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Analysis of E-Banking Development In Islamic and Conventional Commercial Banks: Evidence From Indonesia

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Abstract:
This study analyzes the impact of IT-based banking services on Islamic and Conventional Commercial Banks in Indonesia. It evaluates their influence on the number of bank branches, Automated Teller Machines (ATM), Operating Costs (BOPO), and Net Income (NI). The research uses secondary data from The Financial Services Authority (OJK), Bank Indonesia, and the Indonesian Payment System Association (ASPI) for the 2018-2023 period. The data analysis employs the ECM (Error Correction Model) method. Results show that e-banking services significantly affect the dependent variables. For the branch model, mobile and internet banking impact branch numbers in the long term, but not in the short term. Mobile and internet banking have a long-term effect on ATMs, while the Quick Response Code Indonesian Standard (QRIS) and e-banking services influence ATMs in the short term. In terms of BOPO, mobile banking and QRIS affect it in the long term, while internet banking and QRIS influence it in the short term. Lastly, mobile banking and QRIS have a long-term effect on Net Interest Margin (NIM), but no significant effect in the short term. Overall, the findings demonstrate that mobile banking, internet banking, and QRIS are important factors influencing various banking metrics over different timeframes.

Keywords*:* Digital Banking, Internet Banking, Mobile Banking, QRIS, Branches, BOPO, NIM

JEL Classification Code: G21, L86, O33

1. Introduction

E-banking services are currently owned by almost all commercial banks, both with very common types of delivery channels, such as Automated Teller Machines (ATMs) and other types of delivery channels such as SMS, telephone, Electronic Data Capture (EDC) and the Internet. This is also in line with the trend of social media development and existing policies to realize or direct transactions to the public, not only with cash, so that many economic actors or people have taken advantage of modern banking services that are more efficient and effective through e-banking (OJK, 2015). Banks aim to enhance service convenience by leveraging information technology to ensure secure and efficient transactions. They also focus on providing flexible, efficient, and straightforward services. With e-banking, customers no longer need to visit the bank or wait long lines. E-banking encompasses various products, including mobile banking, commonly referred to as M-banking (Usman et al., 2020). Several factors, such as security and ease of use, influence the public's interest in utilizing electronic banking services (Sulistianingsih & Trishananto, 2021). Commercial banks operate either conventionally or under the Sharia principles, offering payment traffic services.

Internet banking enables customers to perform banking transactions through the Internet using devices such as desktop computers, laptops, tablets, and smartphones connected to the Internet (OJK, 2015).

Banks provide a service called Internet banking, which allows users to communicate, obtain information, and conduct financial transactions online. With financial institutions launching innovative ways to provide services in both developed and emerging economies, this innovation offers a contemporary banking approach (Triwardhani et al., 2023). Mobile banking has several advantages for both banks and bank customers (Sitorus et al., 2019), such as the use of mobile phones or smartphones to conduct financial transactions thanks to a service called mobile banking. The Quick Response Code Indonesian Standard (QRIS) combines QR codes from different Payment System Service Providers (PJSP). To make QR Codes simpler, quicker, and more secure, the payment system industry and Bank Indonesia collaborated to create a QRIS (BI, 2024). Customers may conduct financial transactions on their own without the assistance of tellers or other bank employees, thanks to ATM, which are computer terminals or machines linked to the bank's communication network (OJK, 2015). According to (Desmadirega & Hermana, 2023), ATM and debit cards are the first payment instruments to use cards. Using a machine-readable plastic card, authorized users can access various services, including balance inquiries, money transfers, and deposit acceptance, in addition to withdrawing cash from their accounts.

A Branch Office is a legally domiciled office in Indonesia that carries out banking business activities that are directly responsible to the Head Office. It is also known as an auxiliary branch office and functional branch office (POJK, 2021). Bank branches in conventional banking play a crucial role as physical service hubs where customers can receive direct assistance. Their presence serves as an important point of contact to provide various banking services. However, with the digitalization of banking through e-banking, the role of branch offices is decreasing, and their number is expected to decrease (Riad, 2020). This decrease is important to examine because customers no longer need to visit branch offices in person thanks to technological advancements, such as the Internet and mobile banking. As a result, shifts in the number of branches can indicate how widely the banking industry is implementing digital technology (Istan & Saputra, 2023).

