THE ASYMMETRIC RELATIONSHIP BETWEEN MACROECONOMIC DETERMINANTS AND NON-PERFORMING LOANS: EVIDENCE FROM THE BANKING INDUSTRY OF INDONESIA

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ABSTRACT

Non-Performing Loans (NPLs) represent a risk that can significantly affect the financial performance of banks. This study aims to examine the macroeconomic determinants of NPLs in the Indonesian banking industry from 2005Q1 to 2019Q4. It adopts a novel approach, namely the nonlinear autoregressive distributed model and provides evidence that changes in macroeconomic conditions have an asymmetrical effect on NPLs in conventional banks, conventional rural banks, Islamic banks, and Islamic rural banks. In addition, Islamic banks have greater asymmetrical exposure to macroeconomic variables than their counterparts.

Keywords: Macroeconomic variables; Non-performing loans; NARDL; Indonesian banking industry.

JEL Classifications: E60; G20; G21.

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I. INTRODUCTION
Credit risk is the greatest risk facing almost all financial institutions, especially banks. Credit risk analysis provides early warning about the vulnerability of the financial sector to shocks. Therefore, it is crucial to conduct a credit risk analysis to assist policymakers in preparing crisis prevention measures (Agnello et al., 2012; Agnello and Sousa, 2011). Credit risk is defined as loans (part or whole) that are unpaid, or the failure of borrowers to fulfil their obligations to the bank (Castro, 2013). Kiyotaki and Moore (1997) stated that theoretically, economic circumstances, as reflected by macroeconomic variables, determine the lending performance of banks. They further explained that, when economic conditions are favourable, borrowers are better equipped to service their loans compared to during an economic downturn. In line with Kiyotaki and Moore (1997), using a life-cycle consumption model, Bernanke and Gertler (1998) also reported that in good financial conditions, borrowers are much more likely to service their loans, and vice versa in bad conditions. Meanwhile, Carey (1998) argued that macroeconomic conditions are the single most important systematic factor influencing loan portfolio losses.

Reflecting the importance of understanding the impact of macroeconomic conditions on loan quality, researchers have worked on the issues and reported empirical evidence. In particular, Salas and Saurina (2002), Nkusu (2011), Ali and Daly (2010), Castro (2013), Gulati et al. (2019), Messai and Gallali (2019), Nicolaides (2020), and Pratheesh and Arumugasamy (2020) focused on the effect of macroeconomic variables on changes in credit risk. They found that macroeconomic conditions have a major influence on changes in credit risk and must therefore be included in credit risk analysis. Macroeconomic growth will increase the ability of economic actors to meet their debt obligations, which means that, GDP growth has a significant negative effect on credit risk as reflected in the level of Non-Performing Loans (NPLs) (Carey, 2002; Makri et al., 2014; Männasoo and Mayes, 2009; Messai and Jouini, 2013; Roman and Bilan, 2015; Skarica, 2014). Meanwhile, Monokroussos et al. (2016), using unrestricted vector autoregression, found that a contraction of domestic economic activities and a rise in unemployment affected credit quality in Greek banks. Klein (2013), Makri, et al. (2014), Ghosh (2015), Kjosevski and Petkovski (2017), and Petkovski and Kjosevski (2014) reached the same conclusion, namely that the unemployment rate has a positive and significant effect on credit quality. Other macroeconomic variables that affect NPLs/Non-Performing Financing (NPF) are inflation and foreign exchange rates (Klein, 2013). Inflation can have a positive as well as a negative effect on NPLs (Chaibi and Fitti, 2015).

Previous studies have demonstrated the importance of credit analysis in providing an early warning about financial sector vulnerabilities. However, a research gap remains, namely that previous analysis has only used a symmetrical approach. The symmetrical approach assumes that both positive and negative effects of the macroeconomic factors under examination will have the same implications for bank credit risk. To provide a different perspective, this study adopts symmetric

\[1\] Non-Performing Financing (NPF) is the term commonly used in the literature of Islamic banks, while conventional banks use Non-Performing Loans (NPLs).
and asymmetric approaches to examine the effect of macroeconomic factors on the NPL/NPF of the commercial banking industry in Indonesia. Bussiere (2012) explained that the impact of a certain degree of increase in $X$ variable may not match the impact of a certain degree of decrease in $X$ variable to another variable. Hence, these relationships can only be explained by the asymmetric relationship approach; relying solely on the symmetric approach would lead to a biased analysis. Munir and Iftikhar (2021) argued that most economic variables behave in a nonlinear pattern with asymmetric information. It is therefore necessary to incorporate a nonlinear and asymmetric model to prevent misleading results.

This study differs from previous studies on the Indonesian banking industry; as such, it fills the research gap and enriches the studies on the impact of macroeconomic variables on the NPLs of banks in the country. First, this study uses both the symmetric and asymmetric approaches in contrast to prior studies on Indonesian banking that employed only the symmetric approach (Priyadi et al., 2021; Rachman, et al., 2018). Second, past studies only provided evidence on either Islamic banking (Effendi and Yuniarti, 2018; Fianto et al., 2019; Firmansyah, 2015) or conventional banking (Hardiyanti and Aziz, 2021; Kartikasary, et al., 2020), leading to inconclusive and incomprehensive findings. The current study, in contrast, covers the entire Indonesian banking system (i.e., conventional banks, conventional rural banks, Islamic banks, and Islamic rural banks). Even in cases where Islamic banking was examined, the researchers tended to focus only on commercial Islamic banks and not Islamic rural banks (Kramadibrata et al., 2020; Visca Wulandari and Aprilliani Utami, 2019).

This study’s focus on the Indonesian banking industry is motivated by three important factors. First, as explained by Khattak, et al. (2021), the Indonesian banking industry is considered to be stable, despite the challenges encountered during the Asian financial crisis in 1997/1998 and the global financial crisis in 2008. Second, Indonesia has one of the world’s most advanced dual banking systems, particularly in the Islamic banking sector (Ernst and Young, 2016). Based on this scenario, Indonesia is therefore the most suitable country in which to study the performance of the dual banking system.

