THE INFLUENCE OF CREDIT RISK AND LIQUIDITY RISK ON BANK STABILITY

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Abstract. This research analyzes two fundamental risks that affect the bank stability, such as credit risk and liquidity risk. We used sample, taken from 28 conventional banks in Indonesia during 2013-2017 to analyze the effects of credit risk, liquidity risk and their interaction to the default probability and the reciprocal relationship between these two risks. The results of this study using panel data regression showed that credit risk had a negative effect on default probability, while liquidity risk and the interaction of credit risk and liquidity risk had positive effect on default probability. Through the simultaneous equation models showed that credit risk and liquidity risk did not influence each other, or there was no reciprocal relationship.

Keywords: bank stability; credit risk; liquidity risk; control variables; default probability.

1. INTRODUCTION

The global financial crisis that occurred in 2008 provides valuable lessons for Indonesia to maintain the financial system stability. The financial system plays an important role in carrying out the allocation function of those who experience a surplus to those who experience a deficit. Instability in the financial system will aim the economy towards the crisis. As one of the financial institutions engaged in this system, banks play an important role in maintaining the financial system stability.

Recently, there is a decrease in the number of conventional banks in Indonesia from 2013 to 2017, from 120 banks to 115 banks (Statistik Perbankan Indonesia, 2018), which some get defaulted and some are made by the decisions of mergers and acquisitions. BBC News (2014) wrote that the case of banks that had got defaulted and took a big crucial concern in Indonesia was the case of Century Bank. In 2012, Century Bank was bankrupt-declared. It was due to the inability of Century Bank to resolve the liquidity problems. The instability that led to bankruptcy from Century Bank resulted that the Indonesian government had to issue a bailout of IDR 8.012 Trillion and it was the government loss (Prasetyo, 2018). Another impact was a decrease of the customers' trust that could lead the bank run, decreased the investors' trust, and the social and political costs must be taken if the bailout was not done.

The instability of a bank has a broad impact either the banking sector or other sectors, known as systemic risk (Casu et al., 2006). Casu et al. (2006) stated that banks are very vulnerable to the risk of bankruptcy. The bank's vulnerability to bankruptcy risk results the anticipation of shocks in a bank. It is very necessary, because the instability of a bank will affect financial system stability on macro basis and it can even destroy the economy of a country (Ayomi & Hermanto, 2013).

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The vulnerability of banks to bankruptcy is caused by carrying out the activity process. Banks are faced with various kinds of risks, including the possibility of withdrawing money suddenly by the customers (liquidity risk), debtors do not paying their loans (credit risk), changing interest rates (interest rate risk), and the operational activities of buying and selling securities that run slowly (operational risk) (Cecchetti & Schoenholtz, 2015). Credit risk and liquidity risk are considered as fundamental risks in banks because they are considered to be able to describe the stability of a bank (Hardanto, 2006). Credit activities will affect the risk of bank failure when debtors cannot repay their loans (principal and interest (Freixas & Rochet, 1999). In addition, maintaining a liquidity position from the bank is one of the crucial jobs, because low liquidity can trigger the instability that leads to bankruptcy (Tursoy, 2018).

The classic macroeconomic theory states that credit risk and liquidity risk are related each other as said by Diamond et al. (1983) and Bryant (1980) which showed that bank assets and liability structures are closely related. It is related to debtor failure and withdrawal of funding. Research from Acharya & Mora (2015), Ghenimi et al. (2017), Imbierowicz & Rauch (2014), Louati et al. (2015), Nikomaram et al. (2013) examined from various views about the effect of credit risk and liquidity risk both individual and interaction on bank stability and the relationship between credit risk and liquidity risk.

Although Ghenimi et al. (2017), He & Xiong (2012), and Imbierowicz & Rauch (2014) had tested and demonstrated that credit risk and liquidity risk have an effect on bank stability both individual and interaction. This research is still carried out to complete research with approaches that address issues in Indonesia. This study examines the effect of credit risk and liquidity risk on bank stability by using the sample during the period of the decreasing number of banks that occur in Indonesia.

The first step, we investigate the effect of credit risk, liquidity risk, and the interaction of the two risk categories partially on bank stability by involving several control variables that were considered to contribute to the stability of the bank. The second step is investigating whether there is a reciprocal relationship between the two risks, and whether each other has positive, negative, or no reciprocal relationship between the two risk categories.

Our research is different from the previous research in Indonesia, because the measurement of bank stability is measured on the basis of bank health generally. The used proxy in our study to measure bank stability is a z-score, developed by Boyd & Graham (1986) and used in the measurement of bank stability by Ghenimi et al. (2017), Goetz (2017), Imbierowicz & Rauch (2014), Mercieca, Schaeck, & Wolfe (2007), and Shim (2019).