The Operating Cost Ratio of Operating Income (BOPO) (Awintasari & Nurhidayati, 2021; POJK, 2016) . Operating Costs (BOPO) are a crucial metric for evaluating a bank's operational efficiency. Better-organized management may be indicated by a reduced BOPO ratio, which is mirrored in the operational effectiveness of the business. Since banks become more effective in their operations, lowering operational expenses and achieving a high efficiency score helps increase operating profits (Wiadnyani & Artini, 2023). Conversely, a higher BOPO ratio indicates less efficient operations, leading to reduced profits (Wiadnyani & Artini, 2023). By lowering the need for employees at branch offices and the cost of maintaining ATMs, the growing use of e-banking is anticipated to contribute to lowering the operating costs. The more efficiently the bank generates revenue, the lower the BOPO ratio (Sandy, 2017).

The Net Interest Margin (NIM) is a measure of the difference between the interest in income generated by banks or other financial institutions and the value of interest paid to their lenders (e.g., depositors) relative to their amount (productive interest) assets, which is similar to the gross margin of non-financial companies (Akbar & Iradianty, 2020). The net interest margin is the ratio of net interest revenue to the average total amount of productive assets (OJK, 2020) The ratio known as Net Income (NI) in Islamic banking or NIM in conventional banking is used to assess how well bank management is able to manage their productive assets in order to produce net profit. A ratio called NI is used to determine the profitability of a bank's assets (Awintasari & Nurhidayati, 2021). NIM is highly pertinent in the context of digital banking because in addition to cutting operating expenses, digital banking may improve the effectiveness of credit and deposit management (Mauline & Satria, 2022). By providing quicker, less expensive, and more specialized financial services, e-banking adoption is anticipated to assist banks in managing their productive assets better. As a result, NIM was selected to gauge the contribution of e-banking development to bank profitability.

Based on data from OJK (2023), there is a significant trend in various aspects of banking services in Indonesia between 2018 and 2023, reflecting the positive impact of digitization. The use of Internet banking has increased rapidly, from approximately 2.5 million users in 2018 to more than 5 million in 2023, while mobile banking has also experienced almost threefold growth, from 600 thousand to about 1.8 million users during the same period (OJK, 2023). The QRIS which was launched in 2020, has shown a sharp increase, with the number of users soaring from 100 thousand to more than 1.5 million in 2023. However, along with the rise in the use of digital services, the number of bank branches has decreased from 30 thousand in 2020 to 28 thousand in 2023, and ATM machines have dropped by 15 thousand units, reflecting a shift toward cashless transactions. The Operational Cost-to-Income Ratio (BOPO) has decreased from 85% in 2020 to 75% in 2023, indicating improved operational efficiency owing to the adoption of digital technology. However, the Net Interest Margin (NIM) remained stable with a slight increase from 4.5% in 2020 to 4.7% in 2023, showing that banks successfully maintained profitability despite significant operational changes (OJK, 2023).

Banking digitization through internet banking, mobile banking, and QRIS helped reduce operational costs without sacrificing profitability, as reflected in the decline in BOPO and the stability of NIM. Alam et al. (2020) state that the BOPO is strongly influenced by branch offices and mobile banking, with security and long-term maintenance factors being the reasons for the limited capacity of banks to provide mobile banking in Indonesia. This finding is in line with Sabani

(2023), who shows that the BOPO is influenced by branchless banking, one of the components of financial inclusion. Trinh (2020) also states that internet banking and mobile banking have a significant impact on NIM, while Patricia et al. (2023) show that online banking does not have a clear impact on NIM, although mobile banking has a greater effect. Despite numerous studies examining the impact of digitization on bank operations, most have focused on a single digital service, such as internet banking or mobile banking, without considering QRIS, which was launched in 2019. Therefore, this study aims to examine how internet banking, mobile banking, and QRIS affect the number of branches, ATMs, BOPO, and NIM in both conventional and Sharia commercial banks in Indonesia, and to determine which of the three digital services has the most significant influence on reducing the number of branches, ATMs, BOPO, and NIM in both types of banks.

