IJEM
International Journal of Economics and Management
Journal homepage: http://www.ijem.upm.edu.my

How Does Fintech Lending Affect Islamic Local Banks' Efficiency During COVID-19 Pandemic in Indonesia?

VIRA AMALIA PUTRI[a], INAS NURFADIA FUTRI[a], TASTAFTIYAN RISFANDY[a*], RENIATI RENIATI[b] AND HUJJATULLAH FAZLURRAHMAN[c]

[a]*Faculty of Economics and Business & Center for Fintech and Banking, Universitas Sebelas Maret, Indonesia*
[b]*Faculty of Economics and Business, Universitas Bangka Belitung, Indonesia*
[c]*Faculty of Economics and Business, Universitas Negeri Surabaya, Indonesia*

ABSTRACT

Fintech lending, also known as peer-to-peer (P2P) lending or online loans, refers to lending provided by non-bank financial technology-based companies that provide financial services by connecting lenders and borrowers on a specific online platform. This paper investigates the impact of fintech lending development on the efficiency of Islamic local banks in Indonesia. Local banks are chosen because they differ from national commercial banks in terms of their characteristics and products, and they also serve limited customers in a specific local area (i.e., provincial level). The presence of Islamic local banks in Indonesia is unique because it fills the gap and has a significant contribution to Muslims who do not have (or do not need) access to larger Islamic commercial banks. This is particularly noteworthy given that Indonesia is the most populous Muslim country. Using a sample of 161 Islamic local banks in Indonesia and provincial-level fintech lending data from 2020Q1 to 2020Q4, we find that fintech development in Indonesia erodes Islamic local banks' efficiency, suggesting that their presence is significant and could also be damaging for local banks. However, our finding reveals that the negative effects of fintech development can be reduced in banks with higher levels of efficiency. Our results call for policymakers to monitor the development of fintech to maintain a lending ecosystem that can ultimately relate to financial service stability.

JEL Classification: C33, G21, H21
Keywords: Fintech; efficiency; data envelopment analysis; Islamic local banks

Article history:
Received: 10 January 2024
Accepted: 16 April 2024

[*] Corresponding author: Email: tastaftiyan.risfandy@staff.uns.ac.id
DOI: http://doi.org/10.47836/ijeam.18.1.09

INTRODUCTION

The penetration of financial technology (fintech) in recent years has transformed the financial services industry landscape by providing efficient financial services and the potential to shift financial business models towards digitalization (Leong, 2018). With the advancement of transformation and technology, user activities have become easier (Chong et al., 2023). Some countries positively accommodate fintech or have more lenient regulations regarding fintech, such as Singapore, which implements a “sandbox” policy for fintech development (Fan, 2018). However, some view fintech as a threat to traditional financial institutions, advocating for stricter regulation. For instance, China tightly regulates peer-to-peer lending companies and prohibits the use of tokens and Bitcoin in many public financing activities (Yuan and Xu, 2020). Fintech often experiences faster development in developing countries compared to developed countries. This massive development of fintech in developing countries is mainly driven by the inefficiencies in the banking system and, at the same time, is supported by the rapid advancement of mobile technology (Asaba et al., 2016).

One of the most popular practices of fintech is fintech lending. According to Claessens et al. (2018), fintech lending is a loan service provided to customers through online platforms, which is different from the credit offered by conventional banks or other savings and loan institutions. In this context, fintech lending complements the banking system and helps people improve access to credit (Oh and Rosenkranz, 2020). Fintech lending offers faster loan services than conventional finance, making it a preferred choice for customers who urgently need cash (Asaba et al., 2016). Regarding its role in the banking system, fintech lending can be both a competitor and a catalyst for innovation within the existing banking system (Le et al., 2021). Le et al. (2021) also suggest that the development of fintech has a positive and significant impact on the efficiency and technology adopted by banks.

Efficiency in banking is crucial across various aspects, particularly concerning operational costs. An efficient bank can effectively manage operational expenses, such as technology investments and overhead costs, leading to overall cost control and improved financial performance. Moreover, the more efficient a bank is, the greater its ability to maximize profitability, enabling it to compete more effectively in the market (Allen and Rai, 1996). In addition, efficient banks are associated with customer satisfaction through faster transaction processes and offering competitive interest rates (Berger and Humphrey, 1997; Chang et al., 2017). Efficient banks also tend to invest in new technologies that give rise to new innovations to maintain their competitive advantage in the industry (Delis and Staikouras, 2011). Another important aspect of bank efficiency is its role in promoting economic growth. An efficient bank will facilitate the distribution of funds to both households and entrepreneurs, support investment and consumption activities, and monitor investments more efficiently (Bossone and Lee, 2004), thereby contributing to economic stability (Berger and Humphrey, 1997).

The presence of fintech lending companies or P2P lending platforms can be a threat to banks in channeling credit to their potential customers (Zhang et al., 2020). According to Yeo and Jun (2020), there are two general impacts resulting from competition between fintech lending and bank lending. First, there will be a “risk-shifting effect" from P2P lenders to banks. Fintech lending can affect banking health because banks will tend to take lower risks from borrowers due to extensive competition in the market. Second, there could also be a "buffer-reduction effect”. In this case, banks may experience a decrease in capacity to absorb loan losses, attributable to a decline in loan-deposit margins resulting from decreased bank profitability. Thus, the rapid growth of fintech lending introduces increased competition, which affects banking competition by necessitating banks to continuously enhance their efficiency to compete effectively against fintech lenders.

Bank efficiency is partly or largely impacted by the crisis, and there is ample empirical evidence supporting this assertion. Recently, the world experienced a health and economic crisis due to covid-19 virus. The COVID-19 crisis began as a global health emergency and subsequently escalated into an economic crisis (WHO, 2024). In academia, many researchers have been motivated to examine the impact of efficiency on bank performance, aiming to determine whether the key factors remain consistent across periods before and during the pandemic. This has sparked interest in comparing Islamic and conventional banks during COVID-19, as this comparison has always been an interesting topic for discussion. Indeed, some papers have shown that Islamic banks have demonstrated greater resilience in maintaining efficiency compared to conventional banks (Hasan and Dridi, 2011; Rod Erfani and Vasigh, 2018).