A dual banking system operates differently, whereby conventional banks use the interest rate mechanism in financial contracts, while Islamic banks use profit-sharing contracts. Baele et al., (2014) found that Islamic banks have a lower default risk compared to conventional banks due to their profit-sharing principle. Meanwhile, Farooq and Zaheer (2015) revealed that Islamic banks are more resistant to financial shocks. This study therefore aims to determine the extent to which these two types of banks respond to changes in macroeconomic conditions and examine the credit risk sensitivity of Islamic banks and conventional banks to changes in macroeconomic conditions. Third, Indonesia, with its large and Muslim-majority population, offers valuable insight into unique economic behavior linked to the practice of a dual banking system (Trinugroho et al., 2018).

The main contribution of this research is the provision of a different perspective for use in assessing the effect of macroeconomic factors on the NPLs/NPF of the commercial banking industry in Indonesia. The study provides empirical evidence that macroeconomic variables have an asymmetric impact on NPLs in Indonesian banks. The asymmetric relationship demonstrates that positive and negative
changes in macroeconomic variables produce changes of different magnitudes in banks’ NPLs/NPF. The results can thus be considered when formulating policies to protect banks against future unforeseen crises. Therefore, it is necessary to develop preventive measures aimed at protecting banks from a deeper crisis by considering the asymmetrical effect of macroeconomic variables on NPLs.

II. DATA AND METHODOLOGY

The objective of the study is to examine the determinants of NPLs in the Indonesian banking industry from the perspective of macroeconomic variables by adopting both a symmetric and asymmetric approach. The asymmetric approach argues that a positive or negative change in the macroeconomic variables may lead to different effects on the NPLs in the banking system (Jiang et al., 2021). This measurement is considered essential, especially when analyzing the influence of dynamic macroeconomic variables on banking performance during times of economic turmoil such as financial distress (Liang et al., 2020).

The banking industry in this study comprises conventional banks, conventional rural banks, Shariah (Islamic) banks, and Shariah (Islamic) rural banks based on National Law No 21 (2008). In addition, according to the same law, conventional (interest-based) and Islamic (non-interest-based) banks are defined as commercial banking that offers financial services with payment system activities, while conventional (interest-based) and Islamic (non-interest-based) rural banks also offer financial services but do not involve payment system activities. In addition, conventional and Islamic rural banks mainly provide microfinancing to Small and Medium-sized Enterprises (SMEs).

To achieve the objective of this study, quarterly data is utilized from 2005 to 2019. The period of study was selected based on data availability, for which the relevant data were retrieved from the Indonesian Financial Services Authority, the Central Bank of Indonesia, and the Indonesian Statistical Bureau. Adapting the theoretical framework as suggested by Kiyotaki and Moore (1997), Bernanke and Gertler (1998) and Carey (1998), in the case of banking sector, the regression model of this study is depicted as follows:

\[
NPL_{Bank,t} = \beta_0 + \beta_1 PIGR_t + \beta_2 Infl_t + \beta_3 ER_t + \beta_4 IR_t + \beta_5 Ln_{Size} + \epsilon_t
\]  

where,

- \( NPL_{Bank,t} \): The percentage of non-performing loans (financing) compared to total loans in the Indonesian banking industry, consisting of conventional banks, conventional rural banks, Shariah (Islamic) banks, and Shariah (Islamic) rural banks at time \( t \)
- \( PIGR_t \): The percentage change (growth) in the production index at time \( t \)
- \( Infl_t \): The percentage change in inflation at time \( t \)
- \( ER_t \): The exchange rate of the US dollar to the Indonesian rupiah at time \( t \)
- \( IR_t \): The interest rate (percentage) determined by the Central Bank of Indonesia at time \( t \)
The Asymmetric Relationship Between Macroeconomic Determinants and Non-performing Loans: Evidence from the Banking Industry of Indonesia

Ln_Size: The natural logarithm of the total assets of banks, including conventional banks, Islamic banks, conventional rural banks, and Islamic rural banks in Indonesia at time t

e: Error term

This study employed the Nonlinear AutoRegressive Distributed Lag (NARDL) model to explain the regression model as depicted in Equation (1), following Shin and Greenwood-Nimmo (2014). According to Jiang et al. (2021) and Munir and Iftikhar (2021), NARDL is capable of capturing the asymmetric impact of positive and negative changes in explanatory variables on the dependent variables, given that most economic variables behave in a nonlinear pattern with asymmetric information (Munir and Iftikhar, 2021). Moreover, Shin and Greenwood-Nimmo (2014) and Jiang et al. (2021) added that NARDL can capture both the short- and long-run asymmetric relationship among the observed variables.

In this study, NARDL is employed to assess the symmetric or asymmetric effects of the observed variables in the model, as formulated below:

\[
\Delta \text{NPL}_{\text{Bankt}} = a_0 + a_1 \Delta \text{NPL}_{\text{Bankt-1}} + a_2 \Delta \text{POSPIGR}_{t-1} + \\
a_3 \Delta \text{NEGPIGR}_{t-1} + a_4 \Delta \text{POSInf}_{t-1} + a_5 \Delta \text{NEGInf}_{t-1} + a_6 \Delta \text{POSER}_{t-1} + \\
a_7 \Delta \text{NEGER}_{t-1} + a_8 \Delta \text{POSIR}_{t-1} + a_9 \Delta \text{NEGIR}_{t-1} + a_{10} \Delta \text{Ln Size}_{t-1} + \\
\sum_{i=1}^{n} \Theta_i \Delta \text{POSPIGR}_{t-1} + \sum_{i=1}^{n} \Theta_{2i} \Delta \text{POSPIGR}_{t-1} + \Theta_{3i} \Delta \text{NEGPIGR}_{t-1} + \\
\sum_{i=1}^{n} \Theta_{4i} \Delta \text{POSInf}_{t-1} + \Theta_{5i} \Delta \text{NEGInf}_{t-1} + \\
\sum_{i=1}^{n} \Theta_{6i} \Delta \text{POSER}_{t-1} + \Theta_{7i} \Delta \text{NEGER}_{t-1} + \\
\sum_{i=1}^{n} \Theta_{8i} \Delta \text{POSIR}_{t-1} + \Theta_{9i} \Delta \text{NEGIR}_{t-1} + \sum_{i=1}^{n} \Theta_{10i} \Delta \text{Ln Size}_{t-1} + \mu_t 
\]

