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Determinants of Net Interest Margin in Indonesian Banking Industry: The Moderating Role of Central Bank Interest Rate

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ABSTRACT

Objective – This article is to examine the relationship between net interest margin (NIM) and its determinants: risk averse level, liquidity risk, and credit risk. In addition, the article aims to investigate the moderating role of central bank interest rate on the relationship.
Methodology – We observe 17 Indonesian banks, which are listed on Indonesia Stock Exchange in 2017 – 2021 period. We run panel data regression model with 380 firm-year total observations. The Hausman test suggests that we use Random Effect Model (REM) for the parameter estimation.
Findings – Our study confirms that NIM is determined by credit risk, liquidity risk, and risk averse level. Other than that, we found that central bank interest rate moderates well the relationship of NIM and its determinants by which the dynamic of the relationship of net interest margin and its determinants can be explained.
Conclusion – The presence of the central bank interest rate consistently explains the dynamics of the relationship between NIM, risk-averse level, liquidity risk, and credit risk. Our model accommodates the positive/negative relationship of NIM and its determinants: credit risk, liquidity risk, and risk averse level. These findings are expected to shed light on the mixed and inconsistent findings of previous research.
Novelty – The ongoing impact of the central bank interest rate consistently elucidates the dynamics between NIM, risk aversion level, liquidity risk, and credit risk. These findings are expected to bring clarity to the mixed and inconclusive results observed in prior research.
Keywords: *Net Interest Margin; Credit Risk; Liquidity Risk; Central Bank; Interest Rate; Panel Data*

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I. INTRODUCTION

As vital financial intermediaries, commercial banks contribute to economic development by redistributing investment capital. Their primary income sources are the interest expenses paid by depositors and the interest income received from borrowers. Thus, Net Interest Margin (NIM) serves as a crucial indicator of the profitability and risk management strategies of banks as financial institutions.

Despite NIM has been extensively studied in the past (e.g., Agoraki & Kouretas, 2019; Batten & Vo, 2019; Claessens et al., 2018; Cruz-García & Fernández de Guevara, 2020; Gupta & Mahakud, 2020; Khan & Jalil, 2020), its research remains relevant and impactful in today's ever-changing financial landscape. The authors explore the reasons why research in NIM retains its significance. We found at least five reasons

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highlighting the evolving market dynamics, the evaluation of financial performance, policy implications, and the value of comparative analysis.

Banks are not sole players in financial service industry. Non-bank financial institutions become prominent as the growing numbers of un-bankable and under-bank people. By observing NIM in the context of the prominence of non-bank financial institutions, the authors can understand how banks adapt their strategies, product offerings, and risk management practices to remain competitive.

In addition, NIM continues to be a vital metric for assessing the financial health and performance of banks. Research in NIM contributes to a comprehensive understanding of the factors influencing NIM, such as loan portfolio composition, funding mix, operating costs, and risk management practices. By examining the determinants of NIM, the authors can provide insights into improving efficiency, profitability, and risk-adjusted returns in the banking sector.

Furthermore, NIM research has implications for policymakers and regulatory authorities. Understanding the effects of various policies, NIM can help evaluate the efficacy of regulations including capital requirements and interest rate policies. Research in this area can contribute to evidence-based policymaking, enabling the development of regulatory frameworks that promote financial stability, consumer protection, and sustainable profitability for financial institutions.

Finally, comparative analysis of NIM across banks, regions, and economic cycles offers significant value. Such analysis allows for benchmarking, identification of best practices, and areas for improvement. By exploring variations in NIM metrics, the authors search differences in business models, risk profiles, and competitive strategies. Comparative analysis also facilitates knowledge-sharing and enhances decision-making for financial institutions and policymakers.

Therefore, Net Interest Margin (NIM) research remains highly relevant today due to its implications for financial institutions, policymakers, and the broader economy. Scholars have observed NIM across banks and time periods (Agoraki & Kouretas, 2019; Alwi et al., 2021; Batten & Vo, 2019; Hao et al., 2023; Hersugondo et al., 2021; Khan & Jalil, 2020; Le & Ngo, 2020; Lestari et al., 2021; Manurung et al., 2020; Nguyen et al., 2020; Sharma & Gounder, 2011; Solichah & Hersugondo, 2022; Susilawati & Nurulrahmatiah, 2021). They studied how credit risk, the degree of banks' risk averse, and liquidity risk affect NIM. Their findings are mixed.

