Optimisation of Bank Portfolio Composition in Indonesia[1]

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Understanding bank behaviour is a crucial aspect of the decision-making process at a central bank and banking authority in order to formulate policy that is efficient and on target. In addition, a model that can be used to conduct policy simulations would be extremely useful for decision-makers. A bank model is developed in this paper that can be used for policy simulation. The model is designed for use with banks in Indonesia and is a refinement on various previous models due to the issuance of several new policies. The dynamic function of this model is one advantage that can be used for the forecasting process.

Keywords: Capital buffer, Procyclicality, Business cycle

JEL Classification: E32, G21

1. INTRODUCTION

1.1 Background

In conducting their business, banks are greatly affected by economic conditions as well as the array of policies instituted by the banking and monetary authorities of a country. Consequently, a lot of research has been performed to understand bank behaviour in conducting their operational activities. From the perspective of a bank as a business, banks tend to optimise their portfolio in order to increase revenue. Notwithstanding, some research studies bank behaviour to observe a particular economic phenomenon, like for instance a credit crunch (Blum and Hellwig (1995), Diamond and Rajan (2000) and Agung et al (2001)), bank disintermediation (Alamsyah et al, 2005) or undisbursed loans (Zulverdy, Muttaqin and Prastowo, 2004) and others.

Under a framework of studying bank behaviour, a number of models have been developed to assist policymakers run policy simulations, which are used to present a broader picture of the potential impacts of a new draft policy. In Indonesia, policy simulation models are more commonly developed to help understand the impact of a particular change in monetary policy on a number of

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macroeconomic indicators, including the overarching goal of monetary policy, namely inflation.

Not a lot of models have been developed for the case of Indonesia. Zulverdy et al (2004) claimed to model banks in Indonesia. Agung et al (2001), Zulverdy, Muttaqin and Prastowo (2004) and Alamsyah et al (2005) placed more emphasis on specific phenomena in the Indonesian economy, which involved the role of banks in its development. However, Zulverdy, Gunadi and Pramono (2005a, 2005b) developed a bank model to analyse the impact of a change in policy on bank portfolio in Indonesia. Nevertheless, with the further development of banking conditions in Indonesia and the plethora of banking policy changes, the models mentioned must be reviewed again and recalibrated accordingly.

A bank optimization model is built in this paper to simulate policies instituted by the central bank, specifically in Indonesia, using a range of new banking and monetary policies. Several example simulations are also discussed in order to provide a comprehensive picture of how the model simulates the different scenarios used. For each scenario the model also gives portfolio optimization projections based on macroeconomic projections and the inclusion of dynamic elements.

1.2. Methodology

The bank model developed in this paper is tailored to several of the latest banking policies utilising a modified version f the banking industry organisation approach used by Monti (1972) and Klein (1971). Although other methods like the mean-varied expected utility approach are more commonly used to study the behaviour of a bank (Kane and alkiel (1965), Keeley Furlong (1990), Stiglitz and Greenwald (2003), Wibowo (2005), Hou (2008) and others), this method proves to be more difficult if the objective function is accompanied by many constraints that represent banking and monetary policy. Freixas and Rochet (1997) identified a number of weaknesses in this approach.

Each theory has its own unique characteristics and no method dominates over the others, therefore, observing bank behaviour can be achieved using a modified flexible method, which is powerful enough to overcome the issues faced in daily bank operations. Accordingly, the industrial organisation approach is used in this paper. This method is very simple and easy to understand yet effective in observing and analysing the impact of an economic indicator, banking indicator and policy on the behaviour of a bank, particularly in terms of optimal changes in interest rates and portfolio.

1.3. Motivation

The research and bank model developed in this paper for the case of Indonesia is motivated by the following:

1. A recent change in banking regulations in Indonesia, like the statutory reserve requirement

(GWM) and full implementation of Basel II in 2011, coupled with a lack of literature to document these changes;

2. A lack of reliable bank models to observe bank behaviour in Indonesia;

3. A lack of policy simulation tools that can help with the analysis of banking policy in Indonesia.

2. LITERATURE REVIEW

Bank models using the industrial organisation approach began appearing in the 1980s. Using this approach Dermine(1986) explored deposit insurance and Elyasiani, Kopecky and VanHoose (1995) investigated the cost of changes in portfolio on the separation of the optimal value of bank portfolio. In addition, Pausch and Welzel (2003) conducted research into the affect of the capital adequacy ratio on a bank's ability to extend credit to the real sector and Gunadi (2009) researched the sensitivity of banks in response to monetary policy in light of changes in policy and economic conditions.