where the POS (an additional increase in change of the variable’s value) and NEG (an additional decrease in change of the variable’s value) of the macroeconomic variable values are generated from:

\[
\text{POSPIGR}_t = \sum_{i=1}^{n} \Delta \text{PIGR}_t^+ = \max(\text{PIGR}_t, 0) 
\]

\[
\text{NEGPIGR}_t = \sum_{i=1}^{n} \Delta \text{PIGR}_t^- = \max(\text{PIGR}_t, 0) 
\]

\[
\text{POSInf}_t = \sum_{i=1}^{n} \Delta \text{Inf}_t^+ = \max(\text{Inf}_t, 0) 
\]

\[
\text{NEGInf}_t = \sum_{i=1}^{n} \Delta \text{Inf}_t^- = \max(\text{Inf}_t, 0) 
\]

\[
\text{POSER}_t = \sum_{i=1}^{n} \Delta \text{ER}_t^+ = \max(\text{ER}_t, 0) 
\]
The computation of the long-run coefficients, which consist of negative and positive results, is $\delta_1 = -\frac{a_2}{a_1}$ and $\delta_2 = -\frac{a_3}{a_1}$ for PIGR; $\delta_3 = -\frac{a_4}{a_3}$ and $\delta_4 = -\frac{a_5}{a_4}$ for Inf; $\delta_5 = -\frac{a_6}{a_5}$ and $\delta_6 = -\frac{a_7}{a_6}$ for ER; and $\delta_7 = -\frac{a_8}{a_7}$ and $\delta_8 = -\frac{a_9}{a_8}$ for IR. Furthermore, the asymmetric short-run relationship is also calculated as $\theta_1 = \sum_{i=1}^{n} \theta_{2i} \Delta PIGR_{t-1}$ and $\theta_2 = \sum_{i=1}^{n} \theta_{3i} \Delta NEGR_{t-1}$ for PIGR; $\theta_3 = \sum_{i=1}^{n} \theta_{4i} \Delta POSIN_{t-1}$ and $\theta_4 = \sum_{i=1}^{n} \theta_{5i} \Delta NEGR_{t-1}$ for Inf; $\theta_5 = \sum_{i=1}^{n} \theta_{6i} \Delta POSER_{t-1}$ and $\theta_6 = \sum_{i=1}^{n} \theta_{7i} \Delta NEGR_{t-1}$ for ER; and $\theta_7 = \sum_{i=1}^{n} \theta_{8i} \Delta POSIR_{t-1}$ and $\theta_8 = \sum_{i=1}^{n} \theta_{9i} \Delta NEGR_{t-1}$ for IR.

In line with Shin and Greenwood-Nimmo (2014), the NARDL method was performed by taking several steps similar to the ARDL test after estimating the value of POS and NEG in the determined variables (Cheah, et al., 2017; Haron and Ibrahim, 2019). First, the Phillips–Perron and Augmented Dickey-Fuller (ADF) unit root tests, as suggested by Phillips and Perron (1988) and Dickey and Fuller (1979) respectively, were applied to examine the level of stationarity of the observed variables. No intercept, intercept, and intercept and trend analyses were applied for the unit root tests due to considering the theoretical framework and the characteristics of the data in the observed variables. An advantage of the NARDL model lies in its suitability for use with observed variables that are stationary both in level and first difference (Haron and Ibrahim, 2019; Liang et al., 2020). Second, bounds testing co-integration was used to assess for the presence of co-integration among the variables under consideration (Pesaran et al., 2001). The $H_0$ of the bounds testing suggests there is no co-integration. If the value of the $F$-statistic is higher than the lower and upper bounds, $H_0$ is rejected; hence, the presence of a co-integration relationship can be concluded. In the context of applying NARDL, the co-integration test is explained by the Fpps value (Shin and Greenwood-Nimmo, 2014; Sriyana and Ge, 2019). Moreover, to avoid bias in the results, heteroscedasticity and autocorrelation tests were conducted based on the approach used by Breusch and Pagan (1979) and Savin and White (1996).

Third, the NARDL test was conducted to assess the symmetric or asymmetric movement of the observed variables. To determine such movement, Sriyana and Ge (2019) suggested that the Wald test can be used to explain any short-run or long-run, symmetric or asymmetric, relationship. The $H_0$ of the Wald test implies a symmetric relationship among the observed variables. If the $F$-statistic value of the Wald test for the short-run relationship ($W_{SR}$) and long-run relationship ($W_{LR}$) is significant, $H_0$ can be rejected. Consequently, the existence of an asymmetric relationship is proven in the model. In the Wald test analysis, several possibilities may occur. First, an asymmetric relationship is found only in the short run; second, an asymmetric relationship exists only in the long run; and third, short-
run and long-run asymmetric relationships appear together. Finally, as suggested by Sriyana and Ge (2019), the robustness of the model is tested by performing a cumulative sum (CUSUM) test. The model is deemed stable if the plot does not exceed the critical 5% level of significance.

III. RESULTS AND DISCUSSION

A. Summary of the Data

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
<th>Denomination</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRB_NPL</td>
<td>6.78</td>
<td>1.37798</td>
<td>4.41</td>
<td>9.88</td>
<td>%</td>
</tr>
<tr>
<td>CB_NPL</td>
<td>3.47</td>
<td>1.74602</td>
<td>1.76952</td>
<td>8.328392</td>
<td>%</td>
</tr>
<tr>
<td>SRB_NPF</td>
<td>4.07</td>
<td>0.986354</td>
<td>2.26</td>
<td>6.26</td>
<td>%</td>
</tr>
<tr>
<td>SB_NPF</td>
<td>4.07</td>
<td>0.986354</td>
<td>2.26</td>
<td>6.26</td>
<td>%</td>
</tr>
<tr>
<td>PIGR</td>
<td>0.98</td>
<td>2.81</td>
<td>-8.19</td>
<td>7.97</td>
<td>%</td>
</tr>
<tr>
<td>Inf</td>
<td>6.21</td>
<td>3.426307</td>
<td>2.48</td>
<td>17.11</td>
<td>%</td>
</tr>
<tr>
<td>ER</td>
<td>11,119.37</td>
<td>2096.772</td>
<td>8579</td>
<td>14903</td>
<td>IDR</td>
</tr>
<tr>
<td>IR</td>
<td>7.12</td>
<td>1.99903</td>
<td>4.25</td>
<td>12.75</td>
<td>%</td>
</tr>
<tr>
<td>CRB_Size</td>
<td>69,386.53</td>
<td>41,021.34</td>
<td>17,302</td>
<td>149,623.2</td>
<td>IDR Bn</td>
</tr>
<tr>
<td>CB_Size</td>
<td>4,320,327</td>
<td>2,309,507</td>
<td>1,280,567</td>
<td>8,562,974</td>
<td>IDR Bn</td>
</tr>
<tr>
<td>SRB_Size</td>
<td>5,176,849</td>
<td>3,999,021</td>
<td>626,9323</td>
<td>13,758.29</td>
<td>IDR Bn</td>
</tr>
<tr>
<td>SB_Size</td>
<td>14,1383.5</td>
<td>107,404.3</td>
<td>13,235</td>
<td>350,363.5</td>
<td>IDR Bn</td>
</tr>
</tbody>
</table>