Problem Statement

Some studies found positive effects of credit risk and of bank's risk averse degree on NIM (Batten & Vo, 2019; Cruz-García & Fernández de Guevara, 2020; Hersugondo et al., 2021; Khan & Jalil, 2020). Some found negative effects of both variables. In addition, studies show inconsistent positive effect of liquidity risk, which is measured by loan-to-deposit ratio (LDR), on NIM. Most of studies confirm positive relationship between LDR and NIM (e.g., Hao et al., 2023; Lestari et al., 2021). Other study finds no relationship (Solichah & Hersugondo, 2022).

As far as the author knows, there have been no studies attempting to explain the mixed findings. The authors suggest that the central bank rate acts as a moderator in the relationship between NIM and three variables: credit risk, loan portfolio composition, and the bank's level of risk aversion. The central bank rate is a regulatory-based factor used by the central bank to control the amount of circulating money. Previous studies have shown that the interest rate regime has an impact on bank profitability (Claessens et al., 2018; Khan & Jalil, 2020). By including the central bank rate as a moderating variable, the authors aim to explain the varied effects of credit risk, loan portfolio composition, and risk aversion on NIM.

Based on the information provided, there are several concerns to be addressed. First, will credit risk boost NIM? Besides, does liquidity risk have positive impact on NIM? In addition, will bank's risk averse level increase NIM? Lastly, how does the central bank interest rate moderate the relationship between NIM and its determinants: credit risk, liquidity risk, and risk averse level?

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II. LITERATURE REVIEW

Ho and Saunders (1981) laid the foundation for subsequent studies on the net interest margin (NIM). They assume that bank is a risk averse dealer and market is perfect in sense that no interest rate regulation, no reserve requirement, no default risk on. Therefore, pure spread or pure NIM is influenced by four factors: the degree of managerial risk aversion, the size of transactions undertaken by the bank, bank market structure (level of competition), and the variance of interest rates which is formulated as follows:

$$M = \frac{\alpha}{\beta} + (0{,}5 \times R_A \times \sigma^2{}_I \times Q) \quad (1)$$

where,
M = pure margin
α/β = risk-neutral spread and level of competition
R_A = - (U''/U') = the degree of risk aversion
σ^2_I = variance of interest rate or interest risk
Q = size of transactions

Equation 1 implies two important points. First, more competitive the banking market is, the greater spread a bank could get. In addition, bank margin tends to increase with higher degree of risk aversion, larger size of transaction, and greater interest rate variance.

When market is imperfect, then Ho and Saunders' margin model can be expanded to include more variables regarding the imperfect market condition. Previous studies confirm that Net Interest Margin (NIM) is determined by factors other than factors that Ho and Saunders (1981) estimate.

Sharma and Gounder (2011) investigated the determinants of NIM in banks in Fiji, a developing South Pacific country, from 2000 to 2010. Building on Ho and Saunders' model, they found a positive correlation between NIM and hidden interest rates, operating costs, market power, and credit risk, while negatively correlating with management quality and liquidity risk. However, the relationship with bank capital and the opportunity cost of compulsory reserves did not align with expectations.

Agoraki and Kouretas (2019) conducted research in the banking sector of Central and Eastern European countries (CEE) from 1998 to 2016. The study analysed the impact of the legal framework, along with bank-specific, sectoral, and macroeconomic factors, on NIM. The study concluded that NIM is determined by bank-specific characteristics such as equity, risk, and operating costs. Furthermore, it emphasized the significant role of the legal framework and the presence of foreign-owned organizations in shaping NIM in CEE countries.

Pham (2013) conducted a study on the net interest margin (NIM) in Vietnamese commercial banks from 2008 to 2012, exploring the impact of ownership structures. They identified several factors positively influencing NIM, such as operating costs, credit risk, equity ratio, and liquidity risk. This indicated that banks with better control of costs and risk management, higher equity ratios, and larger lending sizes tended to have higher NIM.

Hao et al. (2023) examined the banking sector in Vietnam during the period of 2007-2018. They studied the influence of loan-to-deposit ratio (LDR), credit risk, and risk aversion level. Using the Fixed Effect Model in panel data analysis, they found that credit risk, risk aversion, and LDR have a positive impact on NIM (Net Interest Margin).

Nguyen et al. (2020) investigated banks in Vietnam from 2006 to 2015. They found that credit risk has a negative effect on NIM, while the level of risk aversion has a positive impact on NIM.