Although much criticism has been leveled at this model for the inability to include risk factors when setting the optimal value (Nys (2004) and Matthew and Thompson (2008)), several other papers (Dermine (1986), Prisman, Slovin and Sushka (1986), De Bondt, Mojon and Valla (2005) Pausch and Welzel (2003) and others) have argued that bank models using the industrial organisation approach incorporate uncertainty when determining a bank's optimal portfolio solution.

A number of empirical studies have been conducted using this approach. Putkuri (2005) developed an empirical study of the banking sector in Finland for an oligopolistic market using quarterly data from 1994-2005. Guevara, Maudos and Perez (2003) used a bank model to analyse the evolution of interest rate convergence and level of competition between banking systems in the euro area in the period from 1993-2001. In addition, Maudos and Nagore(2004) provided evidence for the impact of financial policy, institutions, the macroeconomy and structure on bank competition in 58 countries between 1995 and 1999.

For the case of Indonesia, Zulverdy et al (2004) used a dynamic approach to resolve the problem of maximising bank profit over time accompanied by a number of constraint functions including the bank balance sheet, deposit supply function, credit demand function, statutory reserve requirement and capital adequacy ratio. Zulvery, Gunadi and Pramono (2005a, 2005b) used this model to observe to impact of disparity in the statutory reserve requirement and exchange rate on the optimization of bank portfolio. Alamsyah et al (2005) used the model developed by Zulverdy et al (2004) to observe the phenomenon of banking disintermediation and its effect on monetary policy.

The industrial organisation approach (Monti (1972) and Klein (1972)) assumes that banks continuously strive to maximise profit, taking into consideration several factors as constraint functions. Monti used three objective function approaches. First, banks will maximise profit with consideration of the deposit supply function. Second, banks will maximise funds consisting of deposits by considering the minimum profit that must be achieved. Third, banks will maximise their utility function made up of profit and fund mobilization.

(1) $$\mathrm{Max} \quad \mathrm{U} = (\Pi, \mathrm{D}) \quad \text{where} \quad \frac{\partial \mathrm{U}}{\partial \Pi}, \frac{\partial \mathrm{U}}{\partial \mathrm{D}} > 0$$

In the three approaches mentioned, banks simultaneously seek to optimise portfolio, which will maximise profit and maximise fund accumulation from the general public. Of the three approaches, the profit function can be defined most simply as:

(2) $$\Pi = r_L L + rLiq - r_D D - r_K K$$

Where *L*, *Liq* and K are defined respectively as credit, liquid assets and bank capital, while r_L, r and r_K are he lending rate, policy rate and cost of capital.

The objective function can be optimised if the first order condition is equal to zero. However, finding the value of the parameter used is not simple, there are numerous technical constraints when using econometric techniques, significance, signs and stationarity, which are difficult to consolidate in the bank model. Therefore, the approach used by Freixas and Rochet (1997) must be modified in order to simplify the simulations.

3. MODEL

3.1. Model Framework

Assuming that banks operate in perfect market competition, this paper follows the model developed by Monti (1972) with the three approaches; however, the bank objective function is adjusted in two ways. First, banks maintain adequate liquidity to support financial system stability. In the model developed by Monti, liquidity is interpreted as maximum capital accumulation from the general public. With this approach large credit liquidity shortfalls will remain. Therefore, including a minimum liquidity ratio that must be met by the banks is hoped to alleviate liquidity risk.

Second, banks with the objective of obtaining maximum profit can be noted from the return on assets, which is also at a maximum. This ratio already takes into account effectiveness and efficiency. In order to include these two modifications, the objective function in Equation 2 can be rewritten as follows:

(3) $$Max \quad U = \pi - \frac{\alpha}{2}(liq - \rho_T d)^2$$

Where $\pi = \frac{\Pi}{Asset}$ is the return on assets (ROA), while liq and d are the ratio of liquidity to total assets and ratio of deposits to total assets respectively. α is the parameter adjustment and ρ_T is the percentage of liquidity that must be maintained by the bank. In Indonesia, this percentage is the secondary reserve requirement plus the liquid assets required for the bank's operational activities.

