Available online at
http://myjms.mohe.gov.my/index.php/JEEIR

e-ISSN: 2289-2559

Journal of Emerging Economies & Islamic Research 13(1) 2025, 2135.

Journal of Emerging Economies and Islamic Research

Stress test of credit risk using Monte Carlo simulation: Indonesian *sharia* rural banks

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ARTICLE INFO

Article history:
Received 17 July 2024
Revised 15 October 2024
Accepted 17 October 2024
Published 6 January 2025

Keywords:
Stress Test
Credit Risk
Montecarlo Simulation
Error Correction Model (ECM)

DOI:
10.24191/jeeir.v13i1.2135

ABSTRACT

This study examines the influence of macroeconomic shocks on credit risk within Indonesian *sharia* rural banks for a period of January 2010 to March 2020. This study employs Monte Carlo simulations and the Error Correction Model (ECM). The results indicate that GDP growth, inflation, and exchange rate are significantly influence the Non-performing financing (NPF) in the long term, while interest rate have a considerable impact on the NPF in the short term. Meanwhile, financing or credit growth has no substantial impact on the NPF in either the long term or short term. The stress test results indicate that Indonesian Islamic rural banks have a high probability of default with a forecasted NPF rate of 10.91%, a differential maximum NPF of 0.33 % at a confidence level of 95%. Therefore, it is suggested that the banks should note that the exchange rate has a strong effect on NPF, and anticipate the high probability of default with sufficient capital to cover losses.

1. Introduction

The stability of the *sharia* rural bank known as Bank Pembiayaan Rakyat Syariah (BPRS) is crucial for enabling the community's economy in the real sector as a financial intermediary institution. The impediment of bank operations can hinder the efficient operation of the community's economy, particularly affecting micro, small, and medium enterprises, known as Usaha Mikro Kecil dan Menengah (UMKM), which represent the primary financing target for Islamic rural banks in Indonesia.

In Islamic banks, financing or credit refers to the provision of cash and claims based on *mudharabah*, *musyarakah* contracts, or other financing based on profit-sharing principles (Peraturan Bank Indonesia 2003). Islamic banks, primarily engaged in channeling funding are very prone to financing risks. Financing risk or credit risk, refers to the potential loss resulting from a customer's or another party's inability to fulfill their obligations to the bank. There are five levels of credit risk, including current, special mention,

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substandard, doubtful, and loss (SK Direktur Bank Indonesia 1998). The non-current or non-performing financing consists of substandard, doubtful, and loss categories. An increase in non-current or non-performing financing affects the value of the NPF ratio. Non-Performing Financing (NPF) is the ratio of the total non-current financing to total financing categories granted. The permissible threshold for the NPF ratio of BPRS is 7 % (Peraturan Bank Indonesia 2007).

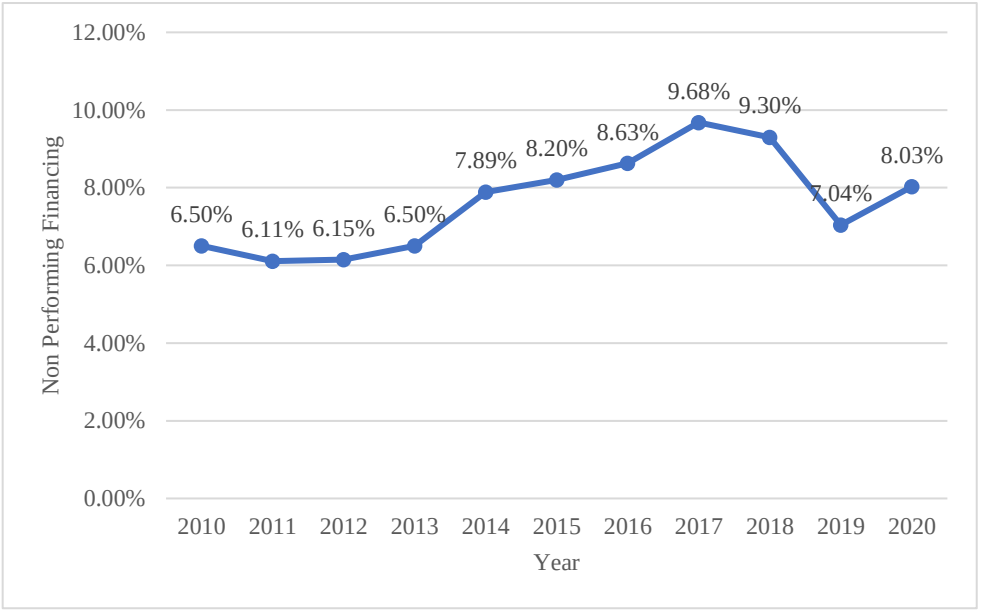

Figure 1. NPF of BPRS in Indonesia 2010-2020

The high NPF of the BPRS, with an average NPF of 8.54 % and a high NPF of 11.8 % in July 2018, signifies a substantial amount of bad financing encountered by the BPRS. The NPF can adversely affect the health of the BPRS by necessitating a larger reserve for bank losses, diminishing the impact on bank operating profit, and resulting in reduced creation of additional bank capital. This affects reduced profit sharing for the Third Party Fund (DPK) customers, prompting them to consider alternative banks or more profitable investments. Yulianto and Solikhah (2016) revealed that an increase in NPF ratio correlates with a decrease in the number of deposits. The public's inclination to deposit funds in Islamic banks will diminish due to concerns regarding the bank's ability to refund the deposited cash or provide minimal profit sharing. If mismanaged, the elevated NPF ratio can jeopardize the bank's insolvency. The determinants of NPF can be attributed to both internal and external causes. Internal factors arise from banking operational activities, including financing growth, whereas external factors stem from macroeconomics conditions, such as economic growth, inflation, interest rates, and exchange rates (Auliani & Syaikhu, 2016).