The lack of studies that examine about liquidity risk credit risk and risk to the stability of banks in Indonesia, becomes one of the factors that encourages to write this research. The choice of conventional banks in Indonesia as the subject of this research is based on several reasons. First, based on Indonesian Banking Statistics for the 2013-2016 period there has been an increase in non-performing loan in conventional banks in Indonesia. This increase in non-performing loan illustrates an increase in credit risk which will increase default probability (Ghenimi et al., 2017; Imbierowicz & Rauch, 2014). Second, an increase in the growth of lending based on Indonesian Banking Statistics for the 2013-2017 period in conventional banks in Indonesia is worried that it will increase non-performing loan. Third, the volatility of the liquidity level with the loan to deposit ratio indicator that occurs in conventional banks in Indonesia based on the Indonesian Banking Statistics period 2013-2017 and the instability of the liquidity level from banks become a concern, because low liquidity will lead banks to bankruptcy (Tran, Lin, & Nguyen, 2016). Therefore, it is still necessary to analyze the influence of credit risk and liquidity risk on bank stability.

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2. LITERATURE REVIEW

2.1 Effect of credit risk and liquidity risk on bank stability

Ghenimi et al. (2017) in their research found that credit risk and liquidity risk have a significant negative effect on bank stability both interactively and individually. It is the same thing with Imbierowicz & Rauch (2014) who found that the interaction of credit risk and liquidity risk has a significant negative effect on bank stability, and individually the higher credit risk and liquidity risk, the higher the probability of bank bankruptcy. Acharya & Mora (2015) found that banks that experience failure are due to the liquidity issues. Shim (2019) showed that the greater the proportion of liquid assets in the company encourages the stability from the bank. On the other hand, Deyoung & Torna (2013) found that credit risk has an important role on the bank stability while liquidity risk does not.

In addition, Kolari et al. (2002) found that the failure of a bank is mainly controlled by low capital, low profits and excessive exposure to certain loans and excessive loan failures. It is implied that liquidity risk does not have a major role on bank stability, besides that capital adequacy also has an important role on bank failure.

Adequate capital will encourage profitability which is a reflection of the performance of a bank (Berger & Bouwman, 2013). Kahane (1977) found that the policy of determining minimum leverage values and policy of asset portfolios limits and liability has an effect on decreasing bank profitability. In line with that, Tran et al. (2016) found that capital has an effect on profitability positively. Increasing profitability decreases default probability (Ghenimi et al., 2017).

In addition, economic growth is driven by a controlled inflation rate. Conversely, too high inflation will have a negative impact on the whole economy because inflation will result in low purchasing power due to the high price and it will decrease the exchange rate of the currency (Suseno & Astiyah, 2009). It will certainly have an impact on banks. When the value of a currency goes down, the return of credit given by the debtor will be in accordance with the nominal value of the currency, and not in accordance with the real value as the inflation occurs, so the bank will be exposed to the risk of inflation and decreases the currency value. Based on the basis of theory and empirical studies above, we hypothesized:

H1: Credit risk had a negative effect on bank stability

H2: Liquidity risk had a negative effect on bank stability

2.2 Relationship between credit risk and liquidity risk

The classic macroeconomic theory states that credit risk and liquidity risk are related each other. Bryant (1980) and Diamond et al. (1983) showed that bank assets and liability structures are closely related. It is related to debtor failure and withdrawal of funding, and shows that there is a relationship between credit risk and liquidity risk. Louati et al. (2015) found that there is a negative relationship between credit risk and liquidity risk in conventional banks in the Middle East and North Africa.

Imbierowicz & Rauch (2014) in their research found that there is a positive relationship between credit risk and liquidity risk but there is no reciprocal relationship between the twos. Diamond & Rajan (2005) found that there is a positive relationship between credit risk and liquidity risk. They explained that if too many projects financed by debt, will have an impact on the inability of banks to meet the needs of depositors. So that in this case, it can be said that credit risk and

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liquidity risk increase together. Based on the above theories and empirical studies and the justification carried out with the object of research in Indonesia, we hypothesized:

H3: There was a reciprocal relationship between credit risk and liquidity risk

3. ECONOMETRIC MODEL AND DATA ANALYSIS

3.1 Econometric Model

We used panel data regression method to examine the effect of credit risk, liquidity risk, and the interaction of credit risk and liquidity risk on bank stability. The equation model used was:

$$Bank\ Stability_{it} = \beta_0 + \beta_1 CR_{it} + \beta_2 LR_{it} + \beta_3 CR_{it} * LR_{it}$$
$$+\beta_4 CAR_{it} + \beta_5 ROA_{it} + \beta_6 Inf_{it} + \varepsilon \qquad (1)$$

