does very well in empirical works because the nature of 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 that represent 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 nature problems, such as structural break, 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 organization approach. The approach considers a bank as a firm that maximizes its objective function, namely profit, 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 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 convenient for this paper to do the analysis of the comparative statics of bank behaviour. One of models of bank behaviour based on the industrial organization approach is also well known as the Monti Klein model.

The rest of this paper is organized as follows. Section two presents reserve requirement policies taken by BI to cope with the excess liquidity problem in Indonesian banking sector. Section three describes about a benchmark model of banking using a conventional reserve requirement policy. Then, the new policy is introduced into the model. Short analyses are also presented in this section. Sensitivity analyses of the model are discussed in section four and followed by the reserve requirement policy analysis in Indonesian banking sector during 2005 – 2008 in section five. Conclusion is the final section.

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

2. The Reserve Requirement Policy in Indonesian Banking

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

According to Asih (2005), there were only 4 banks that had third party funds over Rp 50 trillions but their share of the total third party funds was more than 50 percents. While more than 50 percents of the total numbers of banks had less than Rp 1 trillion of third party funds, which was less than 3 percent share of all third party funds in Indonesian banking sector (Table 1). Effectively, the ratio of reserve requirement rose by 2.2675% on weighted average of the 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%**

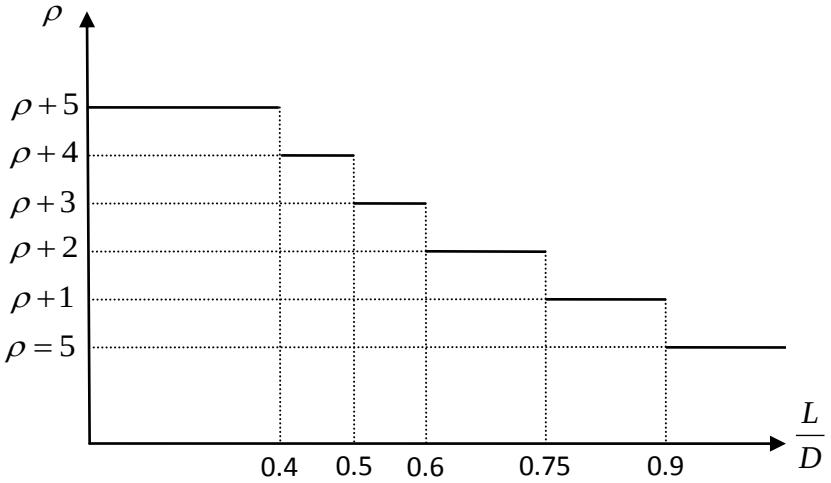
In September 2005, BI introduced the second policy that revised the first policy of reserve requirement for commercial banks. In the second policy, the reserve

[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 (instead of public bonds) to influence the money supply through an open market operation. However, SBI and public bonds have the same characteristics. In the model developed later, this paper will only use public bonds, that is assumed to represent SBI and public bond itself, as a monetary tool.
[8] As of May 2005. Data is taken from Table 2 in Asih (2005).

requirement ratio depended on both the third party funds and banks' loan to deposit ratios. The ratios of reserve requirement that related to the third party funds did not have any change from the first policy, but the ratios of reserve requirement would increase if banks had lower loan to deposit ratios. According to the second policy, a bank has to put its money more in BI as required reserves if the bank has lower loans to deposits ratio. In other words, the higher the bank's loans to deposits ratio, the smaller the amount of money that the bank must be put as required reserves given the bank's deposit volumes constant, and vice versa.

According to the second policy, the ratios of reserve requirements increased by 1% for banks that have loan to deposit ratios between 75% and 90%, increased by 2% for banks that have loan to deposit ratios between 60% and 75%, increased by 3% and 4% for banks that have loan to deposit ratios between 50% and 60%, and between 40% and 50%, respectively. Lastly, the ratio of reserve requirements increased by 5% for banks that have loan to deposit ratios below 40%. Moreover, the interest paid by BI for banks' excess reserves caused by the second policy increased from 3% to 5.5%. These staggered ratios of reserve requirement and loan to deposit ratio relationship can be depicted by Figure 1 below

Figure 1
Staggered Ratios of Reserve Requirement Policy



The objective of the second policy is to give banks an incentive for their effort to increase their lending to private sector, so that their loan to deposit ratios go up and excess liquidity falls. The policy is also to give a punishment for banks that have bad performances in conducting their intermediation function.

