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The Effect of NPL and LDR on ROA through BOPO as an Intervening Variable in Digital Banks in Indonesia Period 2020-2024

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Abstract: This study aims to analyze the effects of *Non-Performing Loan* (NPL) and *Loan to Deposit Ratio* (LDR) on *Return on Asset* (ROA), with *Operating Expenses to Operating Income* (BOPO) as an intervening variable, in digital banks in Indonesia from 2020 to 2024. Employing a quantitative approach with panel data regression using the *Random Effect Model* (REM), this study examines 7 digital banks registered with the Financial Services Authority (OJK). The results reveal that NPL has a positive and significant effect on BOPO, whereas LDR shows no significant effect on BOPO. Directly, neither NPL nor LDR significantly affects ROA however, BOPO has a negative and significant impact on ROA. Mediation analysis demonstrates that BOPO successfully serves as a *full mediator* for the effect of NPL on ROA, but fails to mediate the effect of LDR on ROA. These findings underscore that operational efficiency is a critical factor in sustaining the profitability of digital banking.

Keyword: Digital Banking, NPL, LDR, BOPO, ROA, Intervening Variable

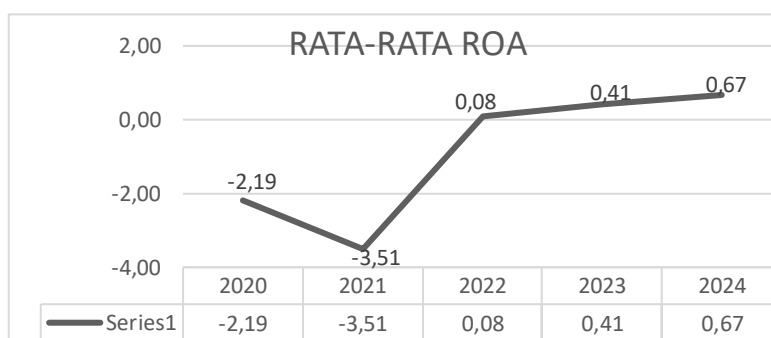
Indonesian Abstract: Penelitian ini bertujuan untuk menganalisis pengaruh *Non-Performing Loan* (NPL) dan *Loan to Deposit Ratio* (LDR) terhadap *Return on Asset* (ROA), dengan *Biaya Operasional terhadap Pendapatan Operasional* (BOPO) sebagai variabel intervening, pada bank digital di Indonesia dari tahun 2020 hingga 2024. Menggunakan pendekatan kuantitatif dengan regresi data panel melalui *Random Effect Model* (REM), penelitian ini menguji 7 bank digital yang terdaftar di Otoritas Jasa Keuangan (OJK). Hasil penelitian menunjukkan bahwa NPL berpengaruh positif dan signifikan terhadap BOPO, sedangkan LDR tidak menunjukkan pengaruh yang signifikan terhadap BOPO. Secara langsung, baik NPL maupun LDR tidak berpengaruh signifikan terhadap ROA; namun, BOPO memiliki dampak negatif dan signifikan terhadap ROA. Analisis mediasi membuktikan bahwa BOPO berhasil menjadi pemediasi penuh (*full mediator*) untuk pengaruh NPL terhadap ROA, tetapi gagal memediasi pengaruh LDR terhadap ROA. Temuan ini menegaskan bahwa efisiensi operasional merupakan faktor krusial dalam menjaga keberlanjutan profitabilitas perbankan digital.

Kata Kunci: Bank Digital, NPL, LDR, BOPO, ROA, Variabel Intervening

INTRODUCTION

The acceleration of financial technology (fintech) has triggered a massive transformation within the banking industry. Shifts in consumer behavior, characterized by an increasing preference for fast, practical, and seamless transactions, have compelled conventional banks to adopt digital business models to maintain market relevance. In Indonesia, this digital transformation is underpinned by high internet penetration, which reached 215.63 million users in 2023. This significant figure has fundamentally altered transactional patterns, as the public increasingly favors online systems over traditional, in-person banking services. Consequently, banks are under pressure to restructure their operational strategies to remain competitive and meet the expectations of modern customers. This strategic shift is empirically evident in the reduced reliance on physical infrastructure, as demonstrated by a decline of 4,152 branch offices between 2020 and 2022.