This paper investigates the impact of fintech on the efficiency of financial institutions using Indonesia as a case study. According to the Indonesia Financial Services Authority (*Otoritas Jasa Keuangan*—OJK)

data in March 2023, there are 102 fintech lending companies that are officially registered and monitored in Indonesia. Additionally, the total disbursement of fintech lending loans as of January 2023 reached IDR 18.73 trillion (around USD 1.2 billion), with operational revenue of IDR 998.79 billion (around USD 63.9 million). These statistics indicate that Indonesia has good fintech development, and its growth is also phenomenal (Phan et al., 2019).

To investigate the link between fintech and efficiency, we focus on Indonesian Islamic local banks (*Bank Perekonomian Rakyat Syariah* - BPRS), a type of bank with a niche market in Indonesia serving customers who seek Islamic financial services.[1] The development of fintech lending is expected to affect local banks more than national commercial banks because both fintech lenders and Islamic local banks serve customers with characteristics similar to BPRS/ Islamic local banks. Moreover, Islamic local banks in Indonesia also have a special position in the market, although their contribution to the GDP is relatively small (Ministry of Finance of Indonesia, 2022). Islamic local banks are the source of funds for lower-middle-income people and micro-businesses. It's noteworthy that in Indonesia, approximately 99% of businesses are classified as small and micro-enterprises. (Risfandy and Pratiwi, 2022).

Therefore, this paper contributes to the literature mainly in the stream of literature of the local or rural banks. Indeed, there are several empirical articles that have investigated Indonesian local or rural banks (Risfandy and Pratiwi, 2022; Saputro et al., 2021; Trinugroho et al., 2017; Risfandy, et al., 2018; Wasiaturrahma et al., 2020). However, no one has investigated the impact of fintech development at the province level on local banks' efficiency. Moreover, most papers have mainly used China as a sample to investigate the link between fintech and efficiency (Cho and Chen, 2021; Lee et al., 2021; Zhao et al., 2022). Indeed, a few papers have attempted to study efficiency within the Indonesian context, such as Widiarti et al. (2015), who examined the efficiency levels of conventional banks in Indonesia and revealed persistent inefficiencies within the sector. Defung et al. (2016) investigated the impact of regulatory changes on the Indonesian banking industry between 1993 and 2011. Their findings suggested that while the overall banking efficiency in Indonesia remained suboptimal, state-owned and foreign-owned banks demonstrated relatively higher efficiency levels, indicating a positive influence on regulatory changes. In the context of Islamic banks, Hidayati et al. (2017) explored the determinants of bank efficiency in Islamic banking institutions in Indonesia during the 2014:Q2 – 2016:Q2 periods. They found inefficiencies in both Islamic banks and Islamic windows. Furthermore, Anwar et al. (2019) found a positive correlation between loan distribution to micro and small businesses (MSBs) and rural bank efficiency.

This paper also enriches the literature regarding fintech's impact on financial institutions' performance. Previous research has focused more on the effects of fintech growth on the banks' performance or profitability, such as Phan et al. (2020), who shows that fintech company growth harms performance, and Zhao et al. (2022), who found that the presence of fintech can reduce the profitability and assets of state-owned banks in China. Another paper by Guo and Zhang (2023) reported that banks with more remarkable fintech development create more liquidity for the public. Similarly, Wu et al. (2023) find that innovation and the application of bank fintech can increase bank credit and liquidity risks but reduce insolvency risk. While papers reviewing the impact of fintech on performance are voluminous, a study investigating the impact on efficiency, particularly in developing countries, is still limited.

Lastly, most of the previous papers investigate fintech-efficiency endogenously by focusing on the internal side, meaning that they view fintech as internal factors developed by the bank to increase bank performance or efficiency (Guo and Zhang, 2023; Lee et al., 2021; Li et al., 2021; Wang et al., 2021; Wu et al., 2023). This suggests that banks develop fintech internally, employing tools such as artificial intelligence (AI) for tasks like opening bank accounts or interacting with customers, utilizing big data to analyze customer preferences regarding bank products, or enhancing mobile banking features to better meet customer needs (Wang et al., 2021). However, there is limited evidence examining the impact of fintech on efficiency exogenously or from outside of the banks. To the best of our knowledge, only Phan et al. (2019) have endogenously investigated the impact of fintech by using the number of fintech companies to proxy fintech development.

[1] In Indonesia, a type of bank that serves and gives financial services to customers within a specific area (province) is called Bank Perekonomian Rakyat (BPR). There are two types of BPR: conventional BPR and Islamic BPR. In some papers, BPR refers to "rural banks," while another paper refers to "local banks." However, "rural" and "local" are the same term. This paper uses "local" instead of "rural."

The rest of the paper is organized as follows. Section two reviews the related literature. Section three explains the methodological approach. Section four presents the results. Section five concludes.

LITERATURE REVIEW

Financial Technology (Fintech)

Financial technology, or fintech, is a digital innovation and technology-based business model innovation that can be applied to support the development of the financial industry (Wang et al., 2021). In line with that, according to Bank Indonesia Regulation Number 19/12/PBI/2017, fintech is the application of technology in the financial system that can impact monetary stability and the financial system's smoothness, security, reliability, and efficiency of payment systems. Fintech companies can provide solutions to the banking industry, including digital lending, personal finance, online and mobile banking, peer-to-peer lending, and investment management (Palmié et al., 2020). To sum up, fintech is an innovation in financial services that adapts to technological advancements to make financial services and systems, especially in banking, more efficient and effective.