Table 1 presents a description of the data during the observation period and shows that the mean percentages for Non-Performing Loans or Financing (NPLs or NPF) varied according to the different types of banks. The Islamic rural banks had the highest mean percentage of NPLs, at 8.48%, while the conventional banks had the lowest mean percentage, at 3.47%. Based on the NPLs and NPF percentages, it is observed that the conventional banks performed better than the Islamic banks. In terms of size, both the conventional banks and conventional rural banks were accumulatively larger than the Islamic or Islamic rural banks. This is shown by the maximum values for bank size, which stood at IDR 8,562,974; IDR 350,363.5; IDR 149,623.2, and 13,758.29 for the conventional banks, Islamic banks, conventional rural banks, and Islamic rural banks, respectively.

Regarding the macroeconomic variables, these fluctuated between 2005Q1 and 2019Q4. Production index change (growth) (PIGR) registered the highest score, at 7.97%, with -8.19% its lowest, while the mean for PIGR was 0.98% and the standard deviation 2.81%. The higher standard deviation relative to the mean reflects the high volatility in the PIGR during the period under study. Moreover, the highest inflation and interest rates, at 17.11% and 12.75%, respectively, reflect the turbulence in economic activity during the period under study. The high
inflation score also explains the increase in the price of goods and services in Indonesia during the observation period. Furthermore, a high interest rate reflects a high cost of borrowing, resulting in a higher return on investment. Finally, the average Indonesian rupiah–US dollar exchange rate during the period 2005–2019 was IDR 11,119.37.

Table 2.
Unit Root Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level Philip-Perron</th>
<th>First Difference Philip-Perron</th>
<th>ADF</th>
<th>ADF</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRB_NPL</td>
<td>-1.813</td>
<td>-11.533***</td>
<td>-7.058***</td>
<td>I(1)</td>
</tr>
<tr>
<td>CB_NPL</td>
<td>-1.834</td>
<td>-8.703***</td>
<td>-6.740***</td>
<td>I(1)</td>
</tr>
<tr>
<td>SRB_NPF</td>
<td>-2.568</td>
<td>-9.752***</td>
<td>-5.599***</td>
<td>I(1)</td>
</tr>
<tr>
<td>SB_NPF</td>
<td>-2.991</td>
<td>-11.244***</td>
<td>-6.235***</td>
<td>I(1)</td>
</tr>
<tr>
<td>PIG</td>
<td>-8.464***</td>
<td>-9.177***</td>
<td>-9.992***</td>
<td>I(0)</td>
</tr>
<tr>
<td>Inf</td>
<td>-3.335**</td>
<td>-6.455**</td>
<td>-4.896**</td>
<td>I(0)</td>
</tr>
<tr>
<td>ER</td>
<td>-2.211</td>
<td>-7.898***</td>
<td>-5.934***</td>
<td>I(1)</td>
</tr>
<tr>
<td>IR</td>
<td>-2.718</td>
<td>-4.073***</td>
<td>-4.676***</td>
<td>I(0)</td>
</tr>
<tr>
<td>LnCRB_Size</td>
<td>0.100</td>
<td>-6.815***</td>
<td>-6.397***</td>
<td>I(0)</td>
</tr>
<tr>
<td>LnCB_Size</td>
<td>-0.047</td>
<td>-9.390***</td>
<td>-6.148***</td>
<td>I(0)</td>
</tr>
<tr>
<td>LnSRB_Size</td>
<td>0.372</td>
<td>-6.287***</td>
<td>-5.805***</td>
<td>I(0)</td>
</tr>
<tr>
<td>LnSB_Size</td>
<td>0.163</td>
<td>-8.127***</td>
<td>-4.908***</td>
<td>I(0)</td>
</tr>
</tbody>
</table>

Shin and Greenwood-Nimmo (2014) outlined how the unit root test is the first step in performing NARDL analysis. To proceed with this analysis, the observed variables in each bank must be in a different order of stationarity. Table 2 shows the results of the unit root test for all the observed variables, based on the Phillips–Perron and ADF unit root tests respectively. Based on the tests, for the conventional banks, the observed variables are stationary at the first difference, I(1). The same results were also recorded for the conventional rural banks, Islamic rural banks, and Islamic banks. Hence, both sets of results provide sufficient justification to proceed with NARDL as the method of analysis (shin and Greenwood-Nimmo, 2014; Liang et al., 2020).

B. NARDL Estimation

NARDL was adopted to examine the asymmetric relationship between the observed variables. Table 3 presents the NARDL results on the observed variables in line with Equation (2). Four models represent each type of bank: conventional rural banks (model 1), conventional banks (model 2), Islamic rural banks (model 3), and Islamic banks (model 4). The NARDL estimation considers the lag
classification criteria; for model 1 and model 2, two lag selections were adopted, while for models 3 and 4, four lag selections were applied. In addition, the value of $R$-squared varies between 79.2% and 94.2%, which reflects the explanatory power of the model in explaining the effect of the independent variables on the dependent variable. To identify the presence of long-run relationships between the observed variables, bounds testing co-integration analysis was conducted, the result of which is reflected in the Fpps value (Shin and Greenwood-Nimmo, 2014; Sriyana and Ge, 2019). Based on the results, all the models are significant at the 1% and 5% levels; therefore, $H_0$ is rejected. The rejection of $H_0$ confirms the existence of a long-run relationship between the observed variables for all models. In addition, based on the heteroscedasticity and autocorrelation tests as suggested by Breusch and Pagan (1979) and Savin and White (1996), there are no autocorrelation issues with constant variance.