2. Literature Review

E-banking, which includes services such as ATMs, EDCs, Internet banking, SMS, phone banking, and mobile banking, has made it easier for customers to access financial transactions. Initially focused on cash withdrawals via ATMs, e-banking evolved into EDCs for payments and internet banking, along with increasing internet access (OJK, 2016). E-banking also supports the growth of the Islamic economy by increasing electronic trust (Maharani et al., 2020; Oppusunggu et al., 2024). This trend is seen in Malaysia, where face-to-face banking has increased rapidly since 2016 as customers seek contactless options driven by convenience, cost savings, and technological advancements (Ong et al., 2023). In Saudi Arabia, e-banking has increased customer satisfaction with fast and secure data handling, although data protection education is still required (AlHaliq & AlMuhirat, 2016). In Indonesia, the adoption of Internet banking continues to increase with trust and social influences as the main drivers, and with increasingly widespread Internet access, the growth potential is also large (Pratama.et.al, 2022; Triwardhani et al., 2023). Mobile banking, which allows transfers and bill payments via mobile phones, has a positive impact on customer satisfaction and bank performance, particularly because of the perceived benefits that drive the use of Islamic banking (Fitria et al., 2021; Riptiono et al., 2021). In addition, QRIS, Bank Indonesia's integrated QR Code system, facilitates digital payments between providers and supports the expansion of Indonesia's digital economy with plans for further integration with neighboring countries (BI, 2024; Rachman et al., 2024). Meanwhile, digitalization is driving a decline in the number of traditional branch offices, especially in densely populated areas such as Java and Sumatra, as well as a decline in the use of ATMs, which used to be the main tool for e-banking (Haris, 2024; OJK, 2023). This trend of reducing physical networks is in line with banks' efforts to shift their focus to an e-banking infrastructure, which is more efficient in managing building and employee operational costs. Operational banking efficiency is measured through the BOPO (operational cost-to-operating income (BOPO) ratio, where the ratio indicates low efficiency supporting profitability, while a high ratio indicates high operational costs that reduce income (Wiadnyani & Artini, 2023). The study by Ermawan and Raharja (2022) also showed that internet banking significantly reduced BOPO from 2017 to 2021, where bank investors in IT, digital systems, and HR reduce operational costs.

3. Research Methodology

Regression analysis and a descriptive quantitative approach were used in this study. Secondary data in the form of monthly time series from 2018 to 2023 were gathered from several sources, including Bank Indonesia (BI), the Indonesian Payment System Association (ASPI), OJK statistical data, and OJK financial supervisory reports. The study's independent variables are the utilization of mobile banking (X1), internet banking (X2), and QRIS (X3), whereas the dependent variables are the number of branches (Y1), ATMs (Y2), BOPO (Y3), and NIM (Y4). Error Correction Model (ECM) analysis is the data analysis method employed in this study. Data processing was performed using Eviews 9 to ascertain the extent to which independent factors had an impact on the dependent variables. Sargan originally presented the ECM in 1984 and Engle-Granger popularized it in 1987 (Widarjono, 2018). Creating a long-term connection model, resolving issues with non-stationary time-series data, addressing short-term imbalances, and addressing false regression issues are only a few of the primary applications of ECM.

Several steps must be completed to construct a model using the ECM technique. the Augmented Dickey-Fuller (ADF) test, which compares the ADF statistical value with the Mackinnon critical value, first determines whether the data are stationary (Rizal & Akbar, 2015). The data were not stationary if the Mackinnon probability value exceeded the 10% significance level. The stationarity test is then carried out at the first-difference level if the data are not stationary at that level (Ardana, 2016). Second, a cointegration test was used to determine whether the two variables had a balanced or long-term connection. To apply the Engle-Granger cointegration test, the multiple linear regression equation must first be regressed to obtain the residuals. Residual stationarity was assessed using the ADF test (Prasetya & Nurcahyo, 2022). The variables in the equation exhibit cointegration if the residuals are stationary. Third, the model must satisfy classical assumption criteria to obtain the best unbiased linear estimator estimate. This was done by performing a classical assumption test (Sholihah et al., 2023). This test comprised autocorrelation, heteroscedasticity, multicollinearity, and normality tests. While the multicollinearity test seeks to guarantee that there is no collinearity between independent variables in the regression model, the normality test determines whether the data are regularly distributed (Iqbal, 2015). To determine whether the variance of the disturbance in the regression function was constant, a heteroscedasticity test was used. An autocorrelation test was used to determine the links between the remaining data (Wahyu, 2021). Fourth, the ECM test seeks to rectify the disparity in the impact of digital banking (including QRIS, Internet Banking, and Mobile Banking) on the number of branches, ATMs, BOPO, and NI. The ECM test is valid if the Error Correction Term (ECT) coefficient at lag one is substantial and negative. The ECT variable was derived from the long-term model and subsequently included in the short-term model (Basorudin et al., 2019). The long-term model is as follows:

$$LnY_t = b_0 + b_1\,LnMB_t + b_2\,LnIB_t + b_3\,DQRIS_t + e_t$$

where Y_t is Branch/ATM/BOPO/NI at time to-$_t$, MB_t is the use of Mobile Banking at time to-$_t$, IB_t is the use of Internet Banking at time to-$_t$, $DQRIS_t$ is Dummy QRIS at time to-$_t$ (1= have QRIS; 0= have no QRIS), e_t is the residual model, b_i is a constant, and *Ln* is a natural logarithm. The short-term models were as follows:

$$D(LnY_t) = b_0 + b_1\,D(LnMB_t) + b_2\,D(LnIB_t) + b_3\,D(DQRIS_t) + ECT_{t-1} + e_t$$

where *D* is the difference in first difference, Y_t is Branch/ATM/BOPO/NI at time-$_t$, MB_t is Use of Mobile Banking at time-$_t$, IB_t is Use of Internet Banking at time-$_t$, $DQRIS_t$ is Dummy QRIS at time t (1= have QRIS; 0= have no QRIS), ECT_{t-1} is *Error Correction Term* at lag 1, e_t is the residual model, b_i is a constant, and *Ln* is the natural logarithm.

A statistical test was then used to evaluate the effect of the independent factors on the dependent variable. The coefficient of determination (R2) test was used to ascertain the extent to which the independent variable could explain the variation in the dependent variable (Widarjono, 2018). The F-test examines the simultaneous influence of the independent variable on the dependent variable, whereas the T-test gauges the partial impact of the independent variable.

4. Finding & Discussion

The stationarity test determines whether the data are stationary. Data that are not stationary when included in the model will produce invalid equations; therefore, the conclusions obtained will be incorrect. To test stationarity, a root test unit test was performed using the Augmented Dickey-Fuller (ADF) test method. The stationarity test of the data using the ADF test was carried out in the form of a level, as well as the first difference. Table 1 lists the results of the ADF root test for each variable.

Tabel 1: Data Stationary Test

Variabel	**MacKinnon (p-values)**	
	Level	First Difference
Branch	0.9279	0.0000***
ATM	0.9934	0.0003***
BOPO	0.1431	0.0000***
NI	0.1850	0.0000***
Mobile Banking	0.9796	0.0000***
Internet Banking	0.9262	0.0000***

Note: *** is stationary at 1%

The results of the root unit test show that, in the form of the level, both independent and dependent variables have a unit root indicated by a MacKinnon p-value of more than 0.10 (10% level), so it can be said that each variable is not stationary at the level. The root test was performed in the form of a first difference. The results show that the MacKinnon p-value of each variable is less than 0.01 (1%). Therefore, it can be concluded that each variable is stationary in the form of the first difference. After stationarity and degree of integration tests were conducted, a cointegration test was conducted. This test uses the Engel-Granger (EG) test, which utilizes the ADF test. The cointegration test aims to determine whether long-term equilibrium exists between the variables used. Cointegration testing was performed by testing the stationarity of the residuals of the long-term equation. Data are considered cointegrated if the residual value (disequilibrium error) is stationary at this level. Table 2 presents the results of the ADF unit-root test for the residual model.

Tabel 2: Residual Stationary Test of the model

Model	**t-Statistic (ADF)**	**MacKinnon (p-values)**
residual Branch	-3.0083	0.0394**
residual ATM	-4.9873	0.0001***
residual BOPO	-4.3952	0.0007***
residual NI	-4.5931	0.0004***

Note: *** indicates significance at the level 1%; ** indicates significance at the level 5%

The results of the cointegration test using the ADF root test unit in Table 2 show that the MacKinnon p-values are smaller than 0.01 and 0.05 (1% and 5% levels, respectively), indicating that there is a stationary residual at that level, so it can be concluded that there is a long-term integration or relationship in the research model. In general, the results of the equation test on the regression model showed no deviation in the ECM estimation. The tests performed were normality, autocorrelation, heteroscedasticity, and multicollinearity.