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Batten and Vo (2019) explored the impact of credit risk and capital adequacy ratio (CAR) on NIM in Vietnamese banks from 2006 to 2014. They discovered that both variables influence NIM. Credit risk has a positive effect on NIM, as does CAR.

Manurung et al. (2020) conducted a study on banks in Indonesia to examine the factors influencing NIM in the Indonesian banking sector during the period of 2014-2018. They did not find any impact of non-performing loan (NPL) and CAR on NIM. In addition, Solichah and Hersugondo (2022) studied the banking sector in Indonesia during the period of 2015-2019. They did not find any impact of loan-to-deposit ratio on NIM.

On the contrary, Lestari et al. (2021) obtained different findings. They studied the loan-to-deposit ratio (LDR) and credit risk and their impact on NIM during the period of 2015-2019. They found a positive influence of the LDR and a negative influence of credit risk on NIM.

Hersugondo et al. (2021) They investigated the determinants of NIM in the banking sector of Indonesia during the period of 2015-2019. They found that CAR (Capital Adequacy Ratio) and non-performing loan (NPL) have an impact on NIM. By employing a random effect model in panel data analysis, they constructed a model for the determinants of NIM. NPL affects NIM both positively and negatively. On the other hand, CAR has a negative effect on NIM.

Previous studies outside of Southeast Asia also indicate the influence of risk aversion level and credit risk on NIM. Khan and Jalil (2020) examined the banking sector in Pakistan during the period of 2003-2017. They found a negative effect of credit risk and a positive effect of CAR on NIM. Additionally, they discovered that interest rates have a positive impact on NIM.

Gupta and Mahakud (2020) discovered the impact of credit risk and capital ratio on NIM in banks operating in India. With an extensive observation period spanning from 1998 to 2016, they examined the relationship between NIM, credit risk, and capital ratio in the Indian context. Employing a fixed-effect panel data model, they identified that credit risk negatively affects NIM, while the capital ratio positively influences NIM.

A study conducted in Europe found the influence of risk aversion level on NIM. Angori et al., (2019) examined the banking sector in the European region during the period of 2006-2014. They employed the parameter estimation technique GMM (Generalized Method of Moments) and found that risk aversion level has a positive impact on NIM.

Two banking studies across multiple countries found the influence of credit risk and risk-averse level on NIM. Cruz-García and Fernández de Guevara (2020) examined banks in 31 OECD countries, they found a positive influence of credit risk on NIM using panel data estimation.

Furthermore, Le and Ngo (2020) examined banks in 23 countries during the period of 2002-2016. They employed an unbalanced panel data model and found that credit risk, measured by non-performing loans (NPL), has a positive impact on NIM. Additionally, they discovered a negative influence of risk aversion level, measured by CAR (Capital Adequacy Ratio), on NIM.

Among many variables that have been observed, all the studies mentioned beforehand observed variables, such as credit risk, measured by Non-Performing Loan (NPL) and liquidity risk, measured by Liquidity to Deposit Ratio (LDR). In addition, regulator's control in banking capital, in terms of minimum capital, shape behaviour of banks into more risk averse.

Thus, when bank's capital adequacy ratio (CAR) exceeds the minimum capital, then bank becomes more risk averse. Indonesian banks have got their CARs much more than the minimum capital. It implies that Indonesian banks are risk averse.

Besides minimum capital mandatory, regulator control market interest rate through central bank rate. Indonesian central bank (BI) uses BI 7-day repo rate as a central bank rate, which is known as BI rate. The rate changes periodically following US bank central rate, which is known as Fed Rate. BI rate matters for it lays a foundation for all market interest rates.

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Anyway, it is still hard to find in the literature studies on the impact of central bank interest rate, especially BI rate, on NIM (e.g., Claessens et al., 2018). We expect to contribute the literature by examining the effect of central bank interest rate on the relationship between NIM and its determinants: credit risk, liquidity risk, and risk averse level.

Theoretical Framework

By expanding the model suggested by Ho and Saunders (1981), we develop determinants model of NIM and applying central bank interest rate as moderating variable. To develop our model, we assume that market is imperfect to include credit risk, liquidity risk, and central bank interest rate. We keep risk averse level, which is included in the pure margin Ho and Saunders' model.