C. Short-run and Long-run Symmetric Results
Wald test analysis was conducted to ascertain the presence of any asymmetric relationships between the variables (see Table 4). For long-run and short-run asymmetric relationships, the values of POS and NEG must be the same and statistically significant, meaning $H_0$ would be rejected. Table 4 presents the results of the symmetric test for all models. In model 1, the long-run relationship tends to be symmetric. This can be seen from the Wald test results of $W_{LR}$, in which the F-statistic is not significant; hence, $H_0$ is accepted. Therefore, a symmetric relationship exists between the variables in the long run for conventional rural banks.

However, in the short run, the values of $W_{SR}$ for POSPIGR=NEGPIGR and $W_{SR}$ for POSER=NEGER are statistically significant. This shows that in the short run, there is an asymmetric relationship between PIGR and ER, and CRB_NPL, meaning $H_0$ is rejected. The existence of an asymmetric relationship implies that conventional rural banks must have appropriate risk management in place, as increases in production index growth and the exchange rate do not have an equal effect in the short run. Furthermore, based on the short-run relationship, an increase in production index growth and the exchange rate has a certain impact on the NPLs of conventional rural banks; however, when they fall to the same level, the impact is either higher or lower but will not be equal due to the asymmetric impact.
<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) Conventional Rural Banks</th>
<th>(2) Conventional Banks</th>
<th>(3) Islamic Rural Banks</th>
<th>(4) Islamic Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPL (-1)</td>
<td>-0.765***</td>
<td>-0.507***</td>
<td>-1.160**</td>
<td>-1.284***</td>
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<tr>
<td></td>
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<td>(0.0804)</td>
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<td>(0.319)</td>
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<td>POSPIGR(-1)</td>
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<td></td>
<td>(0.0694)</td>
<td>(0.0306)</td>
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<td>(0.264)</td>
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<tr>
<td>NEGPIGR(-1)</td>
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<td>(0.0344)</td>
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<td>NEGInf(-1)</td>
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<tr>
<td></td>
<td>(0.0765)</td>
<td>(0.0377)</td>
<td>(0.911)</td>
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<tr>
<td>POSER(-1)</td>
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<td>0.000405***</td>
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<tr>
<td></td>
<td>(0.251)</td>
<td>(0.104)</td>
<td>(1.470)</td>
<td>(0.853)</td>
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<tr>
<td>NEGER(-1)</td>
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<td>-0.0345</td>
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<td>1.801**</td>
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<td>(0.0802)</td>
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<td>(0.784)</td>
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<td>Δ NPL/NPF (-1)</td>
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<td>(0.104)</td>
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<td>(0.215)</td>
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<td>ΔPOSPIGR(-1)</td>
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<td>(0.0219)</td>
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<td>(0.195)</td>
</tr>
<tr>
<td>ΔPOSPIGR(-3)</td>
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<td></td>
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<tr>
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<td>0.171</td>
<td></td>
<td>0.00410</td>
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<tr>
<td>ΔPOSPIGR(-4)</td>
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<td></td>
<td>0.00410</td>
<td>(0.133)</td>
</tr>
<tr>
<td></td>
<td>0.171</td>
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<td>(0.0813)</td>
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<tr>
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<td>0.000827</td>
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<tr>
<td></td>
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<td>(0.0673)</td>
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<tr>
<td>ΔNEGPIGR(-2)</td>
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<td>0.785</td>
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<td>(0.0445)</td>
<td>(0.0207)</td>
<td>(0.549)</td>
<td>(0.266)</td>
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<tr>
<td>ΔNEGPIGR(-3)</td>
<td>0.501</td>
<td>0.343</td>
<td>(0.388)</td>
<td>(0.195)</td>
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<tr>
<td>ΔNEGPIGR(-4)</td>
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<td>(0.0921)</td>
<td>(0.0393)</td>
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<tr>
<td>ΔPOSInf (-2)</td>
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<td>0.0101</td>
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<tr>
<td>ΔPOSInf (-3)</td>
<td>-0.0718</td>
<td>-0.218</td>
<td>(0.467)</td>
<td>(0.279)</td>
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### Table 3.
NARDL Estimation (Continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) Conventional Rural Banks</th>
<th>(2) Conventional Banks</th>
<th>(3) Islamic Rural Banks</th>
<th>(4) Islamic Banks</th>
</tr>
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<tbody>
<tr>
<td>$\Delta POS\text{Inf}(-4)$</td>
<td>0.196 (0.637)</td>
<td>-0.200 (0.351)</td>
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<tr>
<td>$\Delta NEG\text{Inf}(-1)$</td>
<td>-0.0310 (0.0933)</td>
<td>0.118*** (0.0421)</td>
<td>-1.072 (0.934)</td>
<td>-0.257 (0.476)</td>
</tr>
<tr>
<td>$\Delta NEG\text{Inf}(-2)$</td>
<td>-0.142* (0.0826)</td>
<td>-0.0812** (0.0371)</td>
<td>-0.316* (0.170)</td>
<td>-0.0969 (0.124)</td>
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<tr>
<td>$\Delta NEG\text{Inf}(-3)$</td>
<td>-0.148 (0.182)</td>
<td>-0.255** (0.0997)</td>
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</tr>
<tr>
<td>$\Delta NEG\text{Inf}(-4)$</td>
<td>-0.245 (0.207)</td>
<td>-0.241 (0.140)</td>
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<td></td>
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<tr>
<td>$\Delta POS\text{ER}(-1)$</td>
<td>-0.000362 (0.000282)</td>
<td>0.000357*** (0.000125)</td>
<td>-0.000944 (0.00102)</td>
<td>0.000464 (0.000353)</td>
</tr>
<tr>
<td>$\Delta POS\text{ER}(-2)$</td>
<td>-0.00121*** (0.000334)</td>
<td>-0.000292* (0.000145)</td>
<td>-0.00148 (0.00128)</td>
<td>0.000116 (0.000941)</td>
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<tr>
<td>$\Delta POS\text{ER}(-3)$</td>
<td>-0.000178 (0.000128)</td>
<td>-0.000188 (0.000638)</td>
<td></td>
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<tr>
<td>$\Delta POS\text{ER}(-4)$</td>
<td>-0.000818 (0.000761)</td>
<td>-0.000810* (0.000408)</td>
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<td>$\Delta NEG\text{ER}(-1)$</td>
<td>0.00113** (0.000423)</td>
<td>-0.000237 (0.000194)</td>
<td>0.00294*** (0.000951)</td>
<td>0.00102* (0.000356)</td>
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<td>$\Delta NEG\text{ER}(-2)$</td>
<td>0.00108*** (0.000365)</td>
<td>0.000212 (0.000136)</td>
<td>0.00164 (0.00103)</td>
<td>-0.000292 (0.000681)</td>
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<tr>
<td>$\Delta NEG\text{ER}(-3)$</td>
<td>0.000249 (0.000800)</td>
<td>1.87e-05 (0.000470)</td>
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<td>$\Delta NEG\text{ER}(-4)$</td>
<td>0.000317 (0.000628)</td>
<td>0.000671 (0.000415)</td>
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<tr>
<td>$\Delta POS\text{IR}(-1)$</td>
<td>0.117 (0.342)</td>
<td>-0.213 (0.154)</td>
<td>0.377 (0.900)</td>
<td>-0.869 (0.499)</td>
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<tr>
<td>$\Delta POS\text{IR}(-2)$</td>
<td>0.796** (0.336)</td>
<td>0.0638 (0.152)</td>
<td>3.608** (1.436)</td>
<td>0.748 (0.658)</td>
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<tr>
<td>$\Delta POS\text{IR}(-3)$</td>
<td>2.395 (1.629)</td>
<td>1.167 (0.712)</td>
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<tr>
<td>$\Delta POS\text{IR}(-4)$</td>
<td>2.540*** (0.680)</td>
<td>1.289** (0.523)</td>
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<td>$\Delta NEG\text{IR}(-1)$</td>
<td>-0.394 (0.290)</td>
<td>-0.145 (0.121)</td>
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<td>0.720 (0.494)</td>
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<td>$\Delta NEG\text{IR}(-2)$</td>
<td>0.521* (0.265)</td>
<td>-0.0397 (0.124)</td>
<td>0.691 (0.674)</td>
<td>-0.622 (0.416)</td>
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<tr>
<td>$\Delta NEG\text{IR}(-3)$</td>
<td>0.0442 (0.598)</td>
<td>-0.546 (0.415)</td>
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<tr>
<td>$\Delta NEG\text{IR}(-4)$</td>
<td>0.364 (0.633)</td>
<td>0.345 (0.375)</td>
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</tbody>
</table>
Table 3.
NARDL Estimation (Continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conventional Rural Banks</th>
<th>Conventional Banks</th>
<th>Islamic Rural Banks</th>
<th>Islamic Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \ln \text{CRB_Size} )</td>
<td>-8.146*** (2.245)</td>
<td>-0.881 (0.863)</td>
<td>-14.70*** (4.707)</td>
<td>-8.409** (2.973)</td>
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<tr>
<td>Constant</td>
<td>86.16*** (22.74)</td>
<td>17.14 (12.34)</td>
<td>114.3*** (32.96)</td>
<td>93.58*** (30.36)</td>
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<tr>
<td>Observations</td>
<td>58</td>
<td>58</td>
<td>56</td>
<td>56</td>
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<tr>
<td>R-squared</td>
<td>0.792</td>
<td>0.870</td>
<td>0.893</td>
<td>0.942</td>
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<tr>
<td>Fpps</td>
<td>2.79** 7.675***</td>
<td>5.73***</td>
<td>7.675***</td>
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<tr>
<td>Breusch-Pagan</td>
<td>2.370</td>
<td>2.290</td>
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<td>0.320</td>
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<tr>
<td>Durbin-Watson</td>
<td>2.51</td>
<td>2.298</td>
<td>2.174</td>
<td>2.359</td>
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</table>