Table 3: Normality Test

Variable	Mean	Median	Max	Min	Std. Dev	Prob
Branch	-0.0037	-0.0087	0.0941	-0.0902	0.0399	0.536
ATM	0.0009	0.001	0.0058	-0.005	0.0024	0.714
BOPO	0.2329	0.3653	2.2314	-21648	0.8456	0.863
NI	0.0129	0.0175	0.1043	-0.0895	0.0404	0.497

Note: Data processed by E-views 12

A normality test using the Jarque-Bera test was performed to verify that the error term was close to the normal distribution. The results obtained for the branch, ATM, BOPO and NI models show that the residual is normally distributed because the probability value > a = 0.05 (Sugiyono, 2019).

Table 4: Heteroscedasticity Test

Variable	F-statistic	Prob. Chi-Square
Cabang	0.5386	0.4427
ATM	0.3354	0.5469
BOPO	0.3479	0.55
NII	2.507	0.1171

Note: Data processed by E-views 12

Heteroscedasticity test was performed using the ARCH test. The results show that the Chi-Square Probability is greater than 0.05 (Sugiyono, 2019). Thus, it can be concluded that there is no heteroscedasticity or that the residual has homogeneous variance.

Table 5: Multicollinearities Test

Variable	Coefficient Variance	Centered VIF
Mobile Banking	5.22E-05	9.456907
Internet Banking	0.000111	5.898140
DQRIS	2.51E-05	2.732630
C	0.007346	NA

Note: Data processed by E-views 12

A multicollinearity test was performed by examining the Variance Inflation Factor (VIF) value. If the VIF value was less than 10, there was no multicollinearity problem. The estimation results show that the independent variables in the model do not have multicollinearity problems, because the VIF values of all independent variables are less than 10 (Sugiyono, 2019).

Table 6: Autocorrelation Test

Model	**Prob. Chi-square**
Branch	0.0693
ATM	1.0000
BOPO	0.1956
NI	0.0728

Note: Data processed by E-views 12

The autocorrelation test was carried out using the Breusch-Godfrey serial correlation LM test. The above results show that the Chi-Square Probability was greater than 0.05. Therefore, it can be concluded that there were no autocorrelation symptoms in the model. The results of the model estimation using the ECM approach show the relationship between the variables in the short and long terms.

Table 7: Model Estimation Results

Variabel	**Branch**		**ATM**		**BOPO**		**NI**	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
The Long Term								
Mobile Banking	-0.1206	0.0000***	-0.0560	0.0000***	-4.0261	0.0238**	0.1875	0.0214**
Internet Banking	-0.1183	0.0010***	-0.0317	0.0038***	-4.0729	0.1127	0.1714	0.1486
DQRIS	0.0234	0.1710	-0.0075	0.1418	6.3792	0.0000***	-0.5917	0.0000***
C	13.5786	0.0000***	12.7453	0.0000***	190.318	0.0000***	0.1167	0.9039
The Short Term								
D(Mobile Banking)	0.1380	0.2610	-0.0432	0.0000***	-1.9378	0.3507	0.0936	0.3518
D(Internet Banking)	0.0587	0.5374	-0.0191	0.0377**	-2.3267	0.0675*	0.0714	0.4129
D(DQRIS)	-0.0021	0.9689	-0.0091	0.0163**	4.3058	0.0568*	-0.0070	0.7350
ECT(-1)	-0.3969	0.0094***	-0.6085	0.0000***	-0.7017	0.0000***	-0.5141	0.0002***
C	0.0269	0.1402	0.0025	0.0005***	-0.5684	0.0061***	0.0253	0.0294**
R-Squared		0.4333		0.7876		0.6519		0.4009
F-statistict (F)		3.4413		25.034		27.625		4.1815
P-value (F)		0.0295**		0.0000***		0.0000***		0.0100**

Note: ***, **, and *indicate significance at the 1 %, 5%, * and 10%levels, respectively.

The ECM model can be considered valid if the ECT has a negative value and the probability is smaller than the actual level used. Table 3 shows that the model is cointegrated with the expected ECT (-1) parameter with negative and significant values; therefore, the estimated error correction parameter can be used to correct the short-to long-term equation. The value of the ECT (-1) coefficient describes the speed at which the model adjusts towards long-term equilibrium (speed of adjustment). The ECT (-1) coefficient in the branch model shows that 39.69% of the short-term models can be corrected towards long-term equilibrium. The ECT (-1) coefficient in the ATM model shows that 60.85% of the short-term model can be corrected towards the long-term equilibrium. The ECT (-1) coefficient in the BOPO model shows that 70.17% of the short-term models can be corrected towards long-term equilibrium. The ECT (-1) coefficient in the NII model shows that 51.41% of the short-term models can be corrected towards long-term equilibrium.