Although banks have expanded their sources of income, credit continues to be the main driver of profits. When banks encounter elevated credit risks, they tend to raise lending rates as a strategy to mitigate risks. The increase lending rates drive net interest margin wider. Thus, the higher credit risk is, the higher net interest margin (Hao et al., 2023).

The direct impact implies that when the cost of deposit insurance (premium) increases, banks are unable to invest a portion of the deposits in profitable assets. As a result, banks will set higher margins to compensate for the increased opportunity cost. However, the second effect, which involves the interaction of deposit insurance premium with credit risk and the covariance of credit and interest rate risk, is not clearly defined as it depends on other variables. On one hand, with deposit insurance in place, depositors bear lower risk, leading to lower interest rates on deposits. This would cause the net interest margin to increase, resulting in a positive effect.

On the other hand, deposit insurance may incentivize banks to engage in riskier lending practices to offset potential payouts from the insurance (moral hazard). Some studies in the existing literature indicate that when banks adopt riskier lending strategies, creditors may demand higher interest rates. This would lead to lower net interest margins, suggesting a negative relationship with the deposit insurance variable (Cruz-García & Fernández de Guevara, 2020).

The negative effect of credit risk on NIM might be driven insufficient loan monitoring and rushed underwriting of advances to gain a larger market share (Khan & Jalil, 2020). The misallocation of resources to unrelated business activities or fraudulent actions by borrowers, stemming from a lack of due diligence and inadequate monitoring processes, can contribute to the accumulation of bad loans in banks, ultimately leading to reduced profitability (Gupta & Mahakud, 2020; Khan & Jalil, 2020). Thus, the first hypotheses of this study are:

Hypothesis 1a: Credit risk affects NIM positively

Hypothesis 1b: Credit risk affects NIM negatively.

Risk-averse banks, characterized by significant equity holdings, typically depend less on external borrowing. However, this reduced reliance on external funds can potentially raise the average cost of capital due to the diminished tax shield benefits from loan interest. As a result, banks may shift the burden of equity costs onto loan interest rates, leading to higher rates. Consequently, these higher loan interest rates contribute to elevated net interest margins for the banks (Hao et al., 2023).

The greater the capital requirement, the higher the profit margin. This suggests that banks pass on these additional costs to their customers by increasing their margins. Increased capital requirements can diminish bank profitability and overall wealth since higher capital is more expensive than debt, and it also results in a decrease in available wealth.

Consequently, banks will charge higher margins to compensate for the cost associated with maintaining the mandated high levels of capital. Furthermore, higher capital levels enhance the bank's solvency, enabling it to attract deposits at a lower cost, which can translate into higher margins. Taking this effect

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into consideration, our empirical analysis examines the positive impact of minimum capital requirements on the bank interest margin. Furthermore, tighter requirements can result in increased risk aversion among banks, leading them to enhance their capitalization levels and, consequently, operate with higher margins to offset the elevated costs of equity financing (Angori et al., 2019; Cruz-García & Fernández de Guevara, 2020).

On other hand, moral hazard hypothesis suggests that banks with higher capitalization levels tend to allocate their investments towards riskier assets (Le & Ngo, 2020). Thus, to anticipate it, deposit holders required higher interest rate by which bank's margin reduces. Thus, the second hypotheses of this study are:

Hypothesis 2a: Risk averse level affects NIM positively.
Hypothesis 2b: Risk averse level affects NIM negatively.

Commercial banks commonly utilize loan-to-deposit ratio (LDR) to assess the level of safety and liquidity risk. As banks gather capital and grant loans with different maturity periods, they consistently face the potential risk of sudden customer withdrawals. When the ratio of loans to customer deposits is excessively high, the bank has a smaller secure buffer and may encounter liquidity risk if it is unable to meet customer withdrawal demands.

As a result, banks exercise greater caution in lending, leading to higher lending rates and ultimately a higher net interest margin. Based on this reasoning, this study expects that the ratio of outstanding loans to customer deposits will positively influence the net interest margin. Thus, the third hypothesis of this study is:

Hypothesis 3: Liquidity risk affects NIM positively.

The central bank, as a monetary regulator, sets the central bank interest rate to control the money supply. High interest rates are implemented to curb the growth of bank credit, while low interest rates aim to stimulate credit expansion. There are periods when the central bank interest rate remains low in the long term.