Fintech lending and traditional bank lending share similarities, particularly in their function of disbursing loan funds to applicants following a prescribed application process. However, there are several differences between fintech lending and bank lending. According to AFPI (2024), the first distinction lies in the source of funding. Fintech lending obtains loan funding from investors willing to lend their funds to the wider community, whereas banking funding originates from banking products such as savings, deposits, or owner models tied to the bank. Secondly, regarding the loan application process, lending banks typically require a greater number of documents, including resident identity cards, salary slips, credit histories, savings accounts, and even financial reports for business ventures. Meanwhile, fintech lending generally requires only a resident's identity card and personal information. Thirdly, the interest rates charged on bank loans are usually lower, typically less than 2% per month, compared to fintech lending, where the maximum interest rate can reach 0.8% per day. Fourthly, bank lending often involves a longer disbursement time due to field verification processes, and applications may be rejected if conditions are not met. In contrast, fintech lending usually has a shorter disbursement time, ranging from minutes to hours, though there is still a possibility of rejection. Fifthly, in terms of risk and collateral, bank lending necessitates collateral such as property deeds, land, vehicles, or other assets equal to the loan amount to minimize payment failure risk. In contrast, fintech lending typically does not require collateral beyond personal identification. Thus, fintech lending is often chosen as an alternative funding option (Zhang et al., 2019), especially for entrepreneurs starting a business (Ahlers et al., 2015; Mollick, 2014).

Bank Efficiency and Islamic Local Bank in Indonesia

In Indonesia, Islamic local banks are known as *Bank Perekonomian Rakyat Syariah* (BPRS). According to the regulation from the OJK (25/POJK.03/2021), local Islamic banks in Indonesia provide financial services based on Islamic principles to rural communities that are not served by other financial institutions. Fianto et al. (2018) state that Islamic local banks conduct activities based on Islamic principles and laws integrated into their products and services. The main difference between Islamic local banks and non-Islamic local banks is that Islamic local banks apply Islamic law or *Shariah*, that is, the prohibition of charging interest (*riba*) and the requirement that all products and services comply with Islamic guidelines (Fianto et al., 2018). *Riba* refers to the return on funds determined for lending money (Fianto et al., 2019). Therefore, local Islamic banks use a profit-sharing system similar to that of general conventional banks to obtain profit from loans. In order to operate, local Islamic banks should obtain operational permits from the OJK. Currently, there are 165 Islamic local banks as of June 2022, dispersed in dozens of provinces in Indonesia.

Efficiency is an indicator used to measure the value of output generated from a set of inputs used by Islamic local banks. If the output is equal to or greater than the input, then BPRS can be considered efficient (Wasiaturrahma et al., 2020). According to Ngo and Le (2019), there are two methods used to determine the efficiency value of a bank: (1) the Data Envelopment Analysis (DEA) method and (2) the Stochastic Frontier Analysis (SFA). However, the DEA method is often used in research, especially in developing countries like Indonesia, because of the presence of microfinance institutions (Farida et al., 2018). The DEA method is a

non-parametric linear programming method used to evaluate the efficiency and productivity of companies (Lee and Ji, 2009; Setiawan and Sule, 2020).

According to Coelli (2016), efficiency includes two components: technical efficiency and allocation efficiency. Technical efficiency demonstrates a bank's ability to obtain the maximum output from a specific set of inputs. This is in line with Cummins and Weiss (2012), who define technical efficiency as a bank's ability to produce maximum output from a specific set of inputs based on the existing technology. Allocation efficiency, on the other hand, shows a bank's ability to use inputs in an optimal proportion according to the price of each input.

In this study, we use an intermediation approach, meaning that the banking system uses deposits to provide loans to the private sector and increase its revenue. The output-oriented DEA model estimates the technical efficiency of Islamic local banks in achieving its objectives. The output indicators for Islamic local banks are the total loans, while the input indicators are the total deposits and fixed assets. The output comprises all Islamic banks' loans to the customers, including *murabahah, istishna, multijasa, qardh*, and lease loans. On the other hand, total Islamic local banks' deposits include *wadiah* savings and non-profit sharing investment funds. Fixed assets include property, land, buildings, machinery, vehicles, and other office equipment used to conduct business activities (Eickelkamp, 2015). Islamic local banks' fixed assets include fixed assets and inventory used to help Islamic local banks to generate long-term income and to support their business operations.

Hypothesis Development

It is believed that the presence of fintech companies can positively meet consumer needs by efficiently providing financial services. However, fintech can also pose a threat to traditional commercial banks, potentially attracting their customers in the lending market. According to consumer theory, new services that better serve consumer needs can quickly replace traditional ones (Aaker and Keller, 1990). Fintech holds this advantage by offering integrated financial products through digital payments, online deposits, and online loans, which are easily accessible and convenient. Consequently, consumers may switch from commercial banks to fintech services, particularly fintech lending, due to its advantages, such as streamlined loan applications (AFPI, 2024).

Empirical findings regarding the influence of fintech on bank efficiency are mixed, but it actually depends on whether fintech is considered endogenous or exogenous. In an endogenous setting, when fintech is internalized in the banking system and operation, the literature shows that fintech can boost financial institutions' performance. Lee et al. (2021) investigated the impact of fintech industry development on cost efficiency and technology adoption by China's banking sector. The results indicated that fintech development improved bank cost efficiency while also enhancing the technology used by China's banks. The finding of a positive relationship between fintech influence and bank efficiency is supported by Wang et al. (2021), who discovered that fintech contributes to increased profitability, financial innovation, and risk control. Another paper by Guo and Zhang (2023) reports that banks with more remarkable fintech development create more liquidity for the public. Similarly, Wu et al. (2023) find that innovation and the application of bank fintech can increase bank credit and liquidity risks but reduce insolvency risk.

Conversely, in an exogenous setting, the negative impact of fintech is more pronounced. For instance, Phan et al. (2020) show that, by using an Indonesian sample, the presence of fintech growth harms bank performance. In China, Zhao et al. (2022) also find that the presence of fintech can reduce the profitability and assets of state-owned banks. Lee et al. (2023) found the influence of fintech development on commercial bank efficiency in China and found that fintech reduces overall commercial bank efficiency by increasing debt costs, thereby decreasing efficiency. Moreover, both urban and rural commercial banks are heavily affected by the presence of fintech. Given that bank lending activities dominate commercial bank income, continuous customer transition to fintech platforms could erode bank profitability. This situation is exacerbated for banks lacking proper efficiency management, as low efficiency may result in further losses from reduced lending distribution. Fintech's ability to attract lending customers away from banks could diminish bank profitability, making it challenging for banks to maintain competitive interest rates (Borio et al., 2017; Maudos, 2017). Therefore, we put forward the hypothesis as follows:

H_1: Fintech lending has a negative effect on bank efficiency.