Prior studies do not uniformly reveal the determinants influencing financing quality, as indicated by NPF. Karmila (2013) and Saputro et al. (2019) reveal that credit growth has a positive effect on NPL, however Harahap (2017) contends that credit growth adversely affects NPL. Firdaus (2017) posits that GDP growth positively influence NPF, however Sulastri et al. (2016) and Indra (2018) indicate that GDP adversely affects NPF. Conversely, Wahyudin et al. (2020), Dewi (2020), and Romadhoni (2017) asserts that GDP has no impact on NPF. Inflation positively influences NPF, as stated by Wahyudin et al. (2020) and Indra (2018), but Romadhoni (2017), Dewi (2020), and Rindang (2019) assert that inflation has no impact on the NPF of BPRS. According to Indra (2018) and Rindang (2019), interest rates positively influence NPF, however, Putri (2016) indicated a negative effect of interest rates on NPF. Conversely, Wahyudin et al. (2020) asserted that interest rates had no impact on NPF. Romadhoni (2017) asserts that the exhanges rate positively influences NPF, however Sulastri et al. (2016) and Yolanda (2019) contend

https://doi.org/10.24191/jeeir.v13i1.2135

that the exchange rate has no impact on NPF. Given the inconsistent findings, this study seeks to examine factors influencing NPF through the lens of credit risk stress testing at Sharia rural Banks in Indonesia, noting the absence of prior studies addressing stress test of financing or credit risk within this context.

2. Literature review

2.1 Islamic rural bank

An Islamic bank conducts its operations in accordance with sharia principles, and Islamic legal principles regulated in the fatwa of the Indonesian Ulema Council, which include the principles of justice and balance ('adl wa tawazun), benefit (maslahah), universalism (natural), and exclusion of gharar, maysir, usury, injustice and unlawful objects (Hasan, 2009). Islamic banks comprises of commercial banks and Islamic rural bank or called Bank Pembiayaan Rakyat Syariah (BPRS), with the primary distnction being that BPRS are prohibited from receiving deposits in the form of demand deposits and participating in payment system transactions (Undang-undang Republik Indonesia 2008).

2.2 Business cycle theory

Business cycle theory posits that economy will inevitably encounter phases of expansion and contraction, which will alternatively recur over a specific duration. Abel et al. (2008) categories the signs of business cycle as follows: Procyclical indicators are those that align with the fluctuations of the business cycle, while countercyclical indicators move inversely to the business cycle throughout both expansion and contraction. A cyclical indicator indicates a fluctuate independently of the business cycle.

2.3 Financing or credit risk

Financing refers to the provision of funds or claims based on mudharabah or musyarakah contracts, or other financing based on profit-sharing principles (Peraturan Bank Indonesia 2003). Financing can be a source of risk if the prudent principle does not accompany in its distribution. In conventional terms, financing risk or credit risk refers to potential loss incurred when a customer or another party fails to meet their obligations to the bank. NPF is the ratio of the number of non-performing financing and the total financing provided. The number of non-performing loans is the amount of financing classified as substandard, doubtful, and loss collectability.

$$NPF = \frac{Non\ Performing\ Financing}{Total\ Financing}\ x100\% \quad (1)$$

The safe limit for the BPRS NPF ratio is 7% (Surat Edaran Bank Indonesia 2007). The assessment of the soundness of the Islamic rural bank based on the NPF ratio (Salinan Peraturan Otoritas Jasa Keuangan Republik Indonesia 2019) includes:

Table 1. Level of NPF at BPRS in Indonesia

Level	Non Performing Financing (NPF)
1	NPF ≤ 7%
2	7% < NPF ≤ 10%
3	10% < NPF ≤ 13%
4	13% < NPF ≤ 16%
5	NPF > 16%

After the NPF equation estimation are obtained, scenarios based on factors such as financing or credit growth, GDP growth, interest rates, inflation rates, and exchange rates are used to conduct stress testing.

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2.4 Financing/credit growth

Financing or credit growth refers to the fluctuation in the total amount of financing or credit disbursed by a bank over a specific period, typically expressed as a percentage. Financing or credit growth is measured by a formula as follows:

$$FNCGt = \frac{Financing_t - Fiannncing_{t-1}}{Financing_{t-1}} \text{ x } 100\% \quad (2)$$

The growth of financing could increase the opportunity for banks to obtain credit income, thereby reducing the NPF ratio. The finding is in line with Harahap (2017), who revealed that credit growth harmsNPF, in contrast to Karmila (2013), Saputro et al. (2019), and Keeton (1999) in Ghosh (2015), which suggests that the accelerated credit growth leads to an increased in credit losses, due to weak credit standards, resulting in numerous incompetent debtors and subsequent credit issues for banks.

H_1: Financing or credit growth has a significant effect on financing or credit risk (ie. NPF)

2.5 Growth domestic products (GDP) growth

GDP is a macroeconomic term that frequently used to measure economic growth. It measures the market value of all goods and services produced by a country at a given time.

$$GDP_t = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} \text{ x } 100\% \quad (3)$$

A positive GDP growth indicates an increase in individual and company income.Consequently, the ability to fulfil financial obligations (credit) potentially enhances the reduction of NPF (Ahmad & Bashir, 2013). Unlike the findings of Firdaus (2017) and Alfaro et al. (2004), which indicated that GDP growth, indicative of economic expansion, can lead banks to have inflated expectations regarding customer payment capabilities, resulting in diminished vigilance and caution in credit or financing disbursement, thereby raising the risk of increased NPF.