In model 2, only inflation and the exchange rate have an asymmetric relationship with the NPLs of conventional banks in the long run, while the other variables have symmetric relationships in either the short run or long run. In this model, the long-run asymmetric relationships are shown by the F-statistic value of \( W_{LR} \) for \( \text{POSInf=NEGInf} \) and \( W_{LR} \) for \( \text{POSER=NEGER} \), which are statistically significant at the 1% and 5% levels.

\( \text{NEGInf} \) is negative and has a significant effect on \( \text{CB\_NPL} \). A fall in the inflation rate will increase the number of NPLs in conventional banks. This can be explained as a fall in the purchasing power of society, as reflected by the lower inflation score. In turn, this leads to an increase in NPLs in conventional banks as borrowers face repayment difficulties. This result is in line with the studies of Fajar and Umanto (2017), Bayar (2019), and Roman and Bilan (2015), which showed that inflation has a negative impact on NPLs.

Furthermore, an increase in \( \text{POSER} \) will increase the \( \text{CB\_NPL} \) rate. Conventional banks are potentially more exposed to business transactions conducted in foreign currencies as they will be at a disadvantage if the Indonesian rupiah is weak against the US dollar. A high \( \text{CB\_NPL} \) rate may indicate that conventional banks have provided loans to companies involved in international business, such as import and export activities. A weak Indonesian rupiah renders imported goods relatively expensive, thus eroding profit margins and negatively impacting the performance of the company. This will eventually affect the company’s risk profile as a borrower of a conventional bank. These results are consistent with studies by Castro (2013), Tanasković and Jandrić (2015), Bock and Demyanets (2019), and Klein (2013), all of whom concluded that the exchange rate had a significant effect on NPLs.