3. The Model

In this section, we will develop two models. The first model presents bank's optimal decision in portfolio allocations and interest rates when the central bank imposes a conventional reserve requirement. The model is referred as a benchmark model. The second model describes bank's optimal decision in portfolio allocations and interest

rates when the central bank imposes the reserve requirement policy that relates ratio of reserve requirement to the bank's loan to deposit ratio.

A. Benchmark model with a conventional reserve requirement policy

Using an industrial organization approach, we model bank behaviour that follows Freixas and Rochet (1997). It is assumed that the model has a constant of 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 maximization problem, a monopolistic bank's objective is to choose loans L, liquid asset M, and deposits D to maximize its profit. The bank's maximization problem can be written in mathematical expression as

(1) $Max \quad \pi = Lr_L + Mr - Dr_D$

subject to:

(2) $L + M + R = D$

(3) $D = a + br_D$

(4) $L = c - dr_L$

(5) $R = \rho D$

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

Eq (1) defines bank's profit maximization where we assume that fixed costs and the costs of managing loans and deposits equal to zero. Beside of simplifying the model, this assumption is intended to avoid any complication notation in the model. Eq (2) is a simple balance sheet of the bank. Eq (3) represents the bank's customers' supply of deposits. Parameter b is positive representing 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 be regarded as an income, economic growth, inflation, or anything else. This equation implies that an increase in deposit rates will encourage the bank's customers to deposit more.

Eq (4) describes the bank's customers' demand for loans. Parameter d has 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 money from the bank with similar interpretation as 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. Eq (5) is a simple reserve requirement

equation where the bank's reserve in the central bank is a certain portion of the bank's total deposits.

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

(6) $\frac{\partial \mathcal{L}}{\partial L} = r_L + \lambda_1 + \lambda_3 = 0$

(7) $\frac{\partial \mathcal{L}}{\partial r_L} = L + \lambda_3 d = 0$

(8) $\frac{\partial \mathcal{L}}{\partial M} = r + \lambda_1 = 0$

(9) $\frac{\partial \mathcal{L}}{\partial D} = -r_D - \lambda_1 + \lambda_2 - \lambda_4 \rho = 0$

(10) $\frac{\partial \mathcal{L}}{\partial r_D} = -D - \lambda_2 b = 0$

(11) $\frac{\partial \mathcal{L}}{\partial R} = \lambda_1 + \lambda_4 = 0$

(12) $\frac{\partial \mathcal{L}}{\partial \lambda_i} = 0, \quad for\ i = 1, \dots, 4$

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 maximization above is

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

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

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

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

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

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

Eq (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 nor the parameters of the bank's customers' demand for loan function has any influence on the bank's optimal solution on deposit volumes. Similarly, Eq (14) and (18) describe that the policy interest rate affects bank's optimal solution on loan volumes negatively and 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 nor the parameters of the bank's customers' supply of deposits function also has any influence on the bank's optimal solution on loan volumes. These relationships are similar to the standard analysis of bank behaviour

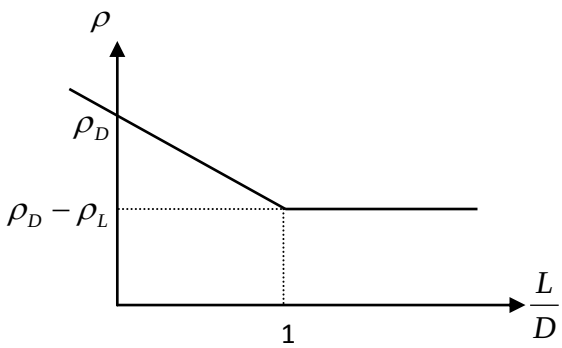
in Monti Klein model that could be found in Freixas and Rochet (1997) or Matthew and Thompson (2008). From these equations, we can see that reserve requirement optimally reduces bank deposit volumes and interest rates, but it does not have any effect on bank loan volumes and interest rates.

Furthermore, reserve requirement volume in Eq (15) depends on the policy interest rate and the parameters of the bank's customers' supply of deposits function. While the bank's optimal solution on liquid assets in Eq (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 Eq (16), we can also see that the ratio of reserve requirement reduces the bank's optimal solution on liquid assets.