Claessens et al. (2018) studied the impact of low-interest rate policies on banking profitability. Using a sample of 3,385 banks from 47 countries during the period from 2005 to 2013, their study reveals that a one percentage point decrease in interest rates leads to an 8-basis points reduction in net interest margin. Notably, this effect is more pronounced (20 basis points) when interest rates are already low.

In addition, Claessens et al. (2018) explain that the prolonged period of low interest rates also has an adverse impact on bank profitability, although the magnitude of the effect varies across different banks. Moreover, with each additional year of experiencing a "low-for-long" interest rate environment, both margins and profitability decline by 9 and 6 basis points, respectively.

Therefore, this suggests that the influence of the three variables, namely credit risk, liquidity risk, and risk-averse level, depends on the interest rate regime set by the central bank. Thus, the fourth, fifth, and sixth hypotheses of this study are:

Hypothesis 4: Central bank interest rates moderates the relationship between credit risk and NIM.
Hypothesis 5: Central bank interest rates moderates the relationship between liquidity risk and NIM.
Hypothesis 6: Central bank interest rates moderates the relationship between risk averse level and NIM.

Figure 1 shows the relationship between net interest margin, risk averse level, credit risk, liquidity risk, moderated by central bank interest rate.

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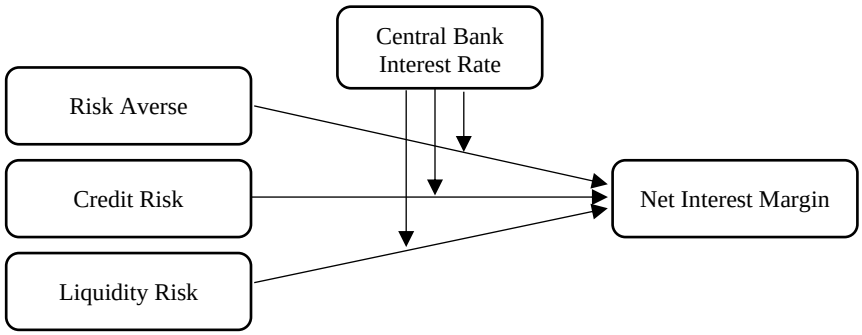

Figure 1. Relationship of NIM and Its Determinants

III. METHODOLOGY

We collected quarterly data with the observation period from the first quarter of 2017 to the fourth quarter of 2021. The population consisted of publicly listed banks on the Indonesia Stock Exchange (IDX). We use purposive sampling by applying the following criteria:

1. Banks that are consistently listed on the Indonesian Stock Exchange (IDX) from 2017 to 2021.
2. Banks provide complete financial statements on quarterly basis during the observation.
3. Banks's stocks are actively traded on IDX.
4. Banks have total capital not less than IDR 5 trillion.

Based on the criteria mentioned above, we obtained 19 banks with quarterly observations during the period from the first quarter of 2017 to the fourth quarter of 2021. Therefore, there are 380 firm-time total observations. The data were sourced from quarterly financial reports downloaded from each bank's website or from the Indonesian Stock Exchange website, www.idx.co.id.

To measure credit risk, we use non-performing loan, denoted as NPL. Non-performing loan refers to the amount of bad loan relative to total loan. Researchers have used NPL as proxy for credit risk (e.g., Alwi et al., 2021; Cruz-García & Fernández de Guevara, 2020; Hao et al., 2023; Susilawati & Nurulrahmatiah, 2021).

We use capital adequacy ratio, denoted as CAP, as a proxy for the risk-averse level of banks. The banking regulator in Indonesia sets a minimum capital requirement for banks. Generally, banks in Indonesia maintain capital adequacy ratio above the government's minimum requirement. Therefore, we see that capital adequacy ratios in Indonesian banks go beyond mere compliance and reflects the prudence of the banks. Researchers have commonly used capital adequacy ratio to calculate the risk-averse level (e.g., Angori et al., 2019; Batten & Vo, 2019; Gupta & Mahakud, 2020).

In addition, liquidity risk is measured by the loan-to-deposit ratio, denoted as LDR. This ratio indicates the proportion of loans extended by a bank relative to the total amount of deposits the bank has collected. LDR is widely used by researchers as a proxy for liquidity risk (e.g., Hao et al., 2023; Lestari et al., 2021).

We collected data including NPL, CAP, dan LDR by downloading quarterly financial reports from company website or IDX website. We apply two control variables: one is bank-specific variable, and another is country-level variable. We use bank's size, as bank-specific control variable. Bank size is measured using natural logarithm of total bank's assets, which is denoted as LNSIZE.