The ECM estimation results for the branch model show an R-squared value of 0.4333, indicating that the variables used in the model can explain the diversity of the number of branches by 43.33%, and the remaining 36.67% can be explained by other factors outside the model. The R-squared value in the ATM model is 0.7876, indicating that the variables used in the model can explain 78.76 diversity of the diversity of ATMs by 78.76%, and the remaining 21.24% can be explained by other factors outside the model. In addition, the BOPO model shows an R-squared value of 0.6519, meaning that the variables used in the model can explain the diversity of BOPO by 65.19%, and the remaining 34.81% can be explained by other factors outside the model. The NI model shows an R-squared value of 0.4009, meaning that the variables used in the model can explain the diversity of the NI by 40.09%, and the remaining 59.91% can be explained by other factors outside the model.

The results of the simultaneous test based on the F-statistic showed that the independent variables had a real effect on the dependent variables (Branch, ATM, BOPO and NI). Table 3 shows that the p-value of the F-statistic is less than the real levels of 1% and 5%, meaning that there is at least one independent variable that has a significant effect on the model. The results of the partial test of the long-term branch model show that Mobile Banking and Internet Banking significantly affect the number of branches. The influence of Mobile Banking of -0.1206) means that every 1% increase in Mobile Banking decreases the number of branches by 0.1206%. Likewise, an Internet Banking influence of -0.1183 means that every 1% increase in Internet Banking reduces the number of branches by 0.1183%. This indicates that digital transformation in the banking sector has shifted customer preferences from physical to more accessible and efficient digital services.

Mobile Banking and Internet Banking technology allow customers to conduct basic to complex banking transactions from the comfort of their homes without having to come directly to the bank (Kiswara, 2021). The decline in the number of branches can be interpreted as a strategy to rationalize the physical infrastructure of banks. Physical branches incur significant operational costs, ranging from building rental and labor costs to infrastructure maintenance. As an increasing number of customers switch to Mobile Banking and Internet Banking services, the need to maintain a large number of branches becomes irrelevant, especially in areas that already have high digital service penetration (Naufal, 2018). Branch closures, although initially may seem like an extreme step, are actually a way for banks to increase efficiency and optimize operational costs in the long term. This also strongly signals that banks are attempting to remain competitive in the digital era by focusing on technology-based services. Meanwhile, in the short term, Mobile Banking, Internet Banking and the QRIS dummy have no effect on the number of branches. This shows that the adaptation and implementation of digital services take time before the impact is seen as a real decrease in the number of branches. In the early stages, banks may maintain the existing number of branches while observing changes in customer behavior patterns.

The results of the partial test of the ATM model for the long term show that Mobile Banking and Internet Banking have a significant effect on the number of ATMs. The influence of Mobile Banking of -0.0560 means that every 1% increase in Mobile Banking decreases the number of ATMs by 0.0560%. Likewise, an Internet Banking influence of -0.0317 means that every 1% increase in Internet Banking reduces the number of ATMs by 0.0317%. The results show that digital banking services reduce customers' dependence on ATMs. Mobile Banking and Internet Banking not only offer balance checking and money transfer services but also payment, top-up, and investment services, which can only be done through ATMs or bank branches (Samsuri, 2022). ATMs are the backbone of banking, serving customers' needs for cash transactions and other basic services. However, with the development of banking digitalization, ATMs have begun to lose relevance in certain contexts. Banks may reduce the number of ATMs as part of a cost-cutting strategy, especially in locations with high digital service usage (Lestari, 2021). However, reducing the number of ATMs does not mean total elimination but rather a reduction in the physical infrastructure in areas that are already connected to digital services. In the short term, Mobile Banking, Internet Banking, and the dummy QRIS have a significant effect on the number of ATMs. The effect of Mobile Banking in the short term is -0.0432, meaning that every 1% increase in Mobile Banking reduces the number of ATMs by 0.0432%. Likewise, the influence of Internet Banking in the short term is -0.0191, meaning that every 1% increase in Internet Banking will reduce the number of ATMs by 0.0191%. In addition, in the short term, the QRIS dummy also affected the number of ATMs by -0.0091, meaning that after the use of QRIS, the number of ATMs decreased by 0.0091% compared with before QRIS. This shows that, after the implementation of QRIS, the need for customers to withdraw cash from ATMs has decreased because QRIS allows direct transactions between parties without cash (Manurung et al., 2024).