B. Model with the reserve requirement policy

We are now introducing a policy that relates the ratio of reserve requirement to loan to deposit ratio into the model. We are going to adjust Eq (5) above in order to comply to the policy. It is assumed that bank will put its money optimally on reserve in the central bank. This means that bank will not put any excess reserve unless it is obligated by the policies. Let ρ be a ratio of reserve requirement that relates to bank's loans to deposits ratio. It is assumed that the relationship has continuous function[9] and the ratio of reserve requirement has the lowest value at loan to deposit ratio reaches one or above[10]. This parameter ρ will depend negatively on bank's loan to deposit ratio. The adjustment of reserve requirement ratio can be depicted in Figure 2 below

Figure 2
The Adjusted Ratio of Reserve Requirement



In the figure of adjusted ratio of reserve requirement, ρ goes up if L/D falls. This relationship implies that along with the increasing of bank's loans to deposits ratio, the adjusted ratio of reserve requirement decreases until one point when the bank's

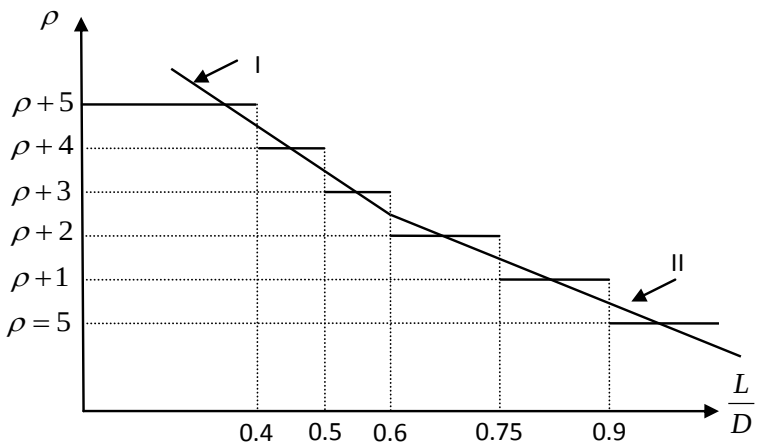
[9] Instead of staggered or discreet function, continuous function is chosen to simplify the model.
[10] This assumption is to simplify the model. According to the second policy, the ratio of reserve requirement will reach the lowest value when loan to deposit ratio reaches 0.9 or above. Changing from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

loans to deposits ratio reaches unity. Mathematically, this relationship can be written generally as

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

In the adjusted ratio of reserve requirement, ρ_D and ρ_L are defined as the ratios of reserve requirement on deposits and loans, respectively. The ratio of reserve requirement 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 loan to deposit ratio. The lowest adjusted ratio of reserve requirement that the bank can get is $\rho_D - \rho_L$, where bank's loan to deposit ratio is equal to one.[12] Here, there are incentive and punishment mechanisms by applying different values of ρ_L. Required reserves can be seen as a cost for banks and the increasing of the adjusted ratio of reserve requirement ρ will potentially reduce banks' profits. Therefore, an increase in bank's loan to deposit ratio when the ratio of reserve requirement on loans ρ_L is high will reduce the adjusted ratio of reserve requirement ρ faster compared to an equivalent increase in bank's loan to deposit ratio when the ratio of reserve requirement on loans ρ_L is low. In this case, bank will have more incentives to increase its loan to deposit ratio. Consequently, a decrease in bank's loan to deposit ratio when the ratio of reserve requirement on loans ρ_L is high will increase the adjusted ratio of reserve requirement ρ faster compared to an equivalent decrease in bank's loan to deposit ratio when the ratio of reserve requirement on loans ρ_L is low. In this case, bank will have more punishments from the decreasing of its loan to deposit ratio. Therefore, an increase in ρ_L will reduce the required reserve of bank in the central bank given any loan to deposit ratio. This implies the incentive and punishment mechanisms are higher.

Figure 3
Incentive and Punishment Mechanisms



[11] It is called as a discount ratio because it is a subtraction of the ratio of reserve requirement 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 $\rho_D - \rho_L$.