As they enter a full operational era for the 2020–2024 period, digital banks in Indonesia face business characteristics that differ significantly from those of conventional banking institutions. By operating exclusively online without physical branches, digital banks are required to commit substantial upfront capital toward information technology infrastructure while simultaneously implementing aggressive marketing strategies to acquire a customer base. These operational conditions have a direct impact on their cost structures, as reflected in the fluctuations of the Operational Expenses to Operating Income (BOPO) ratio. Furthermore, the ease of access to credit through digital applications presents complex challenges regarding credit risk, specifically the Non-Performing Loan (NPL) ratio. Simultaneously, intense competition for deposit interest rates significantly influences liquidity levels, as measured by the Loan to Deposit Ratio (LDR).



Source: Research Result

Figure 1. Trends in Average Return on Assets (ROA) of 7 Digital Banks (2020–2024)

As illustrated in Figure, an anomalous phenomenon is evident in the profitability of digital banks in Indonesia, particularly in 2021, when the average Return on Assets (ROA) experienced a sharp contraction, reaching a negative value. The profitability performance of digital banks in Indonesia continues to face significant challenges. As depicted in the chart, the average ROA of digital banks from 2020 to 2024 remains below the "highly healthy" regulatory threshold ($ROA > 1.5\%$) established by Bank Indonesia. This trend indicates that during the initial phase of migration to digital systems, bank management prioritizes substantial capital allocation toward strengthening information technology infrastructure. Consequently, the banks' ability to generate net income has yet to reach the ideal performance targets mandated by the central bank.

METHOD

This study employed a quantitative research method. The research utilized secondary data in the form of financial statements obtained from the Indonesia Stock Exchange and the official websites of the respective digital banks. The data were processed using EViews 14. The population of this study consisted of all digital banks in the banking sector, with a total of 7 listed companies. The research sample was determined using purposive sampling, which is a sampling technique based on specific considerations tailored to the objectives and problems of the study. Based on these purposive sampling criteria, all 7 digital banks were selected as the research sample. This study involved three types of variables, namely independent variables consisting of the Loan to Deposit Ratio (LDR) and Non-Performing Loan (NPL), an intervening variable consisting of Operating Expenses to Operating Income (BOPO), and the dependent variable, namely Return on Assets (ROA). The data analysis techniques used in this study were as follows:

- 1) Descriptive statistical analysis, to present the data and analyze the characteristics of each variable.
- 2) Regression model selection, to determine the most appropriate model among common effects, fixed effects, and random effects using the Chow, Hausman, and Lagrange multiplier tests.
- 3) Classical assumption test, to ensure the reliability of the regression model to be used, with the criteria of meeting the normality assumptions, ensuring no multicollinearity, and no heteroscedasticity.
- 4) Panel data regression analysis and path analysis, to determine the nature of the relationship and the intervening or mediating role of the BOPO variable between independent variables and the dependent variable.
- 5) Coefficient of Determination (R^2) analysis interprets how much variation in the dependent variable can be explained by the regression model.
- 6) Hypothesis testing, to verify the validity of the assumptions based on data analysis, thus concluding whether the hypothesis is accepted or rejected.