Total assets of non-bank financial institutions relative to Indonesian GDP, denoted as NONBANK. Data on the bank's size was obtained from the financial reports of the banks. On the other hand, data for NONBANK was obtained from the global economy dot com, which provides economic and banking data for more than 200 countries, including Indonesia.

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The central bank interest rate from Bank Indonesia, denoted as RATE, is used as a moderating variable to investigate how the central bank interest rate affects the relationship between NIM and the three variables: liquidity risk, credit risk, and risk averse. Data on the central bank interest rate was obtained from the website of Bank Indonesia: www.bi.go.id.

The moderation of the central bank interest rate is observed through the interaction variables between the central bank interest rate (RATE) and each independent variable, namely CAP, NPL, and LDR. The interaction of variables CAP and RATE is denoted as CAP_RATE. The interaction of variables NPL and RATE is denoted as NPL_RATE. Meanwhile, the interaction of variables LDR and RATE is denoted as LDR_RATE. The dependent variable is Net Interest Margin, denoted as NIM, which represents the ratio of the difference between interest income from loans and interest expenses on deposits to total earning assets.

Therefore, to investigate the relationship between NIM, LDR, CAP, NPL, and RATE, we develop the following regression model:

$$NIM_{it} = \gamma_i + \gamma_1 NPL_{it} + \gamma_2 CAP_{it} + \gamma_3 LDR_{it} + \gamma_4 RATE_{it} + \gamma_5 NONBANK_{it} + \gamma_6 LNSIZE_{it} + \gamma_7 NPL\_RATE_{it} + \gamma_8 CAP\_RATE_{it} + \gamma_9 LDR\_RATE_{it} + \varepsilon_{it} \quad (2)$$

Equation 2 is going to be estimated using the Random Effect Model (REM) if the Hausman test is passed. If the Hausman test is not passed, then we will use the Fixed Effect Model (FEM).

IV. RESULTS AND DISCUSSION

Table 1 presents the descriptive analysis for all variables. The average NIM of the sample companies is close to 5%. This places Indonesia as the country with the highest NIM in Southeast Asia. Based on NPL, Indonesia is classified as having relatively low credit risk, where the highest NPL is 4.82%, still below 5%. Additionally, the average LDR is 89.29%. Generally, Indonesian banks secure more than 10% of the deposited funds, indicating a relatively cautious approach by banks in Indonesia.

The average Capital Adequacy Ratio (CAP) is 25.95%, and the minimum CAP value is 13.41%. This indicates that banks in Indonesia set their CAP well above the minimum requirement stipulated by regulators. This suggests that banks in Indonesia are more risk-averse compared to other countries in the Southeast Asian region.

Table 1. Descriptive Analysis

	NIM	NPL	LDR	CAP	LNSIZE	NONBANK	RATE
Mean	4,98	1,41	89,29	25,95	18,73	6,66	4,6
Median	4,82	1,115	88,125	21,07	18,97	6,62	4,375
Maximum	9,85	4,82	171,32	538,01	21,18	7,24	6
Minimum	-0,95	0	41,22	12,49	13,41	6,24	3,5
Observations	380	380	380	380	380	380	380

The central bank interest rate (RATE) shows a relatively wide range, ranging from 3.5% to 6%. This indicates that the observation period of this study accommodates a fluctuating interest rate regime, unlike the stable low-interest rate regime studied by Claessens et al. (2017). Moreover, the broad range of the central bank interest rate provides a dynamic condition, making it suitable for examining the role of the central bank interest rate as a moderating variable in the relationship between NIM, NPL, LDR, and CAP.

Table 2 displays the correlation matrix among the variables. Each correlation coefficient between variables does not exceed 0.5 or is less than -0.5. This indicates a low potential for multicollinearity in the

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regression model to be built. Although the matrix reveals relationships between NIM and other variables, it is essential to conduct regression analysis to ascertain the causality between NIM and these other variables.

