Al-Kharaj: Journal of Islamic Economic and Business
Volume 8 (4), 2026
P-ISSN: 2686-262X; E-ISSN: 2685-9300

The Effects of Operational Efficiency, Digital Transformation, and Market Risk on Stock Returns of Banks Listed on the Indonesia Stock Exchange

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Keywords:
Operational Efficiency; Digital Transformation; Market Risk; Stock Returns; Banking.

Abstract

Abstract : *This study examines the relationships between operational efficiency, digital transformation, market risk, and stock returns of banking companies listed on the Indonesia Stock Exchange during 2021–2025. It tests the hypotheses that the operating expenses-to-operating income ratio (BOPO) is negatively associated with stock returns, while digital transformation and net open position (NOP) are positively associated with stock returns.*

Methods: *A quantitative associational design was employed using secondary data from annual reports, financial statements, and stock prices. Purposive sampling yielded 31 banks, comprising 155 bank-year observations. Operational efficiency was proxied by BOPO, digital transformation by a dummy variable, and market risk by NOP. Panel data regression was estimated using the Common Effect Model.*

Result: *The results indicate that BOPO ($\beta = 0.249858$; $p = 0.0383$), digital transformation ($\beta = 0.090597$; $p = 0.0340$), and NOP ($\beta = 1.366812$; $p = 0.0350$) are positively and significantly associated with stock returns. Accordingly, the first hypothesis is not supported, whereas the second and third hypotheses are supported. Holding the other variables constant, a one-percentage-point increase in BOPO or NOP corresponded to predicted returns higher by 0.25 or 1.37 percentage points, respectively. Higher BOPO indicates lower efficiency. Predicted returns were 9.06 percentage points higher for bank-year observations classified as digital adopters. The model was jointly significant ($F = 4.03$, $p = 0.0086$) and explained 7.42% of the variation in stock returns.*

Implications: *These findings suggest that bank managers should evaluate operating costs, digital initiatives, and foreign exchange exposure carefully, while investors should consider additional financial and market indicators. Future research should incorporate broader explanatory variables and more detailed measures of digital transformation.*

INTRODUCTION

Understanding the factors associated with banking stock returns is important for evaluating how financial markets respond to banks' operating conditions, technological development, and risk exposure. Bank managers face decisions about controlling operating costs, developing digital services, and managing foreign exchange positions, while investors must assess whether these decisions are reflected in investment returns. These considerations motivate an examination of operational efficiency, digital transformation, and market risk within a common analytical framework. The central problem addressed in this study is whether these three factors explain differences in the stock returns of banks listed on the Indonesia Stock Exchange during 2021–2025.

The theoretical rationale draws on signaling theory, which explains how observable information can convey otherwise unobservable characteristics under conditions of information asymmetry (Spence, 1973). Applied to this study, operating performance, digital service adoption, and foreign exchange exposure may provide information that investors use to evaluate banks' prospects. Operational efficiency is represented by the ratio of operating expenses to operating income, commonly known in Indonesia as BOPO, with a lower ratio indicating greater efficiency. Digital transformation represents the adoption of digital banking services, while net open position (NOP), or Posisi Devisa Neto (PDN), captures the foreign exchange exposure component of market risk. These indicators represent distinct dimensions of banking activity, and their relationships with stock returns require empirical examination rather than an assumption that operational or technological improvements necessarily translate into higher returns.

Recent empirical evidence provides an inconsistent account of the relationship between operational efficiency and banking stock returns. A study using banking data from 2019–2021 reported a positive relationship between BOPO and stock returns (Zettira et al., 2023). This finding runs counter to the expectation that lower operating expenses relative to income should be associated with stronger investment performance. Another study found no statistically significant relationship between BOPO and banking stock returns (Irawan et al., 2023). The contrast indicates that the association is not uniform across the studies reviewed and warrants further examination within a clearly defined sample and observation period.

Research on digital banking also demonstrates the importance of distinguishing between different measures of performance. An examination of digital banking transactions found that mobile banking transactions were positively associated with return on assets, whereas internet banking and ATM transactions were negatively associated with that measure (Tangiduk et al., 2024). These findings suggest that different service channels may have different relationships with accounting profitability. Research on Indonesian digital banks further identified a significant relationship between digital transformation and firm value measured using Tobin's Q (Annur & Muharam, 2025). Although relevant to market valuation, this evidence does not directly establish whether digital transformation is associated with annual stock returns, which measure a different outcome.