H_2: GDP growth has a significant effect on financing or credit risk (i.e. NPF)

2.6 Inflation

Inflation is a continuous increase in the price of goods, which decrease purchasing power, as actual value of income diminishes under the assumption of people's income is constant (Mankiw, 2006). Inflation is measured by the Consumer price index (CPI) as below:

$$Inflation = \frac{IHK_t - IHK_{t-1}}{IHK_{t-1}} \text{ x } 100\% \quad (4)$$

High inflation can hurt the decline in people's purchasing power and ability to pay debts, so it has the potential to worsen the quality of bank financing (Taswan, 2006), as revealed by Indra (2018) and Wahyudin et al. (2020) that inflation has a positive effect on NPF. On the other hand, Barus and Erick (2016) revealed that when inflation occurs, people tend to experience financial difficulties so that bank loan levels are reduced and bad loans are reduced, in line with Saputro et al. (2019) and Klein (2013), who revealed that the real value of debt payments tends to decrease with higher inflation, thereby reducing NPFs.

H_3: Inflation has a significant effect on financing or credit risk (ie. NPF).

2.7 Interest rate

Interest rates are fees for services rendered by banks, to customers engaging in purchase or sale of their products (Kasmir, 2011). Islamic banks benchmark their financing operations using market interest rates such as LIBOR, SIBOR, or JIBOR (Rivai & Ismail, 2013). As interest rates rise, the competitiveness of

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Islamic banks increases, with the profit/loss sharing ratio of Islamic banks being able to compete with the increasing interest rates of conventional bank loans. Some features cause people to choose to borrow or finance at Islamic banks whose cost of funds is considered lower (Kasmir, 2011), thus causing financing at Islamic banks to be higher and affecting the larger NPF ratio. This finding is in line with the studies of Indra (2018) and Nugrohowati and Bimo (2019), which demonstrate that interest rates have a positive effect on NPF. In contrast, Putri (2016) shown that interest rates adversely affect NPF, since rising interest rates lead to a reluctance among individual to borrow funds from banks, thereby reducing NPF due to low demand.

H_4: Interest rate has a significant effect on financing or credit risk (ie. NPF)

2.8 Exchange rate

The exchange rate represents the value of one currency in another country's currency (Sukirno, 2002). The nominal exchange rate is the relative price of the currencies of two countries. The real exchange rate is the relative price of goods between two countries. A country's exchange rate closely correlates with its exports. If the real exchange rate is low, domestic goods will be cheaper than foreign goods, increasing exports (Mankiw, 2006). When the currency depreciates (weakens), the success of entrepreneurs tends to be hampered due to increased production costs, especially those related to imported goods. The increase in production costs affects decreasing the income of entrepreneurs and decreasing the ability to pay debts so that it has the potential to increase the NPF, as revealed by Indra (2018) that the depreciation of the exchange rate contributed to the increase in NPF. On the other hand, an increase in the exchange rate has an impact on benefiting export entrepreneurs (exporters) because the price of domestic goods increases, so that businesses earn more income and the ability to pay debts increases, resulting in a decrease in bank NPF, as Widyaningsih (2021) states that the exchange rate harms NPL.

H_5: Exchange rate has a significant effect on financing or credit risk (i.e. NPF)

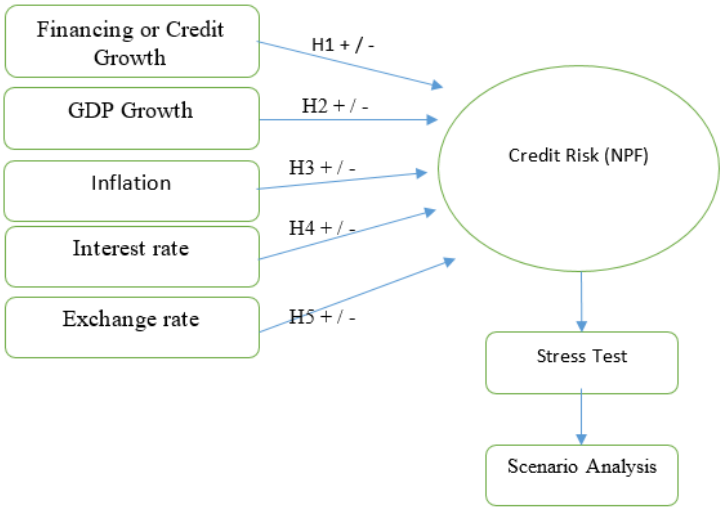

Figure 2. Conceptual framework

2.9 Stress test

The stress test is a method to assess the level of resilience and soundness of banks when faced with crisis conditions that originate from extreme shocks, either externally or internally. A stress test helps the authority and management to develop knowledge in the risk assessment process and improve understanding and perception of risks (Basel Committee on Banking Supervision, 2009). We simplify the test using

https://doi.org/10.24191/jeeir.v13i1.2135

financing risk only. The ratio of NPF serves as a measure of this risk, and it also indicate the probability of default (Quagliariello, 2009) reveals that external shocks originating from macroeconomics can affect giving stress to the probability of default (PD) and expected loss (EL) with hypotheses on loss given default (LGD) and exposure at default (EAD), which have an impact on a bank's profit and capital.