To test the reciprocal relationship between credit risk and liquidity risk we used the method of simultaneous equations with the Two Stage Least Square (2SLS) method. The simultaneous equation model was:

$$CR_{i,t} = C + \beta_1 CR_{i,t-1} + \beta_2 LR_{i,t} + \beta_3 CAR_{i,t} + \beta_4 ROA_{i,t} + \beta_5 Inf_{i,t} + \varepsilon \qquad (2)$$

$$LR_{i,t} = C + \beta_1 LR_{i,t-1} + \beta_2 CR_{i,t} + \beta_3 CAR_{i,t} + \beta_4 ROA_{i,t} + \beta_5 Inf_{i,t} + \varepsilon \qquad (3)$$

CR_{it} and LR_{it} represented credit risk and liquidity risk in bank i in period t. The control variables of this study were capital adequacy ratio (CAR), return on asset (ROA), and inflation. These control variables had been used in the analysis of credit risk and liquidity risk including Diaconu & Oanea (2014) Djalilov & Piesse (2016) Ghenimi et al. (2017), and Imbierowicz & Rauch (2014).

3.2 Data and Sample Selection

The population of this study was the conventional banks listed in the Indonesian Stock Exchange during the 2013-2017 period, amounted to 44 banks. This study used purposive sampling method to the conventional banks that published the financial statements during the period 2013-2017 and listed in the Indonesia Stock Exchange. Moreover, they had complete variable data for the period 2013-2017. The samples that met the sampling criteria were 28 banks with 140 observations. The used proxy in this analysis was presented in table 1.

Table 1. Description Variables

Variable	Proxy	Calculation	Description
Bank Stability	Z-Score	$Z = ln\left(\dfrac{Return\ on\ Asset + Capital\ Ratio}{\sigma\ Return\ on\ Asset}\right)$	The higher the Z value, the lower the default probability of a bank
Credit Risk	NPL	$NPL = \dfrac{Total\ NPL}{Total\ Loan} \times 100$	NPL is a non-performing loan
Liquidity Risk	LDR	$LDR = \dfrac{Total\ Loan}{Total\ Deposit} \times 100$	LDR is a loan to deposit ratio
Interaction		Interaction = CR x LR	The interaction is the same as the multiplication of credit risk (NPL) and liquidity risk (LDR)

Capital	CAR	$CAR = \dfrac{Tier\ 1 + Tier\ 2\ Capital}{Risk\ Weighted\ Assets}$	CAR is a capital adequacy ratio
Profitability	ROA	$ROA = \dfrac{Earning\ Before\ Tax}{Average\ Total\ Assets} \times 100$	ROA is a return on assets
Macro	Inflation	$Inflation = \left(\dfrac{CPI_n}{CPI_{n-1}} - 1\right) \times 100\%$	CPI is the consumer price index and n is the base year.

3.3 Descriptive Statistics

Table 2 provided descriptive overview information from the analyzed data. We presented the descriptive analysis of credit risk and liquidity risk and the control variables listed in table 1. All variables were indicated as mean, maximum value, minimum value, and standard deviation.

Table 2. Descriptive Statistics

	Mean	Maximum	Minimum	Standard Deviation
Z-Score	3.563018	5.544910	2.131382	0.763591
NPL	2.503714	8.540000	0.160000	1.457739
LDR	85.51960	124.0214	42.02000	13.89951
NPL*LDR	0.021791	0.069464	0.000832	0.013324
CAR	18.66100	29.58000	10.44000	3.529667
ROA	1.765214	5.030000	-2.820000	1.163653
Inflation	5.344000	8.390000	3.020000	2.486691

4. RESULTS AND DISCUSSION

4.1. Effect of credit risk and liquidity risk on bank stability

In this section we analyzed the effects of credit risk, liquidity risk, and their interaction on the bank stability with involving several control variables. Table 3 presented the results of statistical analysis using panel data regression method where credit risk used non-performing loan proxy and liquidity risk used loan to deposit ratio proxy. They were independent variables and bank stability with the z-score proxy was the dependent variable.

Table 3. Regression Analysis Results

Independent Variables	Coefficient	P-Value
Constanta	2.350793	0.0000
NPL	-13.29287	0.0025
LDR	0.512948	0.0214
NPL*LDR	17.07237	0.0011
CAR	3.345154	0.0000
ROA	9.635027	0.0000

Inflation	-1.126178	0.0322
Adj. R Square	0.702955	
F Statistic	55.82387	
Probability F Stat.	0.000000	

The used estimation model was random effect. It was chosen by the consideration of the theory and testing that had been done by us. The proposed equation was BLUE (Best Linear Unbiased Estimator) so it did not have classical assumption problems. The significance level was 5%.