Table 2. Correlation Matrix among Variables

VARIABLES	NIM	NPL	LDR	CAP	LNSIZE	NONBANK	RATE
NIM	1.000.000						
NPL	-0.203845	1.000.000					
LDR	-0.079095	-0.216234	1.000.000				
CAP	0.085035	-0.219449	0.153916	1.000.000			
LNSIZE	0.184614	-0.454452	0.014106	-0.255838	1.000.000		
NONBANK	0.278481	0.131371	-0.027215	-0.129559	-0.086397	1.000.000	
RATE	0.153875	0.157387	0.139832	-0.156962	-0.067488	0.137371	1.000.000

Table 3 presents coefficient parameters of all explanatory variables as the results of the regression using the Random Effect Model (REM) for panel data. Based on the Hausman test, the Random Effect Model is the most suitable for parameter estimation. The model also passes the F-test, confirming its adequacy. To protect the model from potential heteroskedasticity and autocorrelation, we generated robust standard errors using the weighted regression with the white cross-section standard error and covariance method. With this method, the t-statistics displayed in parentheses are robust and reliable for testing the significance of variables. The R-squared value indicates that the model can explain nearly 40% of NIM. This level of explanatory power is relatively good for research in the fields of finance and banking.

Based on the t-test for each variable, LDR does not have a significant effect on NIM. This suggests that liquidity risk is not considered by bank management in profit maximization. The result implies that the LDR in Indonesian banks is at a safe level, and liquidity risk is no longer a major concern. However, after interacting LDR with the central bank interest rate (RATE), the impact of LDR on NIM becomes significant and negative.

This indicates that an increase in the central bank interest rate will be followed by an increase in loan interest rates, which will raise credit risk to non-performing levels. To compensate for the increased credit risk, depositors demand higher deposit interest rates, thereby squeezing the bank's interest margin.

Next, the t-test for NPL, which is a proxy for credit risk, shows that credit risk negatively affects NIM. This aligns with hypothesis 1b, which is based on the moral hazard hypothesis. According to this hypothesis, when credit risk decreases, banks may become more reckless in providing high-risk loans, believing they can control the risk when NPL is relatively low. However, depositors anticipate this behaviour and demand higher deposit interest rates, thus compressing the interest margin.

On the other hand, when NPL is interacted with the central bank interest rate, the negative impact of NPL is reduced by the central bank interest rate. This can be understood as follows: when the central bank interest rate is higher, it encourages higher loan interest rates and eventually increase net interest margin. To minimize loan defaults, banks become more cautious in providing credit. If loans are at risk of default, banks take steps to restructure the loans, thereby reducing the risk of defaults.

In addition, the risk-averse level measured by CAP shows a positive influence on NIM. This finding supports hypothesis 2a, which explains the positive relationship between NIM and CAP. The more capital is deposited for self-insurance against credit risk and/or liquidity risk, the more risk-averse the bank becomes. Deposited funds are costly, as there is an opportunity cost where the funds could have been lent out as loans and earned higher interest compared to the interest earned when deposited in money market

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instruments. To compensate for the opportunity cost, banks demand higher loan interest rates. Assuming deposit interest rates remain constant, an increase in loan interest rates raises the interest margin (NIM).

Table 3. Coefficient of Parameters

Independent Variables	Coeffecients	Control Variables	Coeffecients	Interaction Variables	Coeffecients
	-0,49252		0,993479		0,07061
NPL	[-2,744024]***	NONBANK	[10,52876]***	NPL_RATE	[1,920272]*
	0,001157		0,997284		-0,004254
LDR	[0,112772]	RATE	[4,167779]***	LDR_RATE	[-2,241609]**
	0,074029		-0,031669		-0,018164
CAP	[5,339106]***	SIZE	[-0,178064]	CAP_RATE	[-4,989032]***
F-statistic	[27,36823]***				
Hausman Test	REM				
White cross-section standard error and covariance	Yes				

Note:
Dependent Variable: NIM
t-statistic in parentheses
*Level of significance at 10%
**Level of significance at 5%
***Level of significance at 1%

Interestingly, when CAP is interacted with RATE, the positive impact of CAP on NIM is reduced by RATE. In other words, when a bank increases its capital during a period of rising interest rates, the interest margin will decrease. When the central bank interest rate is high, it significantly increases the opportunity cost. As a result, banks will raise loan interest rates even higher to compensate for the significant increase in opportunity cost.

The significant increase in loan interest rates raises the risk of default or non-performing loans. This is anticipated by deposit insurers, who respond by increasing deposit premiums, which are a component of deposit costs borne by banks. Consequently, the rise in deposit premiums puts pressure on the interest margin.

Robustness Check

Table 4 shows robustness check by applying six models by which we can see the consistency of each variable's effect on NIM. It shows consistent positive effect of CAP on NIM. The interaction variable of CAP and RATE is also consistent negative.