Studies of market risk provide additional context but require careful interpretation when applied to banking. Research involving 29 companies included in the LQ45 index during 2021–2023 found a positive relationship between market risk and stock returns, while the exchange rate variable showed no significant relationship with returns (Sukmayani et al., 2025). These findings distinguish the role of a risk indicator from that of exchange rate movements themselves. Evidence from a multisector stock index does not directly resolve whether bank-level foreign exchange exposure, represented by NOP, is associated with banking stock returns. The present study therefore focuses specifically on this dimension of risk without treating NOP as a comprehensive measure of all forms of market risk.

The reviewed literature leaves a gap at the intersection of operating performance, digital adoption, and foreign exchange exposure. Findings concerning BOPO differ, while the digital banking studies discussed above primarily examine accounting profitability or firm value. Evidence concerning these outcomes cannot be assumed to apply directly to stock returns. Similarly, findings about market risk across different industries require further examination before being extended to banks' foreign exchange positions. These differences in outcomes, samples, and variable definitions motivate an integrated analysis of the three indicators in the Indonesian banking sector.

A further issue concerns the interpretation of the relationships being tested. Because BOPO is inversely related to operational efficiency, a positive BOPO coefficient would indicate an association between higher relative operating costs and higher stock returns, rather than evidence that greater efficiency increases returns. Digital transformation measured using a dummy variable identifies differences between adoption categories but does not capture the depth or quality of implementation. NOP likewise indicates foreign exchange exposure without establishing whether exchange rate movements generate gains or losses. Explicitly recognizing these measurement boundaries allows the study to connect its empirical findings to the underlying concepts more precisely.

This study therefore asks whether BOPO, digital transformation, and NOP are significantly associated with the stock returns of banks listed on the Indonesia Stock Exchange during 2021–2025. Its objective is to estimate the direction and statistical significance of these relationships using panel data from 31 banks, comprising 155 bank-year observations. The study tests a negative relationship between BOPO and stock returns and positive relationships for digital transformation and NOP. Its contribution lies in examining operating efficiency, digital adoption, and foreign exchange exposure together in a stock-return model for the specified banking sample and period. This approach extends the reviewed evidence by focusing on investment returns while maintaining explicit distinctions between the constructs and their empirical measures.

METHODS

This study employed a quantitative, non-experimental panel design to examine the relationships between operational efficiency, digital transformation, market risk, and banking stock returns. The population comprised 47 banking companies listed on the Indonesia Stock Exchange during 2021–2025. Purposive sampling was applied using the following criteria: availability of complete audited financial statements for financial years ending on December 31 throughout the observation period; no prolonged trading suspension or delisting; no reported annual losses; availability of all required research data; and financial statements presented in Indonesian rupiah. The selection process yielded 31 banks observed over five years, producing a balanced panel of 155 bank-year observations.

Secondary data were collected through documentary review of annual reports, audited financial statements, published financial ratios, and stock price records obtained from the Indonesia Stock Exchange and the sampled banks' official websites. A spreadsheet-based data extraction sheet was used to organize observations by bank and year. The recorded information covered operating expenses, operating income, net open positions, bank capital, digital banking services, stock prices, and dividends. Data were checked against the source documents for completeness and consistency before being organized in Microsoft Excel and imported into EViews.

Stock returns constituted the dependent variable. Following the operational definition in the research protocol, annual returns were measured as the change in share price plus dividends per share during the observation year, divided by the preceding year-end share price. Operational efficiency was proxied by the operating expenses-to-operating income ratio (BOPO), with lower values indicating greater efficiency. Market risk was represented by net open position (NOP) relative to bank capital, specifically capturing foreign exchange exposure. Stock returns, BOPO, and NOP were expressed as decimal ratios. Digital transformation was represented by a binary

variable distinguishing bank-year observations classified as having adopted digital transformation from those classified as not having adopted it. The service indicators reviewed included mobile banking, internet banking, QRIS or digital payments, online account opening, and virtual assistants or chatbots.