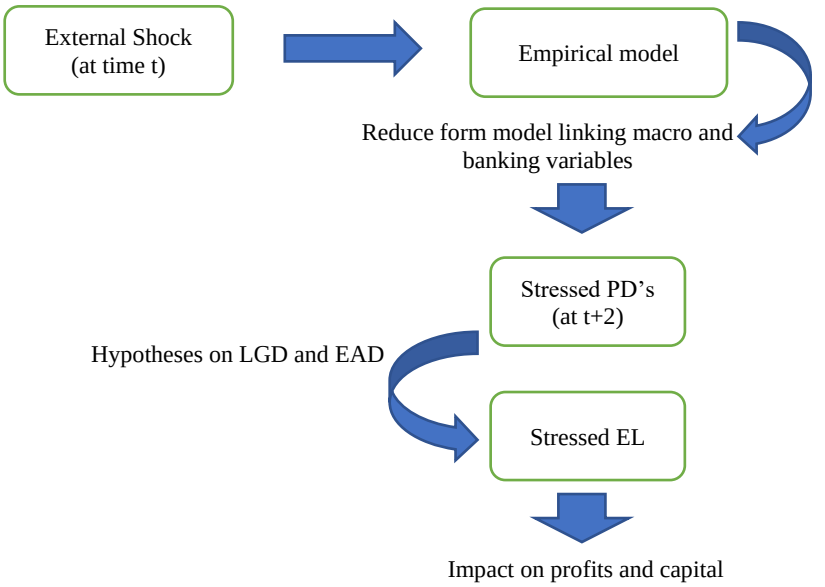

Figure 3. Bank stress test

The probability of default (PD) is the probability that the debtor will default on his obligations to the creditor. The probability of default is measured using the ratio of NPF, adopting the default risk model from Ong (1999) which assumes that default risk is a company's uncertainty in terms of its ability to fulfil all obligations to debtors and obligators. Expected Loss (EL) is the amount of loss that is expected as a result of default. A bank may face an estimated amount of loss when a default occurs, known as Exposure at Default (EAD). After accounting for the collateral the debtor provides as a substitute for the debtor's obligations, Loss Given Default (LGD) represents the portion of bank losses that the bank cannot recover due to a default (Hibbeln, 2010).

2.10 2.10 Monte carlo simulation

The Monte carlo simulation is a quantitative risk assessment technique utilised by organizations in the risk management process, particularly during risk analysis and evaluation. It involves random variables and employs probability distribution derived from historical data and theoretical probability distributions. In a Monte Carlo simulation, values of parameters are drawn randomly from the input probability distribution. Each set of samples is called an iteration, and the outcomes derived from those samples are recorded. A Monte Carlo simulation does this process hundreds or thousands of times, yielding a distribution of potential outcomes. The Monte Carlo simulation offer a more comprehensive view of what might happen and their probabilities.

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3. Method

The study population comprises Islamic banks in Indonesia registered with the OJK, as summarized in the consolidated data of Islamic banks in Indonesia, including a sample of Islamic rural banks, known as Bank Pembiayaan Rakyat Syariah (BPRS), operating from January 2010 to March 2020. The data used are monthly time series data on financing growth (FNCG), inflation (INFL), interest rates (JIBOR), exchange rates (LKURS) and Non-Performing Financing (NPF). Data is sourced from data documentation officially released by the websites of Bank Indonesia (BI) and the Otoritas Jasa Keuangan (OJK). The tests used in this study include descriptive analysis, Error Correction Model (ECM) regression and Stress test using Monte carlo simulation

3.1 Error Correction Model (ECM)

Error Correction Model (ECM) is a regression technique for correcting short-term discrepancies towards long-term equilibrium, with aimed at elucidating the impact of financing growth, GDP growth, inflation, interest rates and exchange rates on NPF of BPRS in Indonesia. The stages and criteria for implementing the ECM technique, including the stationarity test, degree of integration test and cointegration test were carried out. The stationary distribution of the data indicates a tendency for the data distribution to approach the average value, resulting in a constant variance of the data. It is crucial to conduct a stationary test to prevent lancing regression, which can lead to unreliable interpretation results. The Phillips-Perron test (PPTest) is a standard procedure for the stationarity test. This study employs the Phillips-Perron test (PP test) at a significance level of 5%. The criteria states that if the probability value is less than the critical value of 5%, the data is considered stationary; if the probability value exceeds the critical value of 5%, the data is not considered stationary. The degree of integration test is a continuation of the unit root test and is only needed if all the data is not stationary at degree zero or 1 (0). We use the degree of integration test to determine the extent to which the data will be stationary. This test is also carried out with a PP test with a significance level of 5% until the resulting data is stationary. Cointegration is a long-term relationship between variables which although individually are not stationary, but the linear combination between these variables can be stationary. The cointegration test used is the Johansen Cointegration test. If the trace statistic value is greater than the critical value and the probability value is less than the critical value 0.05, it can be concluded that there is a cointegration relationship between variables.

The model estimation of this study as follows:

$$NPF_t = \alpha + \beta_1 FNCG_t + \beta_2 GDP_t + \beta_5 INFL_t + \beta_4 JIBOR_t + \beta_5 LKURS_t + \varepsilon_t \quad (5)$$

Description :

- NPF = Non Performing Financing
- FNCG = Financing growth
- GDP = GDP growth
- INFL = inflation
- JIBOR = interest rate
- LKURS = exchange rate
- ECT = Error Correction Term
- D = Difference
- α = Constanta
- β1,2,3…dst. = coefficient
- ε = Error term

ECM estimates are valid if the cointegrated variables are supported by significant ECT coefficient values (ECT coefficient <1) and negative. If the ECT coefficient is positive, then the direction of the variables

used will be further away from the long-term equilibrium, which means that the ECM model cannot be used (Rahutami, 2011).