METHOD

Sample and Data

The sample in this study consists of all Islamic local banks in Indonesia, totaling 161 Islamic local banks. The selection criteria for the sample are those registered or licensed by the OJK and those with complete and publicly available quarterly financial reports. This study utilizes financial report data from Islamic local banks from the first quarter of 2020 to the fourth quarter of 2020.

Dependent Variable

Our dependent variable is *EFF* (efficiency), which is measured using the DEA method. We follow Le et al. (2021) and Wasiaturrahma et al. (2020), who measure DEA through the calculation of input variables (total deposits and fixed assets) and output variables (total loans). DEA is a method used to measure the efficiency of Decision-Making Units (DMUs), which can transform inputs into outputs (Saw et al., 2020; Wong et al., 2022). A DMU is considered efficient if it uses fewer inputs to produce a certain set of outputs (input-oriented) or if it can produce the most output from a given set of inputs (output-oriented). This study employs an output-oriented DEA efficiency model estimation, meaning that in measuring efficiency, each DMU is obtained from maximizing the weighted average of the output-to-input ratio. This model assumes that the bank needs to operate at an optimal scale. Our choice of output-oriented model is because BPRS falls into the category of small-scale banks compared to commercial banks, has specific business goals, and serves a niche market. According to Li et al. (2021), small-scale banks focus more on achieving better output. In this paper, we focus on technical efficiency because the DEA method "works" very well when calculating technical efficiency scores (Farida et al., 2018).

Independent Variables

The independent variable in this study is *FINTECH*. We measure *FINTECH* as a fintech lending development proxied by total lending (in logarithm form) by fintech platforms in each province and in each quarter, following Lee et al. (2021). Besides *EFF* and *FINTECH*, we also employ control variables consistent with previous studies (Lee et al., 2021; Phan et al., 2019; Risfandy et al., 2022; Trinugroho et al., 2017; Wang et al., 2021): *ROA* (Return on assets to proxy profitability), *TA* (log of total assets, to proxy size), *CAR* (capital-assets-ratio, to measure bank capitalization), *TLTA* (total loans to total assets ratio, used to control for excessive lending), *MPOP* (Muslim population, to measure penetration of Muslim), *INFL* (province' inflation) and *GDP* (provincial-level GDP). The reasons why we put all those variables as controls are as follows. Tan et al. (2016) suggest that banks with high efficiency levels demonstrate superior performance. Additionally, larger bank sizes can enhance efficiency through product diversification, thereby reducing banking risks (Djalilov and Piesse, 2016). Řepková (2015) found that banking capitalization positively affects efficiency. Moreover, excessive bank lending practices, such as extending loans to previously rejected applicants, can increase banking risk Le and Ngo (2020). Macroeconomic indicators like Gross Domestic Product (GDP) and inflation are commonly used determinants of bank profitability and efficiency. High GDP growth typically corresponds to an increased level of bank credit, profitability, and efficiency (Dietrich and Wanzenried, 2011; Trujillo-Ponce, 2013). In addition, inflation influences banks by adjusting interest rates, potentially increasing operational efficiency and profitability (Djalilov and Piesse, 2016). Considering the Islamic banking sample in this study, the size of the Muslim population is significant, as religiosity influences preferences for financial services, particularly *Shariah*-compliant ones, impacting banking profitability and stability (Trinugroho et al., 2017).

Econometrics Specification

To investigate the impact of fintech on Islamic local banks' efficiency, we follow the model from Wang et al. (2021) to construct the equation as follows.

$$EFF_{ijt} = \alpha_0 + \beta_1 FINTECH_{jt} + \beta_2 ROA_{ijt} + \beta_3 TA_{ijt} + \beta_4 CAR_{ijt} + \beta_5 TLTA_{ijt} + \beta_6 MPOP_{ijt} + \beta_7 INFL_{ijt} + \beta_8 GDP_{ijt} + \varepsilon_{it} \quad (1)$$

where i, j, and t refer to bank, province, and quarter dimensions, respectively. *EFF* represents the dependent variable of efficiency, and *FINTECH* represents the independent variable of fintech lending. In addition, *ROA, TA, CAR, TLTA, MPOP, INFL*, and *GDP* serve as control variables.

We estimate equation (1) using ordinary least squares (OLS) and random effects (RE) estimators. This is because one of our important variables, *MPOP*, is time-invariant and, therefore, cannot be estimated using the fixed effects (FE) procedure. We also conduct robustness checks to see whether our results remain consistent if we change the sets of control variables in our equation.

RESULT AND DISCUSSION

Descriptive Statistics

Table 1 shows the statistics of all variables used in this study. The dependent variable, *EFF*, shows a maximum value of 1 (very efficient) and a minimum value of 0.34 (very inefficient), with an average value of 0.27. *FINTECH*, as the main independent variable in this study, shows the average value of IDR 1,6 billion lending for customers per quarter. Although the period of this study is 2020q1-2020q4, in which 3 out of 4 quarters are in the Covid-19 period, the fintech companies still perform well regarding their loan allocation to customers. However, regarding profitability, the statistics show that the Islamic local banks recorded tiny profits because the average *ROA* is less than 1%. Islamic local banks still exhibit good capitalization, with an average value of 17% regarding its *CAR*. Indeed, some banks have negative capital, such as a bank with *CAR* -4%. During the period of our study, which is mainly in the Covid-19 period, Islamic local banks also tend to be risk averse by allocating fewer loans, exhibited by the mean value of *TLTA* with only 63%.