It is evident that central bank rate (RATE) moderates well the three independent variables, including CAP, NPL, and LDR. It appears that all the interaction variables show results that are not mixed and conclusive.

This indicates that the dynamics of the central bank interest rate policy can explain the mixed findings, where the three variables CAP, NPL, and LDR have both negative and positive effects on NIM. The interaction with the central bank interest rate sheds light on the complexities of these relationships, providing insights into how changes in the interest rate can moderate the impact of credit risk, liquidity risk, and risk-averse level on the net interest margin.

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Table 4. Robustness Check

Variables/Model	1	2	3	4	5	6
Independent Variables						
NPL	0,157614	0,071464	0,010543	-0,047799	-0,493964	-0,49252
	[1,855822]*	[0,785213]	[0,102544]	[-0,180032]	[-2,759669]***	[-2,744024]***
LDR	-0,003419	-0,003678	-0,010223	0,016134	0,001221	0,001157
	[-0,518376]	[-0,680987]	[-1,972123]**	[1,429849]	[0,9028]	[0,112772]
CAP	0,007086	0,008275	0,009532	0,077025	0,073403	0,074029
	[4,413706]***	[6,240984}***	[5,625978]***	[4,930771]***	[5,700893]***	[5,339106]***
Control Variables						
NONBANK		1,070404	1,026353		1,001243	0,993479
		[8,423315]***	[13,46379]***		[9,787576]***	[10,52876]***
RATE			0,294846	1,525974	1,000129	0,997284
			[5,412021]***	[5,566287]***	[4,323922]***	[4,167779]***
SIZE			0,056709			-0,031669
			[0,272067]			[-0,178064]
Interaction Variables						
NPL_RATE				-0,011252	0,071424	0,07061
				[-0,215845]	[1,948196]*	[1,920272]*
LDR_RATE				-0,008002	-0,0043	-0,004254
				[-3,533449]***	[-2,539143]**	[-2,241609]**
CAP_RATE				-0,01933	-0,018023	-0,018164
				[-4,484907]***	[-5,229856]***	[-4,989032]***
R-Squared	0,0415	0,261541	0,329258	0,214156	0,39862	0,399657
F-statistic	[5,426517]***	[33,20354]***	[30,51672]***	[14,48230]***	[30,73924]***	[27,36823]***
Hausman Test	REM	REM	REM	REM	REM	REM
White cross-section standard error and covariance	Yes	Yes	Yes	Yes	Yes	Yes

V. CONCLUSION

Based on the findings and analysis above, several conclusions can be drawn. First, risk-averse level positively affects NIM. Second, credit risk negatively impacts NIM. Third, there is not enough evidence to support the influence of liquidity risk on NIM. Fourth, the central bank interest rate reduces the positive impact of risk-averse level on NIM. Fifth, the central bank interest rate makes the negative impact of liquidity risk on NIM significant. Lastly, the central bank interest rate mitigates the negative impact of credit risk on NIM.

The presence of the central bank interest rate consistently explains the dynamics of the relationship between NIM, risk-averse level, liquidity risk, and credit risk. Our model accommodates positive/negative relationship of NIM and its determinants: credit risk, liquidity risk, and risk averse level. These findings are expected to shed light on the mixed and inconsistent findings of previous research.

As the impact of central bank interest rate on the relationship of NIM and its determinants is evident, then it implies that bank's management must imply strategies according to central bank interest rate regime. It seems that different interest rate regime takes different banking strategy. In addition, as imperfect market

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is evident then, banks can determine interest rate higher than pure interest margin estimated by Ho and Saunders' model.

On other hand, we are aware of limitations of our model. First, the model does not include more country-level variables, such as GDP growth, inflation rate, and stock market index (as capital market is alternative funding to banking). Second, our conclusion involves only one regime of central bank interest rate policy. We skipped the other regimes like low-for-long interest rate policy and high-for-long interest rate policy. Third, our study is limited to Indonesia banking market.

Furthermore, this study could be expanded to include contexts with longer-term interest rate regimes, such as the low-for-long interest rate regime and high-for-long interest rate regime. This research focused on the era of a downtrend in the central bank interest rate. It would be intriguing to explore studies that investigate the determinants of NIM during an era of an uptrend in the central bank interest rate. To enrich further study on determinants of NIM, we suggest cross-country analysis in multiple settings of interest rate policy.

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