For the case of Indonesia, Figure 3 intuitively shows that the incentive and punishment mechanisms are bigger when the bank's loan to deposit ratio below 60% compared to that above 60%. The point 60% of loan to deposit axis is picked up 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 by considering the average of loan to deposit ratio at every stage of reserve requirement ratio. Mathematically, these two curves I and II have respectively equation as follows

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

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

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

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

Regarding bank's excess reserve caused by the policies, the excess reserve is formulated as

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

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

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 maximization problem in Eq (1) can be altered by

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

or

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

where r_R is the interest of excess reserve 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 for 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

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

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

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

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

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

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

As we assumed that $r - r_R > 0$ and comparing Eq (24) to Eq (13) and Eq (28) to (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 make bank to collect more deposits from its customers. As a consequence, bank increases its deposit rates to encourage its customers to deposits more. Comparing Eq (25) to Eq (14), we can see that the bank's optimal solution on loan volume is also higher. Thus, an increase in deposit volumes will be balanced by an increase in loan volumes. As a consequence, the bank's optimal solution on loan rates is lower to encourage bank's customers to borrow more money from the bank. This condition is confirmed by comparing Eq (29) to Eq (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. It depends on how much the increase of bank loans compared to the increase of bank deposits. Therefore, we need sensitivity analyses to explore the impact of the policy to bank's optimal solution on 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

These sensitivity analyses are used to have more comprehensive understanding about 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 Eq (24) – Eq (27) with respect to the ratio of reserve requirement 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	-	+	+	++	-

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

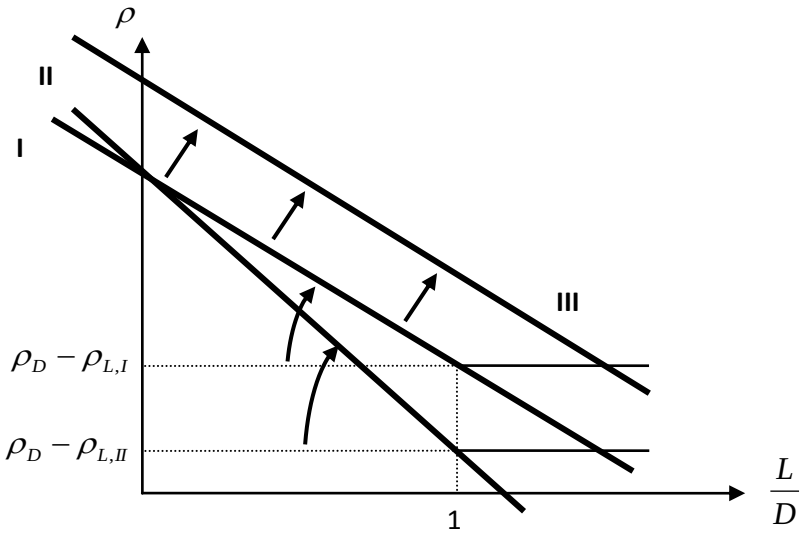
In regard to pure reserve requirement, an increase in the ratio of reserve requirement on deposits reduces the bank's optimal solution on deposit volumes without altering the bank's optimal solution on loan volumes. As results, the bank's optimal solution on reserve decreases and bank's loan to deposit ratio goes up. The increasing ratio of reserve requirement on deposits will also lead the bank to reduce

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

its optimal solutions on liquid assets, as the rate of remuneration is less than the policy interest rate.

In regard to incentive reserve requirement, an increase in the ratio of reserve requirement on loans raises the bank's optimal solution on loan volumes without changing the bank's optimal solution on deposit volumes. As a consequence, the bank's loan to deposit ratio goes up. The increasing ratio of reserve requirement on loans also makes the bank to decrease its optimal solution on liquid assets.

Figure 4
Pure and Incentive 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. While the increasing ratio of reserve requirement on loans is similar to an increase in the slope of the curve of reserve requirement ratio, i.e. from curve I to curve II. These conditions imply that a shifting of the curve of reserve requirement ratio to the right (upward) and an increasing the slope of the curve of reserve requirement will lead the bank to increase its loan to deposit ratio.

Table 3 also shows that incorporating the rate of remuneration or the interest rate on the bank's excess reserve in the central bank 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 profit that leads to raise the bank's reserves. Increasing in its liabilities side should be balanced by increasing in its asset side of the bank's balance sheet. The bank will have more liquid assets and reserve in the central bank. As the result, the bank's optimal solution on liquid assets goes up and the bank will end up with a lower loan to deposit ratio.

5. Analysis of the Indonesian reserve requirement policies in 2005 - 2008

As mentioned earlier, BI launched two policies in order to increase the bank's loan to deposit ratio. From these two policies, there are three simultaneous changes on the model's parameters. Firstly, BI increased the ratio of reserve requirement on deposits (pure) by 2.2675% on weighted average. Secondly, BI related the ratio of reserve requirement to the bank's loan to deposits ratio and lastly BI paid the bank for its excess reserves in BI by 5.5% per year.