Table 1 Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
EFF	644	0.277	0.195	0.034	1.000
FINTECH (mill. IDR)	644	1,660,000	1,940,000	3,130	7,250,000
FINTECH (logarithm)	644	27.156	1.679	21.864	29.612
ROA	644	0.005	0.022	-0.114	0.055
SIZE (mill. IDR)	644	87,700	153,000	364	1,340,000
SIZE (logarithm)	644	17.600	1.150	12.804	21.012
CAR	644	0.178	0.116	-0.048	0.849
TLTA	644	0.631	0.157	0.115	0.921
MPOP	644	93.299	10.140	10.080	98.560
INFL	644	0.170	0.217	-0.386	0.700
GDP (mill. IDR)	644	132,000,000	134,000,000	386,917	468,000,000
GDP (logarithm)	644	17.502	2.257	12.866	19.964

Turning to country-level controls, for the variable *INFL*, the statistics show that the average inflation from all provinces in Indonesia is 16%. This value is quite high, but because the sample is during the COVID-19 period, this is reasonable. Regarding *MPOP*, on average, 93% of the population from all Indonesian provinces is Muslim. Surrounded by Muslims, it is plausible that Islamic local banks should have some specific customers, such as high-religiosity Muslims who need small loans but do not accept interest.

Table 2 presents the coefficient correlation between independent variables used in this study. It could be seen that the values are relatively low and less than 0.5, implying that there is no multicollinearity issue in our regression model.

Table 2 Correlation matrix

	FINTECH	ROA	SIZE	CAR	TLTA	MPOP	INFL	GDP
FINTECH	1							
ROA	-0.001	1						
SIZE	0.223	0.167	1					
CAR	-0.135	0.241	-0.418	1				
TLTA	0.007	-0.032	0.157	-0.140	1			
MPOP	0.310	0.040	0.203	-0.050	0.100	1		
INFL	0.172	0.011	-0.017	0.016	-0.043	0.047	1	
GDP	0.120	0.082	0.116	-0.258	0.040	-0.059	-0.118	1

DEA Efficiency Score

As previously explained, our efficiency variable is derived from DEA calculations using DEAP 2.1 software, focusing on technical efficiency. For a more detailed view, we present Table 4, which displays the efficiency scores obtained from DEA. These scores range between 0 and 1: the closer the score is to 0, the lower the bank's efficiency. Conversely, a score near 1 indicates a higher level of efficiency (Nguyen et al., 2016). The efficiency score results within this sample reveal that the majority of local Islamic banks in Indonesia have low efficiency scores. Specifically, 65.23% of banks possess efficiency scores below 0.3. Conversely, only 30 banks exhibit efficiency scores ranging from 0.7 to 1. The summary of the efficiency score is highlighted in Table 3.

Table 3 Variable definition

Variable	Definition	Reference(s)	Expected sign
EFF	The efficiency score of Islamic rural banks was obtained using the data envelopment analysis (DEA) method.	(Lee et al., 2021; Wang et al., 2021)	n/a
FINTECH	Fintech lending development is proxied by total lending (in logarithm form) by fintech platforms in each province and quarter.	(Lee et al., 2021)	Negative
ROA	Return on assets to proxy profitability	(Risfandy and Pratiwi, 2022; Trinugroho et al., 2017; Wang et al., 2021)	Positive
TA	A log of total assets, to proxy size	(Risfandy and Pratiwi, 2022)	Positive
CAR	A capital-assets-ratio, to measure bank capitalization	(Risfandy and Pratiwi, 2022; Trinugroho et al., 2017)	Positive
TLTA	A ratio of total loans to total assets, is used to control excessive lending	(Le and Ngo, 2020; Risfandy and Pratiwi, 2022; Trinugroho et al., 2017)	Negative
MPOP	Muslim population, to measure the penetration of Muslim	(Trinugroho et al., 2017)	Positive
INFL	Province' inflation	(Risfandy and Pratiwi, 2022)	Positive
GDP	provincial-level GDP	(Risfandy and Pratiwi, 2022; Trinugroho et al., 2017)	Positive

Based on prior studies, the banking industry in Indonesia as a whole still operates inefficiently, including both conventional (Widiarti et al., 2015) and Islamic banking (Hidayati et al., 2017). This situation may have been exacerbated by the COVID-19 pandemic. Although several studies suggest that Islamic banking exhibits higher efficiency levels than conventional banking during financial crises, research findings from Boubaker et al. (2023) indicate that Islamic banking experienced a decline in operational efficiency and performance in 2020 as a result of the COVID-19 pandemic. In addition, Zheng and Zhang (2021) investigated the influence of the COVID-19 pandemic on the efficiency of microfinance institutions in developed Asian countries, and the results showed a significant reduction in the financial efficiency of microfinance institutions. Furthermore, the sample we used, an Islamic local bank, operates as a formal microfinance institution where, based on government regulations, its banking activities are limited to acquiring funds in the form of Indonesian bank certificates, time deposits, and savings. Consequently, Islamic local banks face challenges in competing with larger banks such as national banks. As revealed by Trinugroho et al. (2018), this banking model would be more viable in a less competitive environment.

Table 4 Summary of efficiency score results

Efficiency Score Categories	Frequency	Percent	Cumulation
<0.199	275	42.71	54.66
0.2 - 0.299	145	22.52	65.22
0.3 - 0.399	104	16.15	81.37
0.4 - 0.499	69	10.71	92.08
0.5 - 0.599	14	2.17	94.25
0.6 - 0.699	7	1.09	95.34
0.7 - 0.799	5	0.78	96.12
0.8 - 0.899	2	0.31	96.43
0.9 - 1	23	3.57	100

We also present the results of the scatter plot to identify possible changes in two different sets of variables (Wooldridge, 2016). Specifically, the relationship between the *EFFICIENCY* score and the *FINTECH* variable is depicted in Figure 1. This figure illustrates the negative correlation between *FINTECH* and *EFFICIENCY*. This negative correlation is evident as the data for the variables display both positive and negative values. Within this sample, the variable also indicates values close to zero.