3.2 Stress test using Monte carlo simulation

Stress tests with Montecarlo simulation were used to predict the value of NPF at Islamic rural banks (BPRS) in Indonesia. There are several stages as follows:

1. Determine the best equation model. This simulation uses previously tested equation 5.
2. Determine the coefficients, variable values, standard errors and data distribution assumptions to be used in the simulation. In this simulation, the data distribution is assumed to be normal.
3. Incorporate into the monte carlo simulation. The simulation in this study was carried out to predict the value of NPF based on the intended equation model formula by using Crystal Ball software by Oracle.
4. Set the number of experiments. The simulation in this study used 500,000 trials with a 95% confidence level
5. Carry out simulations and generate simulation results

Table 2. Assumptions of simulation

Long term				
Variable	coefficient	Data		Distribution
		Mean	Std.Error	
C	-55.56			
FNCG	-0.02	1.57	1.35	
GDP	0.28	4.65	1.91	
INFL	-0.12	4.66	1.66	Normal
JIBOR	-0.11	5.2	0.88	
LKURS	6.83	9.37	0.19	
Short term				
Variable	coefficient	Data		Distribution
		Mean	Std.Error	
C	-0.010396			
D(FNCG)	0.02	0.02	1.63501	
D(GDP)	0.06	-0.02	1.08393	
D(INFL)	-0.05	-0.01	0.56718	Normal
D(JIBOR)	-0.23	-0.02	0.39531	
D(LKURS)	3.68	0	0.01886	
ECT(-1)	-0.16	-8.41E-15	0.79143	

4. Result and discussion

The study focuses on Islamic Rural Banks (BPRS) in Indonesia, with the dependent variable being financing quality, represented by NPF. The independent variable include financing growth and

macroeconomic factors, proxied by GDP growth, inflation, interest rates and the Rupiah exchange rate against US Dollar for the period January 2010 to March 2020.

Table 3. Descriptive analysis

	FNCG	GDP	INFL	JIBOR	LKURS	NPF
Mean	1.57	4.65	4.66	5.20	9.37	8.55
Med	1.60	5.05	4.13	5.40	9.47	8.27
Max.	5.06	5.59	8.36	7.59	9.66	11.80
Min.	-3.80	-5.33	2.53	3.78	9.05	6.11

The data presented in Table 3 indicates that the mean value of each variable exceed the standard deviation. This indicates that throughout the study period, all variables adhere to acceptable standards, at the standard deviation is less than the mean value. A lower the standard deviation, indicates that the data points are more closely clustered around the mean, resulting in reduced variability. The highest financing growth recorded was 5,063720 in May 2011, whereas the lowest financing growth observed was -3.795081 in December 2019. The highest economic growth was 5.588000 in May 2010, while the lowest economic growth was -5.325000 in December 2019. The highest inflation rate was 8.363000 in November 2014, while the lowest inflation rate was 2.530000 in February 2019. The highest interest rate was 7.591670 in December 2015, while the lowest interest rate was 3.776600 in April 2012. The highest LKURS was 9.663452 in March 2020, while the lowest LKURS was 9.051227 in July 2011. The highest NPF was 11.80000 in July 2018, while the lowest NPF was 6.110000 in December 2011.

Table 4 indicates that all variables are stationary at the first difference, suggesting that the variables have constant variance and do not change at this level of differencing.

Table 4. Stationary test

Philips Peron (PP)				
Variable	Level		1st Difference	
	Probability	Noted	Probability	Noted
FNCG	0.0000	Stationary	0.0001	Stationary
GDP	0.0254	Stationary	0.0000	Stationary
INFL	0.2798	Non Stationary	0.0000	Stationary
JIBOR	0.1155	Non Stationary	0.0000	Stationary
LKURS	0.9255	Non Stationary	0.0000	Stationary
NPF	0.4966	Non Stationary	0.0000	Stationary

https://doi.org/10.24191/jeeir.v13i1.2135

Table 5. Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.407060	146.6865	95.75366	0.0000
At most 1 *	0.345393	84.48964	69.81889	0.0022
At most 2	0.139121	34.06687	47.85613	0.4982
At most 3	0.083196	16.24045	29.79707	0.6953
At most 4	0.043836	5.903885	15.49471	0.7069
At most 5	0.004775	0.569587	3.841466	0.4504
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.407060	62.19685	40.07757	0.0000
At most 1 *	0.345393	50.42277	33.87687	0.0002
At most 2	0.139121	17.82641	27.58434	0.5096
At most 3	0.083196	10.33657	21.13162	0.7125
At most 4	0.043836	5.334298	14.26460	0.6992
At most 5	0.004775	0.569587	3.841466	0.4504

Table 5 indicates the trace value and maximum value. The eigen statistic at None (r=0) and at most 1 (r=1) exceeds the critical value at the 5% significance level, with a probability of less than 0.05. This indicates a cointegration among the variables, with two cointegrating equations present in the model, allowing for the application of Error correction model (ECM) analysis in the study.