In addition to the two modifications mentioned, the statutory reserve requirement is also included in the model developed. To this end, this policy construct will be taken from the model developed by Gunadi (2009) and Gunadi and Harun (2010) where the GWM ratio is tied to the bank's loan-to-deposit ratio (LDR). A higher LDR will lower the GWM ratio. The relationship between GWM and LDR can be written as follows:

(4) $$gwm = (\bar{\rho} + \rho_D)d - \frac{\rho_D}{LDR}l$$

Where $\bar{\rho}$ is the primary reserve requirement and $\bar{\rho} + \rho_D$ is the minimum reserve requirement that must be borne by the bank if the bank does not extend any credit. In this context, the bank's loan-to-deposit ratio is zero. $\overline{\mathrm{LDR}}$ is the target LDR set by the central bank, and $\frac{\rho_D}{\mathrm{LDR}}$ is the lower GWM incentive in the event of credit allocation. gwm, d and l are the ratios of GWM, deposits and credit to total assets. By making each respective portfolio ratio to total assets, then bank liabilities and assets can simply be expressed as follows:

(5) $$d + k = 1 \quad (Liability)$$

(6) $$l + liq + gwm = 1 \quad (Aset)$$

Or by substituting equation 4 with equation 6, bank assets can be written as follows:

(7) $$l\left(1 - \frac{\rho_D}{LDR}\right) + liq + d(\bar{\rho} + \rho_D) = 1$$

In order to adopt the bank capital requirement as stipulated in Basel II, the capital equation in this model will follow that developed by Pausch and Welzel (2003), Zulverdy et al (2004) and Gunadi (2009)[4], the capital equation can be expressed as follows[5]:

(8) $$\Omega = \frac{k}{l}$$

By substituting equation 8 with 5, bank liability can be written as follows:

(9) $$d + \Omega l = 1$$

4 Analysis of inequality in the bank capital equation can be found in Pausch and Welzel (2003) and Gundi (2009).

5 Based on Basel II, risk-weighted assets can be split into three categories, namely credit risk, market risk and operational risk. Equation 10 indicates credit risk for a credit portfolio with a 100% weighting, while liquid assets are assumed to have a risk weighting of 0%. For operational risk, CAR can be calculated during the simulation.

While the function of bank profit, after dividing by total assets is as follows:

$$(1) \qquad ROA = \pi = r_L l + rliq - r_D d - r_K \Omega l$$

Assuming perfect market competition, banks will be price takers. In other words, the policy rate, deposits and credit as well as the cost of capital are determined exogenously. The bank's problem is maximising its utility function, namely equation 3, where ROA is defined according to equation 10 with several constraint functions like in equations 7 and 9.[6]

In order to find the optimal solution, the Lagrange function of the bank equation can be found using the first order condition.

Equations:

$$(11) \quad \frac{dU}{dl} = r_L(1-\eta) + \lambda_1 x - r_K\Omega + \lambda_2\Omega = 0$$

$$(12) \quad \frac{dU}{dd} = -r_D + \alpha\rho_T(liq - \rho_T d) + \lambda_1(\bar{\rho} + \rho_D) + \lambda_2 = 0$$

$$(13) \quad \frac{dU}{dliq} = r - \alpha(liq - \rho_T d) + \lambda_1 = 0$$

Where , while λ_1 and λ_2 are the Lagrange functions for equations 7 and 9. By solving equations 7, 9 and 11-13, the solution to the bank's problem above is:

Equations:

$$(14) \quad d^* = \frac{(x-\Omega)}{\left(x-\Omega(\bar{\rho}+\rho_D+\rho_T)\right)} - \frac{(r_D+ra-r_K)\Omega^2+(r_L(1-\eta)-rx)\Omega}{\alpha\left(x-\Omega(\bar{\rho}+\rho_D+\rho_T)\right)^2}$$

$$(15) \quad l^* = \frac{1-(\bar{\rho}+\rho_D+\rho_T)}{\left(x-\Omega(\bar{\rho}+\rho_D+\rho_T)\right)} + \frac{(r_D+ra-r_K)\Omega+(r_L(1-\eta)-rx)}{\alpha\left(x-\Omega(\bar{\rho}+\rho_D+\rho_T)\right)^2}$$

$$(16) \quad k^* = \frac{\Omega\left(1-(\bar{\rho}+\rho_D+\rho_T)\right)}{\left(x-\Omega(\bar{\rho}+\rho_D+\rho_T)\right)} + \frac{(r_D+ra-r_K)\Omega^2+(r_L(1-\eta)-rx)\Omega}{\alpha\left(x-\Omega(\bar{\rho}+\rho_D+\rho_T)\right)^2}$$

$$(17) \quad liq^* = \left[1 - (\bar{\rho} + \rho_D)d^* - \left(1 - \frac{\rho_D}{LDR}\right) l^*\right]$$

Optimising the model determines the optimal ratio of leverage, namely:

$$(18) \quad Lev = \frac{1}{k^*}$$

Calculating the leverage ratio supports central bank policy when determining bank capital in line with the risk exposure of the bank.