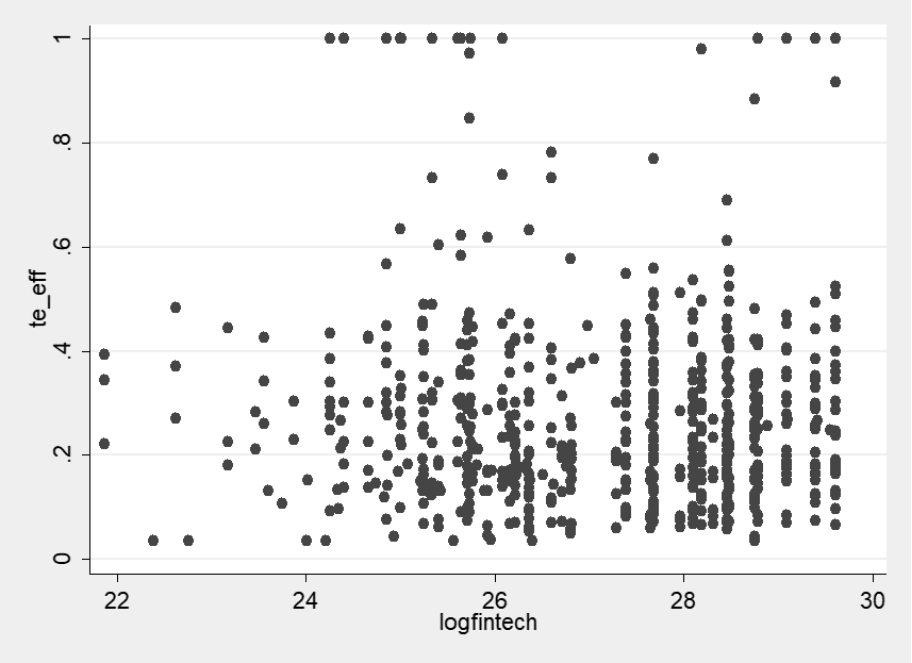

Figure 1 Scatterplot of *FINTECH* and *EFFICIENCY* variables

Baseline Regression Result

In the first set of analysis, we regress *EFF* on *FINTECH* and sets of control variables as in equation (1). From columns (1) and (2) in Table 5, it can be seen that fintech lending development is negatively and significantly associated with bank efficiency, meaning that higher fintech penetration will erode the efficiency of Islamic local banks. It should be noted that our analysis is based on bank and province levels; therefore, it also means that in the province with higher fintech penetration, the efficiency of Islamic local banks tends to be lower. This could happen because customers have switched to adopting fintech lending, which is faster and more efficient compared to bank lending, ultimately reducing banking profitability. Banks with low profitability may face higher costs of debt, making it more expensive for them to borrow funds. Thus, our proposed hypothesis is supported, and the finding is in line with Lee et al. (2023). The results are consistent across different estimation techniques: OLS in column (1) and RE in column (2).

Table 5 Baseline regression

	(1) OLS	(2) RE
FINTECH	-0.0110**	-0.0166**
	(-2.36)	(-2.10)
ROA	0.891***	0.0963
	(2.60)	(0.59)
SIZE	0.00368	0.0322***
	(0.51)	(2.78)
CAR	0.106	-0.00131
	(1.44)	(-0.02)
TLTA	0.487***	0.390***
	(10.61)	(10.42)
MPOP	0.00152**	0.00139
	(2.04)	(0.95)
INFL	0.123**	0.00222
	(2.21)	(0.15)
GDP	0.00451	0.00100
	(1.35)	(0.16)
Constant	-0.0798	-0.237
	(-0.46)	(-0.82)
Year FE	Yes	Yes
N obs.	644	644
R-sq.	0.189	0.193

Notes: ***, **, and * denote significance in 1%, 5%, and 10% levels, respectively.

This result suggests that in the current era, customers who need financial services have many options, not only from formal financial services like national or local banks but also from fintech lenders. It cannot be denied that the presence of fintech as an alternative source of lending poses a threat to banks because they compete with each other (De Roure et al., 2022; Tang, 2019). The competition might be more intense for local banks because they are categorized as small banks offering small credit, like fintech lenders. Moreover, at some points, fintech lending is superior to local bank lending because lending from fintech is usually faster and easier to get. This is because fintech lenders can provide loans to customers with limited capital and engage with risky borrowers who lack collateral (Thakor, 2020).

Prior literature has also reported that fintech lenders as new entrants in the lending market erode bank performance (Phan et al., 2019). From the perspective of customers or those who need small loans, fintech lending can be considered as a substitute or replacement for conventional loans provided by commercial banks. This is supported by Jagtiani and Lemieux (2018), who found that fintech lending is significant in the specific areas where traditional commercial banks are underserved. Knowing that Islamic local banks also serve a niche market (Muslims who need relatively small amounts of loan) that national commercial banks do not target, it is plausible that they are also negatively impacted by fintech development. Moreover, empirical evidence shows the positive impact of fintech and sees fintech development endogenously (fintech inside the bank). In contrast, papers show the negative effects of fintech, considering fintech exogenously (fintech outside the bank). In addition, prior empirical evidence in Indonesia also shows that fintech market development has a negative association with bank-level efficiency (Phan et al., 2019).

Further Analysis: Quantile Regression Result

Since prior studies have shown that bank efficiency is an important factor (Tecles and Tabak, 2010), particularly in significantly influencing bank performance (Mateev et al., 2024), we are interested in examining whether the negative impact of fintech development on efficiency remains consistent across local banks with various efficiency levels. To address this, we employ quantile regression to estimate bank efficiency, as proposed by Koenker and Bassett (1978). Quantile regression has been utilized in several prior studies (Alandejani et al., 2017; Gabaix and Landier, 2008; Hassan et al., 2022; Koutsomanoli-Filippaki and Mamatzakis, 2011). Thus, we regress *EFF* on *FINTECH* in each 10% different quantile and present the results in Table 6. Quantile regression offers advantages for testing the heterogeneity of bank efficiency, departing from conditional-mean models, as it can estimate the entire variance-covariance matrix for all quantiles. In addition, this method also has the ability to provide consistent and robust results, particularly when the error term exhibits heteroscedasticity and is non-normally distributed (Koutsomanoli-Filippaki, 2011)