Table 6. Long term estimation output

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-55.55856	4.346280	-12.78301	0.0000
FNCG	-0.015960	0.059826	-0.266767	0.7901
GDP	0.280198	0.041033	6.828565	0.0000
INFL	-0.123909	0.052620	-2.354795	0.0202
JIBOR	-0.114005	0.091592	-1.244700	0.2157
LKURS	6.831408	0.449821	15.18693	0.0000

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Table 7. Short term estimation output

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.010396	0.041598	-0.249918	0.8031
D(FNCG)	0.017885	0.026250	0.681350	0.4970
D(GDP)	0.057435	0.039308	1.461168	0.1467
D(INFL)	-0.049110	0.072288	-0.679367	0.4983
D(JIBOR)	-0.234221	0.103761	-2.257316	0.0259
D(LKURS)	3.681570	2.198616	1.674494	0.0968
ECT(-1)	-0.164319	0.053896	-3.048847	0.0029

The estimation output in Table 6 and 7 indicates that the Error Correction Term (ECT) value is -0.164319. This suggests that the speed of error correction for each variable the short term to return to long-term equilibrium is - 0.16%. The ECT coefficient value is negative and, in absolute terms, less than 1 (qualifying 0 < ECT < 1). The t statistic value is -3.048847], which exceed the t value of 1.65734, and a probability value of 0.0029 <, which is less than 0.05. Therefore, the ECM model is significant and valid.

The finding that the financing growth variable (FNCG) has no significant influence on the financing quality variable (NPF) is contrary to the hypothesis that financing growth has a significant effect on financing quality. The rising increase of financing (credit) at Islamic Rural Banks (BPRS) in Indonesia does not significantly impact the poor quality of financing (NPF) in either the long term or short term. This is generally due to the loose credit system which is not matched by strict and selective credit supervision, resulting in a high NPF value which is not even comparable to the increase in financing (credit) growth which tends to be slow. These findings are in line with Curak et al. (2013), who found that there was no significant relationship between credit growth and NPF. Over the long term, credit growth has an inverse relationship to the quality of financing (NPF), meaning that when the bank's credit growth declines, the NPF will increase because the slowdown in BPRS credit growth is not matched by qualified control quality so that the NPL ratio increases. Meanwhile, in the short term, credit growth has a positive relationship to the quality of financing (NPF), meaning that when financing growth increases, the NPF increases. This is because an increase in credit caused by public consumption, an increase in people's income, or for the productive sector in developing micro-enterprises that are the object of a BPRS poses the risk of an increase in the NPF level, as revealed by Karmila (2013) and Saputro et al. (2019), which state that credit growth has a positive effect against NPF.

The result that in the long-term equation, GDP growth has a significant effect on financing quality (NPF) is in line with the hypothesis. In line with Firdaus (2017) and Alfaro et al. (2004), which state that GDP growth has a positive effect on NPF. This is because GDP growth, which also shows economic growth, can provide high expectations for banks in assessing their ability to pay customers so that banks are less careful in distributing financing so that it has the potential to increase NPF. GDP growth has a positive effect on financing quality, as is the procyclical indicator in the business cycle theory, which states that the indicator moves in line with the movement of the business cycle, while the NPF moves up in line with GDP growth, which also indicates a cyclical increase of business. The short-term findings indicate that the GDP growth variable has no significant effect on the financing quality variable. This is in line with Wahyudin et al. (2020), Dewi (2020), and Romadhoni (2017) who also revealed that GDP growth had no significant effect on financing quality. This is because not all customers have the ability or good faith to expanding their debts to banks despite GDP growth, which indicates improvement in the community's economy, so that the NPF value continues to rise even though it is not significant because the value is small or insignificant.

The long-term equation demonstrates that inflation significantly influences the quality of finance, corroborating the theory. Inflation adversely impacts the quality of financing, indicating that an increase in inflation results in a fall in the NPF. This is due to the activities of Islamic People's Financing Banks that

https://doi.org/10.24191/jeeir.v13i1.2135

that provide funding in the real sector. Inflation, characterized by a rise in market prices, benefits entrepreneurs by increasing their income, thereby facilitating debt repayment to banks and diminishing NPF. This aligns with the findings of Poetry and Sanrego (2014), which indicated that inflation adversely affects NPF. In the short term, inflation has no significant effect on the financing quality variable (NPF). Continuous demand leading to inflation compels entrepreneurs to adjust their production capacity, including capital, raw materials, technology, and labor. Consequently, it takes time later for entrepreneurs to enhance income and pay debts to banks, which subsequently affects the reduction of bank NPF. Quagliariello (2009) indicates that external shocks from the macroeconomy can impose pressure on the probability of default on the t+2. The financial status of entrepreneurs is still undergoing adjustment, hence in the near term, inflation does not necessarily decrease the NPF, consistent with the findings of Romadhoni (2017), Dewi (2020), and Rindang (2019), which assert that inflation does not impact the NPF of BPRS.

The short-term results indicate that interest rates (JIBOR) significantly impact on financing quality, supporting the hypothesis and aligning with Putri (2016), who demonstrated that interest rates have a negative effect on NPF. In the short term, the interest rate (JIBOR) has a negative effect on the quality of financing (NPF), meaning that when JIBOR increases, the NPF decreases. The return mechanism in Islamic banking is based on a *ju'alah* contract or aligned with the benefits accrued (Fatwa Dewan Syariah Nasional MUI 2007), ensuring that when the debtor achieves business success, rising interest rates do not impede the debtor's ability to meet obligations, consequently reducing the NPF. In the long term, the JIBOR interest rate has no significant effect on the financing quality variable (NPF). Islamic banks utilize alternative financial instruments, such as Interbank *Mudharabah* Investment Certificate instruments or *Mudharabah* Investment Certificate (IMA) to determine profit-sharing levels and margins in financing contracts (Muhammad, 2002). The yields from these instruments is calculated based on a mutually agreed ratio. Although JIBOR serves as short-term money market interest rate (overnight tenor) and generally acts as a benchmark in determining the equivalent profit sharing in Islamic banks sharia, its impact on NPF is minimal. This finding aligns with Wahyudin et al. (2020), which indicates that interest rates do affect NPF.