Data analysis began with descriptive statistics, including the mean, median, minimum, maximum, and standard deviation. Panel model selection involved a Chow test comparing pooled ordinary least squares with bank fixed effects, followed by a Breusch–Pagan Lagrange Multiplier test comparing pooled ordinary least squares with bank random effects. These procedures led to the use of the Common Effect Model, estimated through pooled ordinary least squares with BOPO, digital transformation, and NOP entered as explanatory variables.

Diagnostic procedures included the Jarque–Bera test for residual normality, inspection of pairwise correlations among explanatory variables using an absolute correlation threshold of 0.80, and the Glejser test for heteroskedasticity. The Durbin–Watson statistic was examined as a descriptive indication of residual autocorrelation. Individual regression coefficients were evaluated using t-tests at the 5% significance level, with hypothesis support determined by both statistical significance and the predicted direction. The F-test assessed whether the explanatory variables improved the model relative to an intercept-only specification. R-squared and adjusted R-squared were reported to describe the model's explanatory power.

RESULTS AND DISCUSSION

Research Sample Description

This study examines the relationships between operational efficiency, digital transformation, market risk, and stock returns of banking companies listed on the Indonesia Stock Exchange (IDX) during 2021–2025. Operational efficiency was represented by BOPO, digital transformation by a binary indicator, and market risk by net open position (NOP). Purposive sampling was employed to select banks based on listing status, availability of audited financial statements, financial reporting currency, profitability, and completeness of the required data. Of the 47 banks in the initial population, 16 were excluded during the selection process, resulting in a final sample of 31 banks. Each bank was observed for five years, yielding a balanced panel of 155 bank-year observations. Table 1 summarizes the sample selection process.

Table 1. Research Sample Selection

Criteria	Number of Banks
Banking companies listed on the IDX during 2021–2025	47
Banks excluded due to incomplete audited financial statements	(0)
Banks excluded due to prolonged trading suspension or delisting	(5)
Banks excluded due to reported losses during the observation period	(6)
Banks excluded due to incomplete data for the study variables	(5)
Banks excluded for presenting financial statements in currencies other than Indonesian rupiah	(0)
Final sample of banks	**31**
Observation period	5 years
Total bank-year observations	**155**

Note. Figures in parentheses indicate banks excluded sequentially during sample selection.
Source: Research sample selection records

Descriptive Statistical Analysis

Descriptive statistical analysis was conducted to summarize the characteristics of stock returns, operational efficiency, digital transformation, and market risk before regression analysis. The statistics include the mean, maximum, minimum, and standard deviation for 155 bank-year observations from 31 banking companies listed on the Indonesia Stock Exchange during 2021–2025.

Table 2. Descriptive Statistics of the Study Variables

Variable	Mean	Maximum	Minimum	Standard Deviation
Stock returns (%)	-0.030777	-0,036364	0,480000	-0,48000
Operational efficiency—BOPO (%)	0.793021	0.815100	1,251800	0,138700
Digital transformation (dummy)	0.490323	0,000000	1,000000	0,000000
Market risk—NOP (%)	0.021610	0,008900	0,200400	0,000000

Note. BOPO = operating expenses-to-operating income ratio; NOP = net open position relative to bank capital. Percentage variables were converted from decimal ratios for presentation. Their standard deviations are expressed in percentage points.

Source: Research data processed using EViews.

Stock returns averaged −3.08%, indicating that the mean annual return across the observations was negative. Returns ranged from −48.00% to 48.00%, with a standard deviation of 26.54 percentage points, demonstrating substantial dispersion across banks and years. These descriptive results establish variation in investment outcomes but do not identify its causes.

The average BOPO was 79.30%, indicating that operating expenses amounted to approximately 79.30% of operating income across the observations. Values ranged from 13.87% to 125.18%, showing considerable differences in the ratio of operating expenses to income. Lower BOPO values represent greater operational efficiency. Digital transformation had a mean of 0.49, with 76 observations coded 1 and 79 observations coded 0. This mean represents the proportion of observations assigned to the adoption category rather than the intensity of digital transformation. NOP averaged 2.16% and ranged from 0.00% to 20.04%, indicating differences in foreign exchange exposure relative to bank capital.