Table 6 Further analysis: quantile regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FINTECH	-0.0000923	-0.00119	-0.00314	-0.00853**	-0.00961**	-0.0141***	-0.00740	-0.00581	-0.0210
	(-0.03)	(-0.41)	(-0.87)	(-2.07)	(-2.19)	(-2.74)	(-1.25)	(-0.93)	(-1.36)
ROA	0.461**	0.287	0.376	0.565*	0.867***	0.887**	0.594	0.193	1.667
	(2.23)	(1.33)	(1.41)	(1.86)	(2.68)	(2.34)	(1.36)	(0.42)	(1.46)
SIZE	0.00252	0.00242	0.000553	0.00412	0.00165	0.00353	0.0179*	0.0268***	0.00641
	(0.58)	(0.53)	(0.10)	(0.64)	(0.24)	(0.44)	(1.94)	(2.76)	(0.26)
CAR	-0.0346	-0.0300	-0.0918	-0.122*	-0.147**	-0.151*	0.162*	0.588***	0.541**
	(-0.78)	(-0.64)	(-1.60)	(-1.88)	(-2.12)	(-1.86)	(1.73)	(5.98)	(2.20)
TLTA	0.247***	0.244***	0.291***	0.355***	0.402***	0.468***	0.459***	0.509***	0.703***
	(8.96)	(8.41)	(8.15)	(8.74)	(9.31)	(9.23)	(7.87)	(8.32)	(4.60)
MPOP	0.000255	-0.00000778	-0.000270	0.000110	0.00104	0.000915	0.00133	0.00151	0.00283
	(0.57)	(-0.02)	(-0.47)	(0.17)	(1.49)	(1.11)	(1.41)	(1.52)	(1.14)
INFL	0.0309	0.0429	0.0831*	0.0882*	0.0627	0.0647	0.0476	0.0725	0.262
	(0.92)	(1.22)	(1.92)	(1.80)	(1.20)	(1.05)	(0.68)	(0.98)	(1.42)
GDP	0.000847	-0.00176	-0.00249	-0.00145	-0.00228	0.000240	0.00643	0.0108**	0.0179
	(0.42)	(-0.83)	(-0.96)	(-0.49)	(-0.72)	(0.06)	(1.52)	(2.43)	(1.60)
Constant	-0.124	0.00487	0.125	0.153	0.150	0.197	-0.381*	-0.743***	-0.288
	(-1.18)	(0.04)	(0.92)	(0.99)	(0.91)	(1.02)	(-1.71)	(-3.18)	(-0.49)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	644	644	644	644	644	644	644	644	644

Notes: ***, **, and * denote significance in 1%, 5%, and 10% levels, respectively.

Table 6 shows that, although the impact of fintech on efficiency is consistently negative, its impact is not significant in the banks with low efficiency (quantile 10%-30%) and high efficiency (quantile 70%-90%). Fintech significantly impacts banks with medium efficiency levels (quantile 40%-60%). This finding suggests

that highly efficient banks, those that are fundamentally strong and operate with high efficiency, can mitigate the negative impact of fintech development in the lending market[2]. Banks with higher operational efficiency are often associated with greater profitability (Tan et al., 2016), largely due to their ability to manage risk through diversification of products and services (Djalilov and Piesse, 2016). Consequently, they are better equipped to withstand the challenges posed by fintech companies. Previous studies have also demonstrated that lower bank efficiency negatively affects bank performance (Dietrich and Wanzenried, 2014; Phan et al., 2019). Therefore, banks experiencing low profitability may encounter difficulties in effectively competing in the market. Such banks might struggle to offer competitive interest rates on savings and expand their service offerings (Borio et al., 2017; Maudos, 2017). We also present the results of the fintech variable plot based on quantile regression to observe the impact of fintech on efficiency in Islamic local banks across each quartile (refer to Figure 2). Quantile plots visually indicate whether two sets of data come from the same distribution (NIST, 2024). In this study, quantile plot results indicate a negative influence of fintech on banking efficiency. The upper and lower lines represent the boundaries of the total size of fintech lending (in logs). The adverse effect of fintech lending on efficiency intensifies from the lower quantile (20%-30%) to the middle quantile (40%-60%). Meanwhile, quantiles 10-20 do not seem to have much impact because the line shows a value close to zero. This trend is evident in the declining line until it begins to rise again at the 70% quantile. The effects of fintech also reach banks with high levels of efficiency. However, the influence of fintech on these banks is balanced, as indicated by the line boundaries extending to both positive and negative values, leading to a less significant negative impact of fintech on banks categorized as highly efficient.