Interestingly, the results for both Islamic rural banks and Islamic banks differ from those of conventional banks. In both types of Islamic bank, an asymmetric relationship exists in both the short run and long run. For Islamic rural banks, the \( F \)-statistic values of \( W_{LR} \) for \( \text{POSPIGR=NEGPIGR} \); \( W_{LR} \) for \( \text{POSInf=NEGInf} \);
The Asymmetric Relationship Between Macroeconomic Determinants and Non-performing Loans: Evidence from the Banking Industry of Indonesia

WLR for POSIR=NEGIR; WSR for POSER=NEGER; and WSR for POSIR=NEGIR are significant at the 5% and 10% levels. This means H₀ is rejected. The findings confirm that production index growth, inflation, and interest rates have asymmetric relationships with NPF in the long run. Moreover, the exchange rate and interest rate also have asymmetric relationships with NPF in the short run.

In the long run, NEGER has a negative and significant relationship with SRB_NPF, which confirms that a stronger Indonesian rupiah–US dollar exchange rate will reduce the NPF of Islamic rural banks. This may occur if uncompetitive prices make it difficult for borrowers to export their products (Bock and Demyanets, 2019). Hence, this condition threatens their commercial sustainability and ability to generate profits to share with the Islamic rural bank, as well as the ability to repay their financing principal to the bank. Castro (2013) and Tanasković and Jandrić (2015) also identified a relationship between exchange rates and NPF in the banking sector.

Table 4.
Symmetric Test Results
Here, ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Conventional Rural Banks</th>
<th>Conventional Banks</th>
<th>Islamic Rural Banks</th>
<th>Islamic Banks</th>
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<tr>
<td>Symmetry Test</td>
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<td>WLR for POSPIGR=NEGPIGR</td>
<td>1.004</td>
<td>2.57</td>
<td>3.613*</td>
<td>6.138**</td>
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<td>WLR for POSInf=NEGInf</td>
<td>1.727</td>
<td>6.925**</td>
<td>3.723*</td>
<td>8.237**</td>
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<tr>
<td>WLR for POSER=NEGER</td>
<td>1.58</td>
<td>30.88***</td>
<td>0.374</td>
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<td>WLR for POSIR=NEGIR</td>
<td>0.1154</td>
<td>0.5621</td>
<td>4.885**</td>
<td>9.498***</td>
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<tr>
<td>WSR for POSPIGR=NEGPIGR</td>
<td>5.246**</td>
<td>1.797</td>
<td>1.639</td>
<td>10.3***</td>
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<td>WSR for POSInf=NEGInf</td>
<td>2.411</td>
<td>0.4657</td>
<td>0.5623</td>
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<td>WSR for POSER=NEGER</td>
<td>25.73***</td>
<td>0.08559</td>
<td>4.597*</td>
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<td>WSR for POSIR=NEGIR</td>
<td>2.799</td>
<td>0.02836</td>
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<td>1.722</td>
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<td>Long-run Effects:</td>
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<tr>
<td>POSPIGR</td>
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<td>-0.199</td>
<td>-0.256</td>
<td>0.232</td>
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<tr>
<td>NEGPIGR</td>
<td>2.411</td>
<td>8.995***</td>
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<td>1.545</td>
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<td>0.129</td>
<td>0.845</td>
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<td>3.033*</td>
<td>1.354</td>
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<tr>
<td>NEGInf</td>
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<td>6.013**</td>
<td>0.2477</td>
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<tr>
<td>NEGER</td>
<td>-0.121</td>
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<td>POSER</td>
<td>1.471</td>
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<td>1.374</td>
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<td>0.001</td>
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<td>112.2***</td>
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<td>0.000</td>
<td>-0.001</td>
<td>0.001</td>
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<tr>
<td>POSIR</td>
<td>2.972*</td>
<td>2.737</td>
<td>3.462*</td>
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<td>NEGER</td>
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<td>-0.287</td>
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<td>POSIR</td>
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<td>1.633</td>
<td>0.670</td>
<td>0.878</td>
<td>6.413**</td>
</tr>
</tbody>
</table>
In addition, POSIR has a negative and significant relationship with SRB_NPF. A rise in the interest rate will increase the rate of NPF in Islamic rural banks. This result is consistent with Castro (2013), Louzis et al. (2012), and Chaibi and Ftiti (2015), who revealed that an increase in debt burden led to high NPL levels. The finding also shows that Islamic rural banks clearly continue to be affected by interest rates, despite the bank adopting a profit and loss sharing approach. This is potentially indicative of the fact that the Islamic banks still use interest rates as a benchmark for profit computation (Zabri and Haron, 2019). An increase or decrease in the interest rate will influence the required profit-sharing ratio with borrowers. Hence, a high interest rate will lead to a higher profit-sharing ratio and ultimately increase the possibility that borrowers will not be able to pay either the financing principal or the amount required under the profit-sharing ratio.

In Islamic banks, an asymmetric relationship in both the long run and short run is also evident for the variables of production index growth, inflation, and interest rate, while the other variables show a symmetric relationship. This is shown in Table 4, where the values of \( W_{LR} \) for POSPIGR=NEGPIGR, \( W_{LR} \) for POSInf=NEGInf, and \( W_{LR} \) for POSIR=NEGIR are significant at the 1% and 5% levels. Furthermore, \( W_{SR} \) for POSPIGR=NEGPIGR is also significant at the 1% level, reflecting the asymmetric relationship in the short run between production index growth and the NPF of Islamic banks.

POSInf has a positive and significant asymmetric relationship in the long run with the NPF of Islamic banks. In the case of these banks, the high rate of inflation that leads to an increase in NPF is possibly due to an increase in the prices of goods and services, which will create additional costs at the household level and increase production costs at the company level. These additional costs will mean fewer opportunities for Islamic bank borrowers to share profits due to the fall in real income as well as to repay the financing principal to the bank. This finding is in line with Chaibi and Ftiti (2015), who found a positive influence of inflation on NPF; a high level of inflation will reduce the real income of borrowers, hence reducing their ability to repay debts.

POSIR and NEGIR have a negative relationship with the NPF of Islamic banks. The asymmetric relationship with interest rates therefore confirms that this type of bank continues to use the interest rate as a benchmark rate for determining its profit ratio (Zabri and Haron, 2019). The finding also clearly highlights how Islamic banks must have good risk management in place if they are to manage their interest rate exposure, especially during times of financial distress, potentially leading to the central bank’s macroeconomic policy to revise interest rates.