The results of the partial test of the long-term BOPO model show that Mobile Banking and the QRIS dummy have significant effects on the BOPO. The influence of Mobile Banking of - 4.0261 means that every 1% increase in Mobile Banking reduces BOPO by 4.0261%. Meanwhile, the influence of the QRIS dummy of 6.3792 means that after the use of the QRIS, the BOPO value increased by 6.3792% compared to before the QRIS. This shows that the adoption of Mobile

Banking significantly reduced operational costs. Digital services allow banks to serve more customers without adding physical resources, thereby increasing their operational efficiency. The use of Mobile Banking can reduce various costs, such as the cost of managing physical branches, labor, and maintaining non-digital infrastructure (Widiana et al., 2023). On the other hand, QRIS has a significant positive effect on BOPO, where after the use of QRIS, BOPO increased by 6.3792%. This may be due to the initial implementation costs of the QRIS system such as technology development costs, market education, and adjustments to operational procedures. In the short term, Internet Banking and the dummy QRIS have a significant effect on BOPO. The effect of Internet Banking in the short term of -2.3267 means that every 1% increase in Internet Banking will reduce BOPO by 2.3267%. This shows that Mobile Banking and Internet Banking are able to increase operational efficiency. In addition, in the short term, the QRIS dummy also affects BOPO by 4.3058, meaning that after using QRIS. The BOPO value increased by 4.3058% compared to that before the QRIS. This indicates high initial investment costs and operational adjustments in the early stages of the QRIS implementation. However, in the long term, the QRIS is expected to provide higher efficiency benefits.

The results of the partial test of the long-term NI model show that Mobile Banking and the dummy QRIS have a significant effect on NI. A Mobile Banking effect of 0.1875 means that every 1% increase in Mobile Banking will increase NI by 0.1875%. This suggests that Mobile Banking can increase net interest income through increased transaction volumes generated by mobile banking services such as payments and transfers. Mobile Banking users are more likely to conduct banking transactions more routinely, which in turn increases bank revenue from fees or service charges (Muzdalipah & Mahmudi, 2023). Meanwhile, the influence of the QRIS dummy of -0.5917 means that after the use of QRIS, the NI value decreased by 0.5917% compared to before the QRIS. This can occur because QRIS allows transactions without fees or with low fees, thus reducing bank income from interest-based transactions or fees that are usually charged for conventional payment methods. In the short term, Mobile Banking, IB, and the dummy QRIS have no effect on NI. This shows that the impact of using digital technology and QRIS on net interest income takes longer to become significant. This could also be because customers and banks are still in the adjustment stage for new transaction patterns (Sriekaningsih, 2020).

5. Conclusion

This study aims to analyze the impact of e-banking development, including Internet banking, mobile banking, and QRIS, on various operational aspects of commercial banks in Indonesia, both conventional and Sharia (BUS and UUS), specifically on the number of branches, ATMs, BOPO, and NI. The results from the simultaneous test using the F-statistic show that the independent variables significantly affect the dependent variables (branches, ATMs, BOPO, and NI), as indicated by p-values below the 1% and 5% significance levels, indicating that at least one independent variable significantly impacts the model. Partial tests further indicate that in the long term, mobile banking and internet banking significantly influence the number of branches and ATMs, although these variables, including QRIS, do not have short-term effects on branches but do influence ATMs in the short term. Regarding BOPO, the long-term effects come from Mobile Banking and QRIS, while the short-term effects are driven by Internet Banking and QRIS. As for NI, Mobile Banking and QRIS have long-term significance, although no short-term effects from Mobile Banking, Internet Banking, or QRIS were observed.

These findings suggest that digital transformation in banking significantly enhances operational efficiency and reshapes physical infrastructure, leading to fewer branches and ATMs as digital services such as MB and IB grow in popularity. However, initial investments in systems such as QRIS can raise short-term costs, which should be factored into banks' long-term strategies. The impact of technology on NII highlights the need for banks to adopt strong marketing strategies to capitalize on digital transactions. Thus, banks are encouraged to optimize digital services by enhancing customer convenience and accessibility, while educating customers about QRIS and other digital innovations to foster faster adoption and efficiency. In addition, banks should regularly assess the costs of new technologies to ensure investment yield efficiency and revenue growth in the long term.

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