The long term outcomes indicates that the exchange rate (LKURS) has a significant effect on the quality of financing (NPF). The finding is in line with Romadhoni (2017), which asserts that the exchange rate (LKURS) has a positive effect on the NPF. Over the long term, the exchange rate (LKURS) has a positive effect on financing quality (NPF), indicating that when the exchange rate (LKURS) increases or depreciates, the NPF increases. The depreciation of the currency has an impact on hampering business success by escalating production costs, particularly for importers and the diminishing entrepreneurs' revenues. Consequently, entrepreneurs encounter challenges in debts repayment, which may lead to an escalation in NPF. This aligns with Indra (2018), which states that exchange rate depreciation relates to an increase in NPF. In the short term, the exchange rate (LKURS) exerts no significant influence on the financing quality variable (NPF), as fluctuations in the rupiah exchange rate are relatively transient and do not impede customers' ability to fulfil their financing obligations as stipulated in the contract (Wijoyo, 2016). Fluctuations in the rupiah exchange rate influence the timing of customer engagement in *murabahah* finance, namely during the initiation of the transaction. The price of the purchased goods is established according to market costs, the installments payments were agreed upon without accounting for future fluctuations in the rupiah exchange rate. Consequently, in the short term, the exchange rate variations do not necessarily elevate the NPF. This aligns with the findings of Sulastri et al. (2016) and Yolanda (2019), which indicated that the exchange rate does not influence the NPF of BPRS.

https://doi.org/10.24191/jeeir.v13i1.2135

Table 8. Sensitivity test

Long term equation									
F-stat	**Prob. F(2,115)**	**Obs* R-sq**	**Prob. Chi-Sq)**	**Note**	**F-stat**	**Prob. F(1,120)**	**Obs*R-sq**	**Prob. Chi-Square(2)**	**Note**
90.43614	0.0000	75.19	0.0000	Autocorrelation	81.32	0.0000	49.28	0.0000	Heteroskedastisity
F-Stat	p-value								
6.659	0.0000								
Short term equation									
F-stat	**Prob. F(2,113)**	**Obs* R-sq**	**Prob. Chi-Sq**	**Note**	**F-stat**	**Prob. F(1,119)**	**Obs*R-s**	**Prob. Chi-Sq**	**Note**
0.037205	0.9635	0.080	0.9607	No Autocorrelation	1,839088	0.1776	1,841537	0.1748	No Heteroskedastisity
F-stat	P-value								
3.885	0.0001								

Tables 9 and 10 indicate that the long-term equation model exhibits issues with autocorrelation and heteroskedasticity. However, the short term equation models demonstrate no issue of autocorrelation and heteroskedasticity, with a probability chi-square value greater than 0.05.

4.1 Stress test

This study employed a stress test utilising a Monte carlo simulation comprising 500,000 trials, facilitated by Crystal ball software from Oracle. The variables considered in this analysis include financing growth (FNCG), GDP growth (GDP), inflation (INFL), interest rate (JIBOR) and exchange rate (LKURS), with the assumption that the follow a normal distribution.

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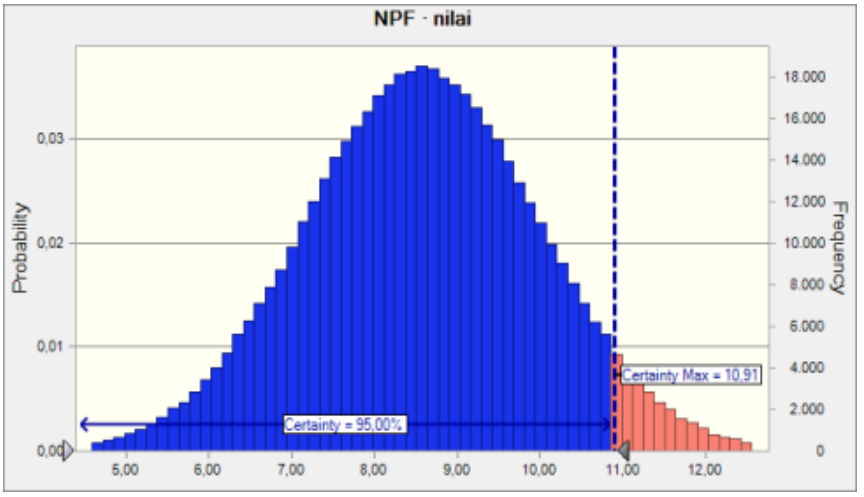

Figure 4. Forecast NPF

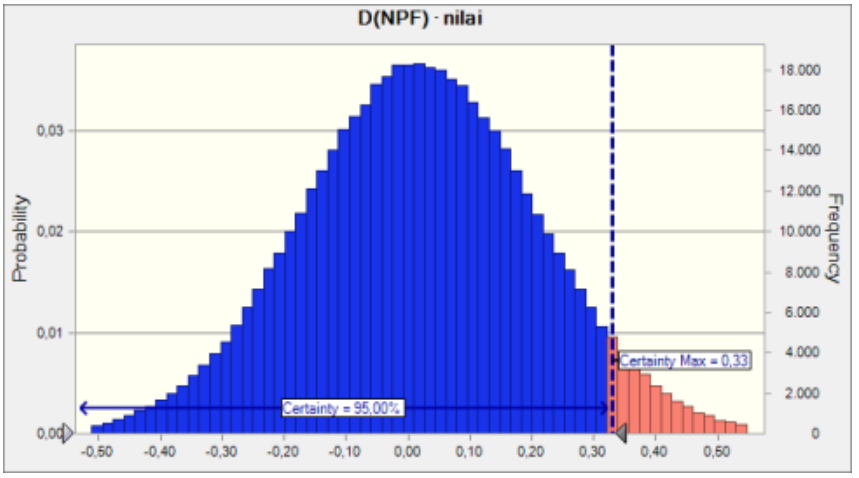

Figure 5. Forecast D(NPF)