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[6] For the time being, remunerations for the statutory reserve requirement are not included in the model because it would only add to the number of unnecessary parameters when seeking the optimal solution. After an optimal solution is found then this parameter can more simply be included into the optimal solution.

3.2. Parameters and Baseline

By taking the bank data position at the end of September 2010, the baseline used in this model for the case of banks in Indonesia is as follows:

Parameter		Baseline Value
BI rate	r	0.065
Deposits interest rate	r_D	0.096
Credits interest rate	r_L	0.137
Cost of capital	r_K	0.010
LDR-Target	$\overline{LDR}$	0.800
Primary reserve requirement	$\bar{\rho}$	0.080
Incentive reserve requirement	ρ_D	0.080
Liquidity Ratio	ρ_T	0.200
Adj CAR	Ω	0.082
Adjustment	α	6.870

By taking a composition of parameters similar to those above, the optimal composition of bank portfolio is presented in the following table.

Portofolio		Composition
Deposits	d	0.9384
Credits	l	0.7507
Capital	k	0.0616
Liquid Assets	liq	0.1742
Reserve requirements	gwm	0.0751
LDR		0.8000
ROA (profit)	π	0.0198
CAR		0.0800
Leverage ratio	Lev	16.2440

It can be interpreted from the table above that by setting the target LDR at 80% and CAR at 8% then optimal deposits, credit and liquid assets are 94%, 75% and 17% of total bank assets respectively, with a leverage ratio of around 16 times the bank's capital. From these results it can also be interpreted that if the parameters reflect the current interest rate and policy conditions, then the bank will turnover larger profits if its liquid assets are less than the required liquidity ratio, namely around 17% of deposits.

3.3. SIMULATIONS

3.3.1. A 1% increase in the Bank Indonesia Rate

This simulation was run to find changes in the bank portfolio composition in the event of a change in the BI rate. Against a scenario of a 1% hike in the BI rate (to 7.5%), ceteris paribus, the optimal portfolio composition is presented in the following table.

Portofolio		Baseline	Composition
Deposits	d	0.9384	0.9385
Credits	l	0.7507	0.7495
Capital	k	0.0616	0.0615
Liquid Assets	liq	0.1742	0.1753
Reserve requirements	gwm	0.0751	0.0752
LDR		0.8000	0.7986
ROA (profit)	π	0.0198	0.0178
CAR		0.0800	0.0800
Leverage ratio	Lev	16.2440	16.2707

Against a scenario of an increasing BI rate, lending and savings rates will also increase.[7] The savings rate and lending rate increase respectively by 10.1% and 13.9%. Therefore, this change in the BI rate will have a direct and indirect impact through lending and savings rates, which will alter the composition of deposits and credit. Banks become more attractive places to invest when the composition of deposits increases. On the other hand, a decline in the composition of credit would also raise the composition of liquid assets. A lower composition of credit coupled with higher deposits would reduce bank LDR by 14 bps, which is below the target. This scenario also demonstrates that with higher lending rates banks can still increase their profits.

[7] The relationship between lending and savings rates and the BI rate is explained in more detail in Section 4.

3.3.2. A 1% increase in the Primary Reserve Requirement

This simulation aimed to observe the changes in bank portfolio composition due to a change in the primary reserve requirement. Against a scenario of a 1% increase in the primary reserve requirement to 9%, ceteris paribus, the optimal portfolio composition is as follows:

Portofolio		Baseline	Composition
Deposits	d	0.9384	0.9393
Credits	l	0.7507	0.7400
Capital	k	0.0616	0.0607
Liquid Assets	liq	0.1742	0.1743
Reseve requirements	gwm	0.0751	0.0857
LDR		0.8000	0.7878
ROA (profit)	π	0.0198	0.0183
CAR		0.0800	0.800
Leverage ratio	Lev	16.2440	16.4804

A 1% increase in the primary reserve requirement to 9% causes the composition of deposits and liquid assets to increase and the composition of credit to total assets to decrease. Referring to previous research (Zulverdy et al (2004), Gunadi (2009)), nominally bank deposits and liquid assets will decrease due to an increase in the primary reserve requirement. This indicates that total bank assets will decrease more than the decline in deposits or liquid assets. In addition, the composition of credit to total bank assets also decreases, which reduces the LDR. The decline in the portion of credit is also affected by the decrease in capital, which increases the bank leverage ratio. Ultimately, bank profit will decline.