With the significance level used at 5%, it could be seen from table 3 that the probability of credit risk was 0.0025 <0.05 with a coefficient of -13.29287. These results indicate that credit risk has a negative effect on bank stability. The negative effect of credit risk on bank stability is based on the negative role of inflation on bank stability which is considered to encourage credit risk. It is seen in table 3 that inflation has a significant negative effect on bank stability. This phenomenon explains that high inflation will encourage the weakening of the exchange rate which results in an unsuitable return on loans when the exchange rate weakens. These results confirm the results of a study from Ghenimi et al. (2017) and Imbierowicz & Rauch (2014).

The probability of liquidity risk was 0.0214 < 0.05 with a coefficient of 0.512948. These results indicate that liquidity risk has a positive effect on bank stability. The positive influence of liquidity risk on bank stability means that the provided credit is quite high, compared to the deposit of third party fund, so that the higher amount of channeled credit will increase more profitability of loan repayments which encourages the bank stability. Profitability with a proxy for return on assets is proved to have a significant positive effect on bank stability.

In addition, the cause of liquidity risk can contribute positively to the bank stability due to the liquidity issues. It occurs because the high amount of channeled funds in the form of credit compared to the third party funds, will still be controlled with strong capital. It is proven by a significant positive capital adequacy ratio to the stability. It agrees with Greuning & Bratanovic (2009) and Kolari et al. (2002) which stated that strong capital will be able to absorb potential losses. These results contradict to the results of the study of Acharya & Mora (2015), Ghenimi et al. (2017), and Imbierowicz & Rauch, (2014). The difference in the results of this study is certainly driven by some justifications of the research conducted in this study such as subject matter, proxy, and the conditions where the research is conducted.

The probability of credit risk and liquidity risk interaction was 0.0011 < 0.05 with a coefficient of 17.07237. The results are not surprising that they show a positive effect of credit risk and liquidity risk interaction on bank stability. The reason is that bank still can control the variables that play a role in the stability of the bank. Bank is still able to maintain liquidity and able to make profits through lending, so that it will encourage profitability that will strengthen the bank stability. It is proven by the results of return on assets and capital adequacy ratios that significantly increase the stability of the bank.

4.2. The relationship between credit risk and liquidity risk

In this section we analyzed the relationship between credit risk and liquidity risk, involving several control variables. Table 4 presented the results of statistical analysis using simultaneous equation model in which credit risk used non-performing loan proxy and liquidity risk used loan to deposit ratio proxy.

Table 4. Results of Simultaneous Equation Analysis

Fist Equation (NPL as Dependent Variable)	Second Equation (LDR as Dependent Variable)

Independent Variables	Coefficient	p-value	Independent Variables	Coefficient	p-value
C	0.012389	0.3102	C	0.849877	0.0000
LDR	0.017086	0.2236	NPL	0.263380	0.4915

The chosen method was two stages least square because the simultaneous equation model showed over-identified results through order condition testing. The used estimation model was random effect. It was chosen with consideration of the theory and testing that had been done by us. The level of significance was 5%.

The result of the first equation hypothesis test in table 17 could be seen that the LDR probability value was 0.2236 > 0.05. These results indicate that the LDR does not affect the NPL. The result of two stages least square, the second equation in table 18 can be seen that the NPL probability value is 0.4951 > 0.05. These results indicate that the NPL has no effect on the LDR. So that it can be concluded that H_0 is accepted and H_a is rejected, which means there is no reciprocal relationship between credit risk and liquidity risk.

The results of this study indicate that there is no simultaneity problem in the model formed between credit risk and liquidity risk. It shows that the high and low credit risk is not affected by liquidity risk, and the high and low liquidity risk is not affected by liquidity risk. Simply, there is no reciprocal relationship between credit risk and liquidity risk. The results of this study support the results of a study conducted by Ghenimi et al. (2017), Imbierowicz & Rauch (2014) who found that there is no reciprocal relationship between credit risk and liquidity risk in banks.

5. CONCLUSION AND IMPLICATION

Liquidity risk and credit risk were the two most important risks that must be faced by banks. This study studied how the influence of credit risk and liquidity risk on bank stability. We found that credit risk had a negative effect on bank stability. It was due to the role of the control variable, named inflation, which drove an increase in credit risk. Therefore it reduced the stability level of the bank.

Liquidity risk with a loan to deposit ratio proxy had a positive effect on bank stability. The high loan to deposit ratio could drive banking yields in the form of loan interest. It would boost profitability and increase the capital so that banks were increasingly able to absorb potential losses. Similarly, the interaction of the two risks to the bank stability had a positive effect. It was because banks, that were still able to maintain liquidity, would be able to generate profits through lending. Therefore, it would encourage profitability which might strengthen the stability of the bank.

Our findings had several implications that could be used as suggestions in policy making. First, credit risk contributed negatively to bank stability, so it was important for banks to maintain credit risk so that it does not exceed the safe limits of the Central Bank. Second, capital encouraged the bank stability so banks needed to strengthen their capital.

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