The model shows that the increasing of reserve requirement ratio on deposits by BI is a good policy because it definitely increases the bank's loan to deposit ratio. With regard to the ratio of reserve requirement on loans, the effect of the regulation is greater when the bank's loan to deposit ratio is less than 60% or the curve I in Figure 3, compared to that when the ratio is greater than 60%, or the 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 the curve I, which is greater than the magnitude of slope of the curve II that has about 10 and 5 on average, respectively. The model shows that a steeper slope of the curve of reserve requirement ratio will give a greater effect on increasing the bank's loan to deposit ratio. Therefore, the slope of the curve I is more effective to increase the bank's optimal solution on loan volumes and to shift the bank's liquid assets to loans.

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

According to the Indonesian banking data,[14] the Indonesian banking sector's loan to deposit ratio is around 73.2% which is on the curve II. Thus, the ratio of reserve requirement is around 6.715% on weighted average. Therefore, there will be a big reduction of banks' portfolio on 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 experience a reduction of acceleration of increasing loan to deposit ratio in Indonesian banking sector, although it is still high. If BI wants to accelerate banks in reducing their liquid assets and in increasing their loans

[14] As of December 2008. Source Bank Indonesia.

so that banks' loan to deposit ratio rises, then BI should increase the magnitudes of slope and intercept of the curve II. Conversely, BI has to decrease the magnitudes of slope and intercept of the curve II if BI wants to slowdown banks in reducing their liquid assets and in increasing their loans.

However, the slowdown of increasing loan to deposit ratio could be one of BI's strategies for Indonesian banking system. A slowdown of increasing loan to deposit ratio is also needed to avoid an excessive loan from banks to private sector. There will be a trade-off of timing for slowdown of increasing loan to deposit ratio. If the central bank is too early to slowdown of increasing loan to deposit ratio, then the economy would suffer from reducing loans and increasing liquidity. In contrast, if the central bank is too late to slowdown of increasing loan to deposit ratio then the economy would also suffer from inflation and less liquidity. Therefore, a good timing for slowdown of increasing loan to deposit ratio is quite important and this could be an interesting research for the future.

The last impact of the reserve requirement policy is a 5.5% interest paid by BI for the bank's excess reserves. The model suggests that paying the interest will increase the bank's optimal solution on liquid assets and deposits and decrease the bank's optimal solution on loans. As a result, the bank's loan to deposit ratio falls. These conditions imply that the reserve requirement policy is counterproductive with the BI's objective to increase banks' loan to deposit ratios. Accordingly, the model suggests that the policy of paying interest on banks' excess reserves in BI should be abolished to give an optimum effect of reserve requirement policy in increasing loan to deposit ratio of Indonesian banking sector.

6. Conclusions

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

Based on the model's results, we conducted sensitivity analyses for the changes of the ratios of reserve requirements on deposits and loans as well as the rate of remuneration. These sensitivity analyses showed that the positive changes of all ratios of reserve requirements can increase the bank's loan to deposit ratio. It also showed that giving an interest on excess reserve will decrease the bank's loan to deposit ratio. Therefore, the rate of remuneration will be counterproductive to the aim of reserve requirement regulation.

The evaluation on the reserve requirement policy revealed that BI is on the right path to increase banks' loan to deposit ratio in Indonesian banking sector. Two policies of reserve requirement are effective to deal with the problem. However, the effect of regulations can be increased by shifting the curve II of the ratio of reserve requirement upward (to the right) and by raising the magnitude of the curve II's slope to give a greater impact and to accelerate the shifting of banks' assets from public bonds (including Bank Indonesia Certificate) to loans. The model also showed that the regulation of paying an interest for banks' excess reserve should be abolished to give an optimal effect of the reserve requirement regulation on increasing banks' loan to deposit ratio in Indonesian banking sector.

There are two issues that we think are important regarding the policy and the model. Firstly, the reserve requirement policy in Indonesian banking sector could be dangerous if banks have a high loan to deposit ratio and still have an incentive to give more lending to private sector. There is no tool in the policy that has a capability to reduce or stop an excessive loan growth. Therefore, it is very important to study how the excessive loan growth can be avoided by the system. Secondly, bank deposits are naturally dominated by short term deposits. It will be luxurious if the incentive mechanism in lending is also accompanied by restructuring maturity of deposits because banks will have less liquidity risk if they have a bigger share of long-term deposits. These two issues will be our further researches in order to improve the policy. Therefore, the policy can be used as an instrument that can strike a balance between monetary stability and financial stability. It can also apply macro-micro prudential measures to the banking system.

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