3.3.3. Resilience of Bank Capital

This simulation is one way to calculate the optimal amount of bank capital. Before determining the optimal amount of bank capital, an assumption is required concerning the magnitude of the desired intermediation function by all banks. This is critical because a larger intermediation function not only requires more bank capital nominally, but also a larger capital buffer is necessary to absorb the risk that emerges, thereby alleviating potential instability in the financial system. The capital buffer is calculated by comparing the level of CAR achieved with the level of CAR required pursuant to prevailing regulations, in this case 8%.

Consequently, in this simulation several values of LDR are used to reflect the varying magnitude of intermediation. Accordingly, previous bank capital will determine the size of the capital buffer required to support the bank's operational activities. In order to obtain a better policy in terms of capital, the bank's leverage ratio is calculated as a supporting value.

The simulation of varying levels of bank intermediation returned the following results:

LDR	CAR	Capital Buffer	Leverage Ratio
80% (baseline)	8%	0.0%	16.2440
83%	10.8%	2.8%	11.9203
85%	12.5%	4.5%	10.1837
90%	16.5%	8.5%	7.5711
95%	20.1%	12.1%	6.1155
100%	23.3%	15.3%	5.1880

The higher the loan-to-deposit ratio of a bank, the level of capital that has to be maintained increases and the leverage ratio declines.

4. MODEL APPLICATION

4.1. Projection Framework

In this research banks are assumed to operate under perfect market competition, where banks are price takers, hence, the policy rate (BI rate), savings rate and lending rate are exogenous variables with the exception of the cost of capital. To find a value for the BI rate additional data and information is required from different sources. Furthermore, these exogenous variables are required when projecting the portfolio composition of a bank. No discussion is contained within this paper regarding the methodology to find the value of these exogenous variables. Consequently, the variables used are taken from other research.

In order to project the interest rate, this model utilizes the short-term forecast for the Indonesian economy (SOFIE) model (Bank Indonesia, 2008). Using the SOFIE model, future savings rates can be calculated if the current savings rate is known and the BI rate has been set. Meanwhile, lending rates are affected by savings rates and non-performing loans. A model can be used to project non-performing loans, which was developed for stress testing as part of the Financial Sector Assessment Program conducted by the International Monetary Fund (IMF). The projected value of non-performing loans is influenced by the BI rate, economic growth, inflation and the real effective exchange rate.

4.2 Simulation Projection Model

The simulations were conducted using assumptions for the Macroeconomy, SBI, real effective exchange rate and GDP. Using these assumptions, savings rates, lending rates and NPL were projected.

	Year	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15
Deposits interest rates	r_D	8.2500	8.8436	8.8690	8.8700	8.8700	8.8700
Credit interest rates	r_L	14.1509	14.9338	15.0624	15.0766	15.0722	15.0807
NPL		2.9790	2.6248	2.5551	2.3822	2.0207	1.8657

5. SIMULATION PROJECTION MODEL

Other models that could map macro variables with the bank itself supported the simulation projection model for a particular bank. Several models were used to explain the magnitude of savings and lending rates based on the available macro variables. In order to observe the dynamic behaviour in this model, a forecast was used in this research for three variables, namely savings rates, lending rates and non-performing loans (NPL). The forecasts used were taken from previous research.

The results of the simulation are presented in the following table:

	Year	2010	2011	2012	2013	2014	2015
SBI	$\boldsymbol{r}$	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650
Deposits interest rates	$\boldsymbol{r_D}$	0.0825	0.0884	0.0887	0.0887	0.0887	0.0887
Credit interest rates	$\boldsymbol{r_L}$	0.1415	0.1493	0.1506	0.1508	0.1507	0.1508
Cost of capital	$\boldsymbol{r_K}$	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
LDR	$\overline{\boldsymbol{LDR}}$	0.7800	0.8000	0.8300	0.8500	0.8500	0.8500
NPL	$\boldsymbol{NPL}$	0.0298	0.0262	0.0256	0.0238	0.0202	0.0187
Primary reserve requirements	$\overline{\boldsymbol{\rho}}$	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800
GWM LDR	$\boldsymbol{\rho_D}$	0.0780	0.0800	0.0830	0.0850	0.0850	0.0850
Alat Liquid	$\boldsymbol{\rho_t}$	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
CAR	Ω	0.0802	0.0802	0.0802	0.0802	0.0802	0.0802
Adjustment	α	6.8700	6.8700	6.8700	6.8700	6.8700	6.8700
Deposits		0.9396	0.9397	0.9399	0.9401	0.9401	0.9400
Credits		0.7532	0.7527	0.7497	0.7477	0.7478	0.7478