Figure 4 dan Figure 5 indicate that, over the long term, the forecast maximum NPF is 10.91%, with a confidence level of 95%. The short term forecast indicates that the maximum D(NPF) is 0.33%, with a certainty level is 95%. The data indicates that Islamic Rural Banks (BPRS) in Indonesia exhibit a default probability, as evidenced by the NPF value exceeding 7%, categorizing them at level 3 in terms of the bank's health rating according to NPF (Salinan Peraturan Otoritas Jasa Keuangan Republik Indonesia 2019). The high probability of default can influence the anticipated losses that impact the bank's profitability and capital reserves. The outcome will lead to an increased reserve for bank losses, resulting in a diminished effect on bank operating profit, while the formation of additional bank capital will be low. An increase in expected losses (EL) correlate with a higher the potential loss or credit risk encountered by banks. Consequently, it is essential for Islamic rural banks (BPRS)to exercise caution, remain vigilant, and proactively anticipate the high probability of default by maintaining sufficient capital reserves to mitigate potential losses. The role of a bank supervisor requires banks to hold more capital reserves (Bernanke, 2013), and Beltratti and Stulz (2011) affirm that capital is a critical factor influencing a bank's performance.

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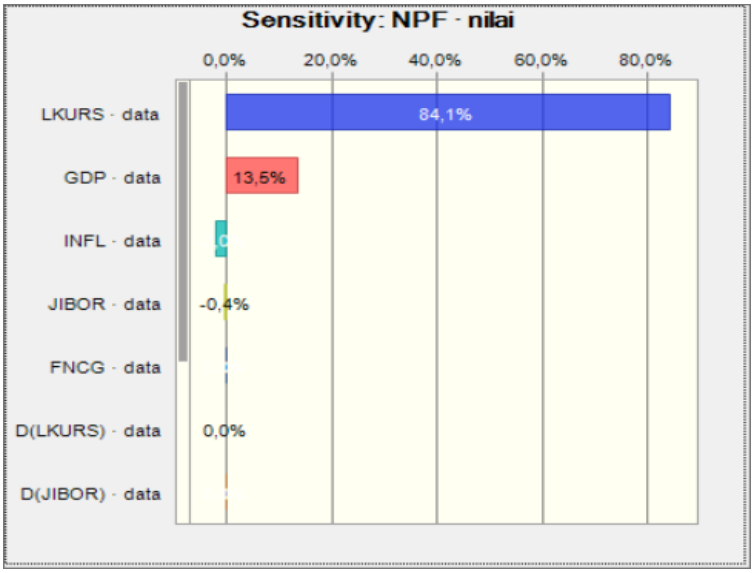

Figure 6. Sensitivity

Figure 6. indicates that the high level of NPF is influenced by the exchange rate, GDP growth, inflation and interest rate. The strong influence of the exchange rate on NPF is due to the depreciation of the rupiah against the US dollar from 2010 to 020. This depreciation adversely affected entrepreneurs' debt repayment capabilities, consequently influencing NPF levels. The depreciation of the exchange rate can be attributed to several factors, including the ongoing current account deficit since 2012, the withdrawal of predominantly foreign portfolio investments from Indonesia, state budget politics concerning debt, the strengthening of the US economy, and global economic slowdown (Adam, 2015).

The evidence supports the notion that the exchange rate contributed to the 2008 global crisis. The stagnation of interbank loan flows and hampered international trade transactions were the primary factors contributing to this situation. The 1998 financial crisis was initiated by external shocks, characterized by a significant depreciation in the exchange rate. This event contributed to instability within the Indonesian banking sector and resulted in a multi-dimensional crisis. It is worth noting that controlling the probability of default requires careful consideration of various influencing factors, with particular emphasis on the exchange rate, which significantly impacts NPF. It is crucial regulators and the government to manage macroeconomic factors, particularly the exchange rate, to foster a favourable enviroment for the stability of banks, especially Islamic Rural Bank (BPRS) in Indonesia.

5. Conclusion

The study concluded that the long-term increase of gross domestic product (GDP), inflation, and currency rates significantly influences the NPF. Conversely, the interest rate significantly influences the NPF in the short run. The augmentation of financing has no significant effect on the NPF budget, both in the short term and the long term. The forecasted maximum NPF is 10.91%, the differential maximum NPF is 0.33% at the confidence level of 95%. The results of the stress test reveal that the Islamic Rural Bank (BPRS) in Indonesia has a substantial probability of defaulting on its obligations. This signifies that the bank must focus more on the determinants influencing NPF, especially the currency rate, which exerts considerable influence, and strive to anticipate the elevated likelihood of failure while ensuring adequate capital reserves to sufficiently mitigate losses.

https://doi.org/10.24191/jeeir.v13i1.2135

Acknowledgements

This study has many limitations including variables, theories, data, analytical methods, and simple stress tests that has not yet measured the resilience of bank capital. Suggestions, criticisms and constructive input are needed for further improvement.

Conflict of interest statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

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