RESULTS AND DISCUSSION

	ROA	NPL	LDR	BOPO
Mean	-0.897714	1.940000	83.83286	113.2949
Median	0.290000	1.740000	84.05000	96.71000
Maximum	4.790000	7.890000	163.1900	287.8600
Minimum	-14.11000	0.000000	0.010000	43.40000
Std. Dev.	5.118811	1.729884	31.69171	57.47892
Skewness	-1.481652	1.303940	0.317497	1.805280
Kurtosis	4.466502	5.174423	4.070224	5.544547
Jarque-Bera	15.94221	16.81335	2.258368	28.45333
Probability	0.000345	0.000223	0.323297	0.000001
Sum	-31.42000	67.90000	2934.150	3965.320
Sum Sq.	919.0820	233.4710	280126.6	561580.4
Sum Sq. Dev.	890.8758	101.7450	34148.39	112330.1
Observations	35	35	35	35

Source: Research Result

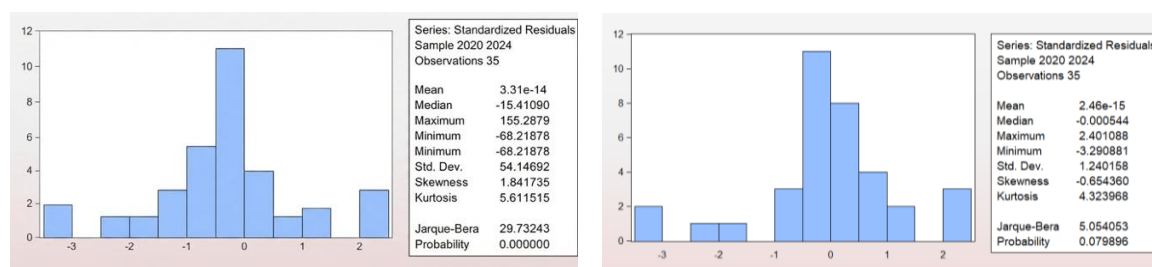
Figure 2. Descriptive Statistical Analysis Results

Based on the descriptive statistical analysis of the seven digital banks sampled during the 2020–2024 period, there are clear variations in financial performance. The average *Return*

on Assets (ROA) was recorded at -0.90%, with a standard deviation of 5.12%. This value highlights a significant difference in profitability levels among the banks, with ROA performance ranging from a low of -14.11% to a high of 4.79%. This negative average ROA indicates that during the observation period, some digital banks were still in a major expansion phase that weighed on their net income.

Variations are also evident in the efficiency and risk indicators. The BOPO ratio recorded an average of 113.29%, with a wide range from 43.40% to 287.86%. The fact that the average BOPO exceeds 100% reflects the substantial operational burden that digital banks must bear to support their technological infrastructure. Meanwhile, regarding liquidity, the average LDR(-1) stood at 83.83% (with a standard deviation of 31.69%), indicating a well-balanced level of loan distribution, accompanied by credit risk NPL(-1) which averaged 1.94% with a stable level of dispersion (standard deviation of 1.73%).

Overall, these descriptive statistics confirm that the financial characteristics of each digital bank in the research sample are quite diverse. In this study, the independent variables (LDR, NPL, and BOPO) are applied with a one-period time lag (t-1) to account for the delayed impact of previous financial conditions on current profitability. Regarding the panel regression model selection, the Chow test results showed a probability value below 0.05, initially pointing toward the *Fixed Effect Model* (FEM). However, the Hausman test produced a probability value above 0.05, statistically confirming that the *Random Effect Model* (REM) is the most appropriate and consistent model for examining the influence of these lagged variables in this study.



Source: Research Result

Figure 3. Normality Result (for Path 1 & Path 2)

Based on the normality test results presented in Figures , the two research path models show varying results. The Jarque-Bera probability value for Path 1 is $0.0000 < 0.05$, indicating that the residual data for Path 1 is not normally distributed. This non-normality is strongly suspected to stem from the presence of extreme values (outliers) in the BOPO variable, given the quite sharp fluctuations in the operational efficiency levels among the banks studied. Conversely, the normality test result for Path 2 shows a probability value of $0.7989 > 0.05$, proving that the residual data for Path 2 is normally distributed and has fulfilled the classical assumption of normality.