Panel Data Model Selection

Panel model selection was conducted to determine whether the data supported a Common Effect Model (CEM), Fixed Effect Model (FEM), or Random Effect Model (REM). The Chow test compared CEM with bank fixed effects, while the Breusch–Pagan Lagrange Multiplier test compared CEM with bank random effects. Table 4 presents the results.

Table 3. Panel Data Model Selection Results

Testing Procedure	Statistic	*p*-value	Selected Model

Chow test	*0.880239*	0.6468	Common Effect Model
Breusch–Pagan LM test	1.957144	0.1618	Common Effect Model

The Chow test produced a probability value above 0.05, providing insufficient evidence to favor bank fixed effects over pooled estimation. The LM test also produced a probability value above .05, providing insufficient evidence of bank-level random effects. Both tests therefore supported the use of CEM.

Additional diagnostic checks showed that the Jarque–Bera test did not reject residual normality (p = 0.07). The normality test therefore indicates that the regression residuals satisfy the normality assumption at the 5% significance level. Absolute pairwise correlations among the explanatory variables were below 0.80. The Glejser test produced probability values above 0.05 for all explanatory variables, indicating no detected heteroskedasticity under that test. The Durbin–Watson statistic was 1.99 and was retained as a descriptive indicator of residual autocorrelation. The subsequent analysis used the reported CEM estimates.

Regression Analysis Results

Regression analysis examined the relationships between BOPO, digital transformation, NOP, and stock returns. Stock returns served as the dependent variable, while the three explanatory variables were entered together in the model. Table 5 reports the estimated coefficients and their statistical significance.

Table 4. Panel Data Regression Results

Variable	Coefficient	Standard Error	*T-statistic*	*p*-value	Significance
C	-0.302879	0.103089	-2.938027	0.0038	Significant
BOPO	0.249858	0.119568	2.089684	0.0383	Significant
PDN	1.366812	0.642526	2.127247	0.0350	Significant
Digital Transformation	0.090597	0.042333	2.140122	0.0340	Significant

BOPO had a positive and statistically significant coefficient. Based on the unrounded estimate, a one-percentage-point increase in BOPO was associated with a .25-percentage-point increase in predicted stock returns, holding the other explanatory variables constant. Since higher BOPO indicates lower operational efficiency, this result should not be interpreted as evidence that improved efficiency increases stock returns.

Digital transformation also had a positive and statistically significant coefficient. Based on the unrounded estimate, observations coded 1 had predicted stock returns 9.06 percentage points higher than observations coded 0, conditional on BOPO and NOP. This finding concerns the difference between the two coded categories and does not measure the effect of increasing digital maturity.

NOP exhibited a positive and statistically significant relationship with stock returns. A one-percentage-point increase in NOP was associated with a 1.37-percentage-point increase in predicted stock returns, holding the other explanatory variables constant. This association relates specifically to the foreign exchange exposure indicator used in the study.

Hypothesis Testing Results

Hypothesis testing assessed whether each estimated relationship was statistically significant and consistent with its hypothesized direction. H_1 predicted a negative relationship between BOPO and stock returns, whereas H_2 and H_3 predicted positive relationships for digital transformation and NOP, respectively.

Table 5. Hypothesis Testing Results

Hypothesis	Coefficient	t-statistic	Probability	Decision
H1 BOPO has a negative effect on stock returns	0,249858	2.09	0,0383	Rejected
H2 Digital transformation has a positive effect on stock returns	0,090597	2.14	0,0340	Accepted
H3 Net open position (NOP) has a positive effect on stock returns	1,366812	2.13	0,0350	Accepted

The hypothesis testing results indicate that BOPO, digital transformation, and net open position (NOP) have positive and statistically significant effects on stock returns. The positive BOPO coefficient contradicts the hypothesized negative relationship; therefore, H1 is not supported, whereas H2 and H3 are supported. The overall F-test indicates that the model provides a statistically significant improvement over an intercept-only model, although its explanatory power remains limited.