Capital	0.0604	0.0603	0.0601	0.0599	0.0599	0.0600
CAR	0.0802	0.0802	0.0802	0.0802	0.0802	0.0802
Liquid assets	0.1737	0.1722	0.1720	0.1720	0.1719	0.1719
Reserve requirements	0.0731	0.0751	0.0782	0.0803	0.0803	0.0803
LDR	0.8016	0.8010	0.7977	0.7953	0.7954	0.7955
Leverage ratio	16.56	16.57	16.64	16.68	16.68	16.68
ROA (Profit)	3.66%	3.69%	3.73%	3.72%	3.76%	3.79%
CAR (w oprisk)				8.01%	8.01%	8.01%
capital_buffer	6.0%	7.7%	9.4%	11.1%	12.8%	14.6%
CAR (adjustment)	0.0782	0.0782	0.0782	0.0782	0.0782	0.0782
additional capital	0	0	0	0	0	0
CAR buffer	0.00%	2.21%	4.51%	6.85%	9.16%	11.51%

Simulations were run using baseline parameters with due regard for the performance of savings and lending rates. The portfolio composition is presented in the table above. The composition of term deposits in the portfolio increased in line with the higher savings rate. Meanwhile, in terms of assets the portion of credit experienced a decline while liquid assets increased. Additionally, bank LDR posted a slight decline.

With the consideration that profit accumulation is included in capital, it can be seen that bank assets (assuming that bank assets in 2010 are 100) continue to increase. Furthermore, bank capital increases, which indicates that the bank in question has increasingly strong capital considering that there is a target LDR and the bank's liquid assets are maintained.

	2010	2011	2012	2013	2014	2015
Asset	100.00	111.95	125.88	141.57	158.78	178.30
Deposits	93.96	105.19	118.31	133.08	149.26	167.61
Credits	75.32	84.26	94.38	105.84	118.73	133.33
Capital	6.04	6.76	7.57	8.49	9.52	10.69
Liquid assets	17.37	19.28	21.65	24.35	27.30	30.64
Reserve requirements	7.31	8.40	9.85	11.37	12.76	14.32
ROA (Profit)	3.66	4.14	4.69	5.27	5.97	6.75
Net Profit	3.58	4.05	4.60	5.17	5.85	6.62

6. CONCLUSION

6.1. Conclusion

This research is the development and recalibration of previous models from several research papers used to simulate policy, in particular in the banking system of Indonesia. Differing from past research, this paper uses the respective ratios of bank balance sheet items against the total assets of the corresponding bank. A number of issues that developed were accommodated under a framework of reducing liquidity risk and credit risk, thereby bolstering financial system stability.

Several simulations were conducted covering avariety of scenarios in order to observe the impact of a policy on the optimal composition of a bank. Furthermore, the model also tried to project the bank's portfolio composition taking into consideration macroeconomic projections and banking indicators. The dynamic model was developed using different scenarios, which is expected to provide policymakers with a clearer picture of the conditions of a particular bank over time.

6.2. Implications and Recommendations

Despite the weaknesses, the bank model developed in this research has a number of advantages in simulating the impact of policy on the banking system. Therefore, this model can be used as an additional tool to assist policymakers at the central bank with the supplementary information required when formulating new polices. By using this model as an operational tool, the weaknesses of the model will be further exposed and possible enhancements will be forthcoming. Further development of this model is required in order to increase its usefulness.

6.3 Follow-up Research

Looking at the results of this research there are a number of measures that can be taken to improve the results. Further research and development could include:

1. The type of market in the model developed in this research should be further developed to represent an oligopoly, which can better capture market conditions and interaction between the banks and money market.

2. The types of deposits and credit could be developed to be more diverse although the optimal solution would become more complex. Nevertheless, this kind of model would be more useful in simulating capital policy in line with Basel II, which includes a variety of risks.

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