An important lesson from the results of this study concerns the significant relationship between macroeconomic conditions and the financial system, especially in relation to banking resilience, as seen from the level of NPLs (NPF). However, the relationship between the two is not always symmetrical; it can also be asymmetrical. These results are supported by the findings of Claessens and Kose (2018) and Jiang et al. (2021), who concluded that there were interactions between the real and financial sectors, mainly related to the disruption of credit markets following shocks in economic activities. In another study, Claessens and Kose (2013) revealed that the financial crisis was marked by output losses and turbulent macroeconomic conditions such as production, consumption, investment, and
financial variables in the form of assets and credit prices. In addition, Nicolaides (2020) generally stated that a weak global macroeconomic conditions may pose a threat to the financial sector, especially to credit in the banking sector. Nicolaides (2020) and Pratheesh and Arumugasamy (2020) expressed similar views in the case of Europe and India, the impact of financial turmoil resulted a weakening of macroeconomic conditions and a decline in companies’ performance, leading to an increase in the proportion of bad loans in the banking portfolios.

In addition to the above analysis, Figure 1. illustrates the bootstrapping analysis, which reflects the cumulative effect of macroeconomic influence on NPLs (NPF) in the Indonesian banking industry. The influence reflects both the symmetric and asymmetric patterns based on the Wald test, as previously explained. Finally, to assess the robustness of the model, as suggested by Sriyana and Ge (2019), cumulative sum (CUSUM) analysis was employed. Based on Figure 2, in general, all models have stable parameters. Model 1 is stable before the period 58 but the movement of the line in the observation period 58–60 is dynamic and above the upper line. This shows that the model does not have stable parameters particularly during the dynamic period. All of the results in the CUSUM test are displayed by the plots of the CUSUM statistics; these either exceed or do not exceed the critical bounds line, which is below the 5% level of significance.

![Figure 1. Bootstrapping Analysis of the Indonesian Banking Industry](image-url)

Cumulative effect of PIG on CRB_NPL

Note: 95% bootstrap CI is based on 100 replications
Figure 1. Bootstrapping Analysis of the Indonesian Banking Industry (Continued)

Cumulative effect of ER on CRB_NPL

Note: 95% bootstrap CI is based on 100 replications

Cumulative effect of INF on CRB_NPL

Note: 95% bootstrap CI is based on 100 replications
Figure 1.
Bootstrapping Analysis of the Indonesian Banking Industry (Continued)

Cumulative effect of IR on CRB_NPL

Cumulative effect of PIG on CB_NPL

Note: 95% bootstrap CI is based on 100 replications
Figure 1.
Bootstrapping Analysis of the Indonesian Banking Industry (Continued)

Cumulative effect of INF on CB_NPL

Cumulative effect of ER on CB_NPL

Note: 95% bootstrap CI is based on 100 replications
Figure 1.
Bootstrapping Analysis of the Indonesian Banking Industry (Continued)

Cumulative effect of IR on CB_NPL

Note: 95% bootstrap CI is based on 100 replications

Cumulative effect of PIG on SRB_NPF

Note: 95% bootstrap CI is based on 100 replications
Figure 1.
Bootstrapping Analysis of the Indonesian Banking Industry (Continued)

Cumulative effect of INF on SRB_NPF

Note: 95% bootstrap CI is based on 100 replications

Cumulative effect of ER on SRB_NPF

Note: 95% bootstrap CI is based on 100 replications
Figure 1. Bootstrapping Analysis of the Indonesian Banking Industry (Continued)

Cumulative effect of IR on SRB_NPF

Cumulative effect of PIG on SB_NPF

Note: 95% bootstrap CI is based on 100 replications
Figure 1.
Bootstrapping Analysis of the Indonesian Banking Industry (Continued)

Cumulative effect of INF on SB_NPF

Note: 95% bootstrap CI is based on 100 replications

Cumulative effect of ER on SB_NPF

Note: 95% bootstrap CI is based on 100 replications
The Asymmetric Relationship Between Macroeconomic Determinants and Non-performing Loans: Evidence from the Banking Industry of Indonesia

Figure 1.
Bootstrapping Analysis of the Indonesian Banking Industry (Continued)
Cumulative effect of IR on SB_NPF

Note: 95% bootstrap CI is based on 100 replications

Figure 2.
CUSUM Stability Test

Note: 95% bootstrap CI is based on 100 replications
Figure 2.
CUSUM Stability Test (Continued)
IV. CONCLUSION
This study concludes that the banking industry in Indonesia has asymmetric vulnerability to changes in macroeconomic conditions. Conventional rural banks have a short-run asymmetric relationship with production index growth and exchange rates, while conventional banks have a long-run asymmetric relationship with inflation and exchange rates in relation to NPLs. Conversely, both Islamic rural banks and Islamic banks have greater exposure to asymmetric relationships with macroeconomic variables in both the short- and long-run. Such asymmetric relationships indicate that positive and negative changes in macroeconomic variables may lead to different magnitudes of changes in the NPLs (NPF) of banks.

To pave the way forward, an understanding of banking characteristics is crucial to the ability to respond to the economic uncertainty such as in the case of financial turmoil. The uncertainties that have arisen during the crisis, such as volatility in production index growth, inflation, exchange rates, and interest rates, have impacted banks differently depending on their type (Islamic or conventional) and characteristics. Hence, financial authorities such as the central bank, financial services authority, and the government of Indonesia must be prudent with their economic policies. In addition, the financial services authority must realize that changes in macroeconomic variables may have both a symmetric and an asymmetric impact. It is therefore crucial that the financial authorities hold sufficient information on the asymmetric effect of macroeconomic variables on banking portfolios to assist in the formation of policies aimed at safeguarding the banking sector for the benefit of the nation’s economy.

Finally, this study has at least two limitations that future studies on the banking system may seek to address. First, the observation of our study was limited to the Indonesian banking industry. It may, therefore, be possible to extend the sampling and include a cross-country comparison with other nations that operate a dual
banking system, such as Malaysia, Algeria, Bahrain, Bangladesh, Pakistan, Qatar, and Saudi Arabia. This would produce a more comprehensive study in terms of explaining the asymmetric relationship between macroeconomic variables and NPLs/NPF at the cross-country level. Second, our study does not include the period of the COVID-19 pandemic due to the limitations of time-series data when the study was conducted. Future studies may further extend this study in the context of the COVID-19 period.

REFERENCES