Model Fit and Overall Significance

Table 6. Model Fit and Overall Significance

Indicator	Value
R^2	*0.0742*
Adjusted R^2	0.0558
F-Statistic	4.03
Prob. (F-Statistic)	0.008579
Number of Observation	155

The overall regression model was statistically significant, *F*-Statisticc = 4.03, $p = 0.008579$. This result indicates that BOPO, digital transformation, and net open position (NOP) were jointly associated with stock returns. The model's R^2 was 0.0742, indicating that the explanatory variables accounted for 7.42% of the observed variation in stock returns, while 92.58% remained unexplained by the model. The adjusted R^2 was 0.0558, corresponding to an explanatory power of 5.58% after accounting for the number of predictors and the sample size. These results demonstrate that the model was statistically significant but had limited explanatory power.

DISCUSSION

Operational Efficiency and Stock Returns

The results show that BOPO is positively and significantly associated with stock returns, contrary to the negative relationship proposed in H1. Since a higher BOPO represents higher

operating expenses relative to operating income, this finding does not indicate that improved operational efficiency increases stock returns. Instead, it demonstrates that higher relative operating costs were associated with higher returns within the sampled banks and observation period.

This result challenges the study's expectation that lower BOPO would provide a favorable signal of cost management and therefore be associated with stronger stock returns. Signaling theory provides a framework for understanding how observable information may communicate otherwise unobservable characteristics (Spence, 1973). Applied to this study, however, the positive coefficient suggests that the relationship between operating conditions and stock returns cannot be explained solely by the assumption that investors consistently favor lower operating expense ratios.

The direction of the finding is consistent with research reporting a positive relationship between BOPO and banking stock returns during 2019–2021 (Zettira, Evana, & Putri, 2023). It differs from evidence showing no significant relationship between BOPO and banking stock returns (Irawan, Prawatiningsih, & Nugraha, 2023). These contrasting findings indicate that the association is not uniform across the reviewed studies. Differences in observation periods, sample characteristics, and model specifications may contribute to the variation, although the present analysis does not directly test these explanations.

One possible explanation is that operating expenses include expenditures intended to support future business development, while stock returns may reflect expectations about future performance. The observation period also includes 2021, making expectations of economic recovery a potentially relevant context. These explanations remain tentative because the model neither separates operating expenses by purpose nor measures investor expectations or pandemic-related effects. The finding therefore provides no basis for recommending higher operating costs. Its practical implication is that BOPO should be evaluated alongside the composition of expenses, revenue performance, and the bank's broader financial condition.

Digital Transformation and Stock Returns

Digital transformation is positively and significantly associated with stock returns, supporting H2. Based on the reported coefficient, observations coded 1 have predicted returns approximately 9.06 percentage points higher than observations coded 0, holding BOPO and NOP constant. This finding concerns the categories represented by the binary indicator rather than incremental improvements in technological capability.

The positive association is consistent with the interpretation that digital transformation may convey information about a bank's adaptability and future business prospects. Digital services may also create opportunities to expand customer access and improve service delivery. The Technology Acceptance Model identifies perceived usefulness and perceived ease of use as relevant determinants of technology acceptance (Davis, 1989). This perspective offers a possible explanation for how digital services could generate benefits, but the present study does not measure these acceptance constructs or test whether customer adoption mediates the relationship with stock returns.

Related evidence shows that digital transformation is significantly associated with the value of Indonesian digital banks measured using Tobin's Q (Annur & Muharam, 2025). This supports the relevance of digital transformation to market valuation, although firm value and annual stock returns are distinct outcomes. Research on digital banking transactions also reports different relationships with profitability across mobile banking, internet banking, and ATM services

(Tangiduk, Kantohe, & Marunduh, 2024). Taken together, these findings suggest that the financial relevance of digitalization depends partly on the services and performance measures examined.

The present study extends this discussion by examining stock returns within a model that also includes operating efficiency and foreign exchange exposure. Its binary measure, however, cannot distinguish differences in digital maturity, service quality, transaction intensity, or technological investment. Bank managers should therefore evaluate digital initiatives through measurable operational and customer outcomes, while future research could employ more detailed indicators to investigate which dimensions of digital transformation are associated with investment performance.

Market Risk and Stock Returns

NOP is positively and significantly associated with stock returns, supporting H3. The coefficient indicates that a one-percentage-point increase in NOP is associated with a 1.37-percentage-point increase in predicted stock returns, conditional on the other explanatory variables. Because NOP represents foreign exchange exposure relative to bank capital, this finding concerns a specific component of market risk rather than market risk as a whole.