	NPL(-1)	LDR(-1)		ROA	NPL(-1)	LDR(-1)	BOPO
			ROA	1.000000	-0.255744	-0.019632	-0.970249
NPL(-1)	1.000000	-0.172572	NPL(-1)	-0.255744	1.000000	-0.172572	0.228299
LDR(-1)	-0.172572	1.000000	LDR(-1)	-0.019632	-0.172572	1.000000	0.029969
			BOPO	-0.970249	0.228299	0.029969	1.000000

Source: Research Result

Figure 4. Multicollinearity Result (for Path 1 & Path 2)

Based on the correlation matrix, the multicollinearity test for both path models shows results that are free from multicollinearity issues. In Path 1, the strongest interaction among the independent variables occurs between NPL (-1) and LDR (-1) with a correlation coefficient of

-0.1726. Meanwhile, in Path 2, the strongest interaction among the independent variables is found between NPL(-1) and BOPO with a value of 0.2283. Given that all correlation coefficients in both paths are well below the threshold (< 0.90), it is confirmed that there is no indication of multicollinearity. Consequently, all research variables in both Path 1 and Path 2 are proven valid to proceed to the panel data regression estimation stage.

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	30.34787	12.53121	2.421783	0.0213	C	0.440798	0.206416	2.135478	0.0427
NPL(-1)	4.286248	4.031416	1.063212	0.2956	NPL(-1)	-0.001932	0.054432	-0.035499	0.9720
LDR(-1)	-0.021855	0.048505	-0.450579	0.6553	LDR(-1)	-9.97E-05	0.000489	-0.203938	0.8401
					BOPO	0.001466	0.001384	1.059015	0.2997

Source: Research Result

Figure 5. Heteroscedasticity Result (for Path 1 & Path 2)

Based on the heteroskedasticity test results using the Glejser test, both Path 1 and Path 2 models show results that are free from heteroskedasticity issues. In Path 1, the probability values for NPL(-1) and LDR(-1) are 0.2956 and 0.6553, respectively. Meanwhile, in Path 2, the probability values for all independent variables namely NPL(-1) at 0.9720, LDR(-1) at 0.8401, and BOPO at 0.2997 > 0.05 significance level (> 0.05). This indicates no significant effect of the independent variables on the absolute residual values in both models. Consequently, the regression models for Path 1 and Path 2 are proven to satisfy the classical assumption of homoskedasticity.

R-squared	0.106554	Mean dependent var	103.6728	R-squared	0.951662	Mean dependent var	-0.402902
Adjusted R-squared	0.050714	S.D. dependent var	56.54967	Adjusted R-squared	0.946985	S.D. dependent var	4.500533
S.E. of regression	55.09709	Sum squared resid	97142.07	S.E. of regression	1.036252	Sum squared resid	33.28836
F-statistic	1.908194	Durbin-Watson stat	1.766740	F-statistic	203.4407	Durbin-Watson stat	1.511061
Prob(F-statistic)	0.164851			Prob(F-statistic)	0.000000		

Source: Research Result

Figure 6. Autokoleration Result (for Path 1 & Path 2)

The autocorrelation test aims to examine whether a linear regression model has a correlation between the error term in period t and the error term in the previous period ($t-1$). Based on the panel data regression estimation results, the *Durbin-Watson stat* for Path 1 is 1.7667, while the *Durbin-Watson stat* for Path 2 is 1.5111. In general, a *Durbin-Watson* value ranging between 1.5 and 2.0 indicates that there is no serious indication of autocorrelation issues in both models. Consequently, the regression models for Path 1 and Path 2 satisfy the classical assumptions and are deemed appropriate for the subsequent analysis stage.

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	105.0883	25.27296	4.158131	0.0003	C	9.162396	0.639227	14.33355	0.0000
NPL (-1)	11.82355	4.719882	2.505052	0.0191	NPL(-1)	-0.211205	0.131976	-1.600322	0.1197
LDR(-1)	-0.235342	0.256762	-0.916578	0.3681	LDR(-1)	-0.002065	0.001286	-1.605709	0.1185
					BOPO	-0.083161	0.003612	-23.02036	0.0000

Source: Research Result

Figure 7. t-statistic Result (for Path 1 & Path 2)

Based on the partial test results (t-test), the test on Path 1 indicates that NPL(-1) has a positive and significant effect on BOPO ($0.0191 < 0.05$) whereas LDR(-1) has no significant effect ($0.3681 > 0.05$). Meanwhile, in Path 2 NPL(-1) ($0.1197 > 0.05$) dan LDR (-1) ($0.1185 > 0.05$) have no significant effect on ROA, but BOPO is proven to have a negative and significant effect on ROA ($0.0000 < 0.05$).