The positive direction is broadly comparable with evidence of a positive relationship between market risk and stock returns among LQ45 companies (Sukmayani, Gama, & Astiti, 2025). The comparison is limited, however, because that study examines a multisector sample and its risk measure should not be treated as interchangeable with bank-level NOP. The present findings therefore contribute evidence specific to foreign exchange exposure in the sampled banking companies.

A possible explanation is that foreign exchange exposure creates opportunities for gains when currency movements favor the positions held by a bank. Such exposure may also generate losses when exchange rates move adversely. The current model does not examine the direction of currency positions, exchange rate changes, or hedging practices, so it cannot establish which mechanism accounts for the positive association. The finding should consequently not be interpreted as evidence that increasing foreign exchange exposure guarantees higher returns. Its practical relevance lies in identifying NOP as an indicator that merits consideration alongside the composition and management of foreign currency positions.

Overall Explanatory Power and Research Implications

The overall F-test shows that the model improves statistically on an intercept-only specification. Its explanatory power nevertheless remains limited: the three variables account for 7.42% of the variation in stock returns, falling to 5.58% after adjustment for model size. Statistical significance therefore coexists with substantial unexplained variation.

These results suggest that operating conditions, digital transformation, and foreign exchange exposure provide relevant but incomplete information about banking stock returns. The findings do not establish causal effects or show that the three indicators are sufficient for predicting investment outcomes. Investors should interpret them alongside other financial and market information, while bank managers should avoid treating positive regression coefficients as direct prescriptions for increasing expenditure or risk exposure.

Future research could extend the model by incorporating theoretically relevant factors such as profitability, asset quality, bank size, market returns, and macroeconomic conditions. More detailed digitalization measures, explicit treatment of foreign exchange positions and hedging, and robustness checks using alternative specifications would help assess whether the reported relationships persist. These extensions would strengthen the distinction between statistically

detectable associations and the mechanisms through which banking activities may relate to stock returns.

CONCLUSION

Conclusion

This study examined the relationships between operational efficiency, digital transformation, market risk, and stock returns using 155 bank-year observations from 31 banks listed on the Indonesia Stock Exchange during 2021–2025. The results indicate that BOPO, digital transformation, and net open position (NOP) are positively and significantly associated with stock returns. The positive BOPO coefficient contradicts the hypothesized negative relationship, meaning that H1 is not supported, whereas H2 and H3 are supported. Because BOPO is inversely related to operational efficiency, this finding should not be interpreted as evidence that improved efficiency increases stock returns.

The study contributes empirical evidence by examining operating costs, digital adoption, and foreign exchange exposure within a single banking stock-return model. Its findings highlight the importance of distinguishing operational efficiency from its inverse proxy and foreign exchange exposure from broader market risk. Although the overall model is statistically significant, it explains only 7.42% of the variation in stock returns. The three indicators therefore offer a partial explanation of investment performance within the sampled banks and period.

Several limitations constrain the conclusions. The sample and five-year observation period limit generalization to other banks, sectors, and economic conditions. The binary digital transformation measure does not capture differences in digital maturity or implementation quality. BOPO does not distinguish changes attributable to operating expenses from those attributable to operating income, while NOP captures only the foreign exchange component of market risk. The observational design also supports conclusions about associations rather than causal effects.

Recommendations

Bank managers should assess operating expenses in relation to their contribution to business performance, evaluate digital initiatives using measurable outcomes, and manage foreign exchange exposure prudently. The positive BOPO and NOP coefficients do not justify increasing costs or risk exposure to pursue higher stock returns. Investors should use these indicators alongside profitability, asset quality, capital strength, valuation, and market conditions rather than as a sufficient basis for investment decisions.

Further studies should extend the observation period and examine whether the relationships differ across bank characteristics and economic conditions. More detailed digital transformation measures, such as active digital users, digital transaction shares, or technology investment, could improve measurement precision. Analyses of foreign exchange exposure should consider currency positions, exchange rate movements, and hedging practices. Incorporating theoretically justified explanatory variables and testing alternative specifications, lagged relationships, and standard errors appropriate to panel data would help assess the robustness of the findings and clarify the mechanisms underlying banking stock returns.

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