According to the t-test results, NPL(-1) has a positive and significant effect on BOPO (0.0191) because an increase in non-performing loans requires higher allocation for allowance for impairment losses (CKPN) and collection costs, whereas LDR (-1) has no significant effect on either BOPO or ROA (> 0.05) since digital banks' liquidity distribution does not sensitively drive internal operational efficiency or final asset profitability due to high technological automation. On the other hand, NPL(-1) has no direct effect on ROA (0.1197) due to risk mitigation via previously prepared CKPN allocations, while BOPO proves to have a negative and highly significant effect on ROA(0.0000), emphasizing that management's ability to control operational expenses, IT investments, and promotional strategies is the primary determinant of digital bank profitability.

R-squared	0.951662	Mean dependent var	-0.402902
Adjusted R-squared	0.946985	S.D. dependent var	4.500533
S.E. of regression	1.036252	Sum squared resid	33.28836
F-statistic	203.4407	Durbin-Watson stat	1.511061
Prob(F-statistic)	0.000000		

Source: Research Result

Figure 8. Results of the Coefficient of Determination

Based on the estimation results presented in Table the obtained *Adjusted R-squared* value is 0.9470, which indicates that 94.70% of the variation or fluctuation in the dependent variable can be explained simultaneously by the combination of independent variables included in the model. Meanwhile, the remaining 5.30% is explained by other variables or external factors not included in this research model.

R-squared	0.951662	Mean dependent var	-0.402902
Adjusted R-squared	0.946985	S.D. dependent var	4.500533
S.E. of regression	1.036252	Sum squared resid	33.28836
F-statistic	203.4407	Durbin-Watson stat	1.511061
Prob(F-statistic)	0.000000		

Source: Research Result

Figure 9. F Test Results

The F-test probability of 0.0000 indicates that the three independent (NPL,LDR and BOPO) variables jointly affect ROA.

Input:	Test statistic:	Std. Error:	p-value:
a 11.82355	Sobel test: -2.49035461	0.3948266	0.01276157
b -0.083161	Aroian test: -2.48803631	0.39519449	0.01284506
s _a 4.719882	Goodman test: -2.4926794	0.39445836	0.01267833
s _b 0.003612	Reset all	Calculate	

Input:	Test statistic:	Std. Error:	p-value:
a -0.235342	Sobel test: 0.91585098	0.0213695	0.35974506
b -0.083161	Aroian test: 0.91498968	0.02138961	0.36019705
s _a 0.256762	Goodman test: 0.9167147	0.02134936	0.35929216
s _b 0.003612	Reset all	Calculate	

Source: Research Result

Figure 10. Sobel Test Results

Based on the Sobel test results, BOPO significantly mediates the effect of NPL on ROA with a p-value of 0.012761, whereas BOPO does not significantly mediate the effect of LDR on ROA given the p-value of 0.359745.

CONCLUSION

This study concludes that LDR, NPL, and BOPO simultaneously affect the financial performance (ROA) of Digital Banks in Indonesia. Partially, NPL has a positive and significant effect on BOPO, while LDR has no significant effect on either BOPO or ROA. Furthermore, BOPO has a negative and significant effect on ROA and successfully acts as a full mediator for the indirect effect of NPL on ROA.

For bank management, operational efficiency should remain a top priority by controlling non-productive operating expenses and limiting aggressive "burning money" promotional strategies. Strict credit scoring algorithms must be implemented to mitigate credit risk early before it inflates loss provisions (CKPN) and damages profitability. For future researchers, a longer observation period and the inclusion of additional variables are recommended to capture the dynamic nature of the digital banking sector.

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