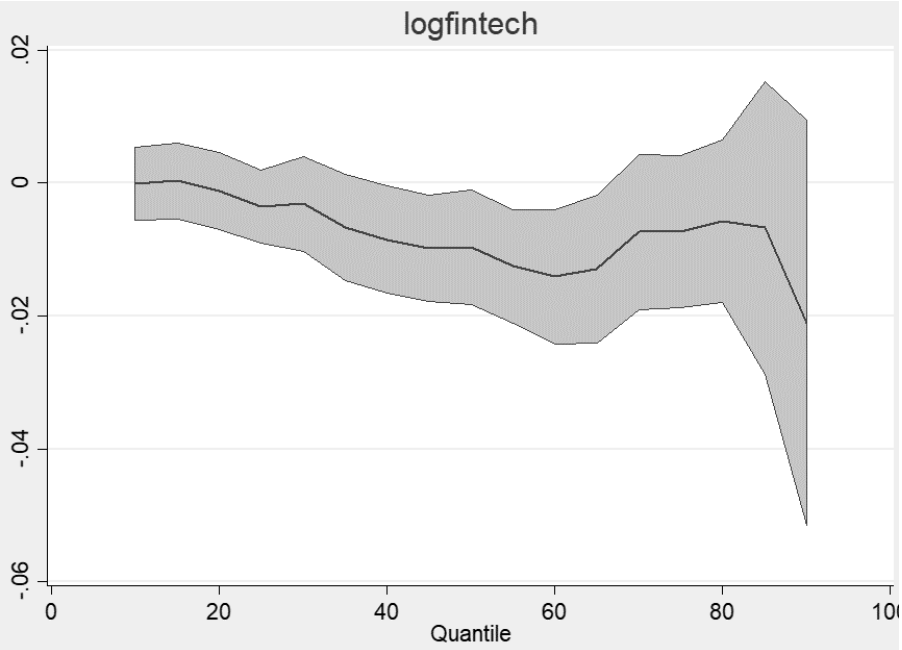

Figure 2 Results of quantile regression plotting

Robustness Checks

In this part, we are willing to see whether our result is altered by changing the formation of control variables, the thing that often happens in the empirical approach of finance study. The results presented in Table 7 are as follows. First, *ROA* is dropped from the analysis, and the result remains consistent. *FINTECH* is still significant at the 5% level. Second, we removed *SIZE* from the regression, but *FINTECH* still showed significant and negative signs, although its significance dropped to a 10% level. Third, we omit *CAR* from the regression, and the result is still similar. *FINTECH* is significant at a 5% level, and it also shows negative signs. Fourth, we removed the *TLTA* variable and observed that the *FINTECH* variable became insignificant despite having a negative coefficient value. We also turn to remove provincial level controls one by one,

[2] There might be a causal effect; however, in this paper, we are not focused on this issue.

which are *MPOP*, *INFL*, and *GDP*, but columns (5), (6), and (7) still show significant signs for *the FINTECH* variable.

Table 7 Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FINTECH	-0.0166**	-0.0143*	-0.0166**	-0.0128	-0.0146*	-0.0167**	-0.0165**
	(-2.09)	(-1.84)	(-2.10)	(-1.52)	(-1.91)	(-2.09)	(-2.09)
ROA		0.183	0.0955	0.101	0.0935	0.0930	0.0966
		(1.12)	(0.61)	(0.56)	(0.57)	(0.57)	(0.59)
SIZE	0.0337***		0.0322***	0.0224*	0.0338***	0.0330***	0.0325***
	(2.95)		(2.96)	(1.81)	(2.96)	(2.83)	(2.81)
CAR	0.00736	-0.0499		0.0641	0.000162	-0.00193	-0.00206
	(0.14)	(-0.97)		(1.10)	(0.00)	(-0.04)	(-0.04)
TLTA	0.390***	0.383***	0.390***		0.392***	0.390***	0.390***
	(10.43)	(10.17)	(10.49)		(10.47)	(10.44)	(10.45)
MPOP	0.00137	0.00200	0.00139	0.00209		0.00137	0.00136
	(0.93)	(1.42)	(0.95)	(1.35)		(0.93)	(0.94)
INFL	0.00202	0.000256	0.00225	0.00397	0.00241		0.00213
	(0.14)	(0.02)	(0.15)	(0.24)	(0.16)		(0.14)
GDP	0.00110	0.00216	0.00102	0.00380	0.000384	0.000910	
	(0.17)	(0.35)	(0.16)	(0.57)	(0.06)	(0.14)	
Constant	-0.265	0.202	-0.238	-0.0453	-0.182	-0.245	-0.225
	(-0.93)	(0.85)	(-0.86)	(-0.15)	(-0.64)	(-0.84)	(-0.82)
Year FE	YES	YES	YES	YES	YES	YES	YES
N obs	644	644	644	644	644	644	644
N banks	161	161	161	161	161	161	161
R-sq	0.194	0.172	0.193	0.0407	0.194	0.194	0.193

Notes: ***, **, and * denote significance in 1%, 5%, and 10% levels, respectively.

We also conducted further robustness test analysis (See Table 8). Considering that deposits are one of the determinants of bank efficiency in Islamic banking (Hidayati et al., 2017), we introduced the *DEPOSIT* variable as a new factor for conducting a robustness test, as displayed in column 1. The deposit variable represents the logarithm of Wadiah and *Mudharabah* savings. The results of the robustness test indicate that *FINTECH* consistently remains negative and significant, and the *DEPOSIT* variable also shows significance in efficiency. These findings are consistent with Hidayati et al. (2017).

Table 8 Further robustness checks

		Low MPOP	High MPOP	Java	Non-Java
	(1)	(2)	(3)	(4)	(5)
FINTECH	-0.0133*	-0.0228	-0.0224**	-0.00000772	-0.0190
	(-1.84)	(-1.43)	(-2.03)	(-0.00)	(-1.15)
DEPOSIT	-0.0909***				
	(-8.69)				
ROA	0.189	0.106	0.0411	-0.0681	0.333
	(1.19)	(0.45)	(0.17)	(-0.30)	(1.43)
SIZE	0.117***	0.0205	0.0418***	0.0394***	0.0124
	(8.00)	(1.14)	(2.74)	(2.79)	(0.62)
CAR	-0.118**	-0.0745	0.120	0.0412	-0.0287
	(-2.22)	(-1.05)	(1.44)	(0.43)	(-0.48)
TLTA	0.386***	0.422***	0.379***	0.420***	0.348***
	(10.83)	(7.05)	(7.74)	(8.09)	(6.41)
MPOP	0.000925			-0.000145	0.00172
	(0.71)			(-0.02)	(0.95)
INFL	0.00282	0.00122	-0.00179	-0.0149	0.0146
	(0.19)	(0.06)	(-0.08)	(-0.62)	(0.81)
GDP	-0.000178	0.000855	0.00351	-0.000205	0.00427
	(-0.03)	(0.03)	(0.55)	(-0.03)	(0.11)
_Constant	-0.186	0.226	-0.150	-0.691	0.113
	(-0.72)	(0.38)	(-0.39)	(-0.84)	(0.15)
Year FE	YES	YES	YES	YES	YES
N obs	644	248	396	400	244
N banks	161	62	99	100	61
R-sq	0.246	0.201	0.197	0.195	0.219

Notes: ***, **, and * denote significance in 1%, 5%, and 10% levels, respectively.

According to Trinugroho et al. (2017), Islamic banks in areas with high Muslim populations tend to exhibit high bank performance. Therefore, in the next stage of robustness checks, we performed a split-sample analysis based on the median Muslim population. Column (2) of Table 8 shows the results of the split sample regression below the median Muslim population, while column (3) shows the regression results based on the

split sample above the median. The results suggest that the *FINTECH* variable consistently exerts a negative impact on bank efficiency in regions that are predominantly Muslim. In this paper, we also split the sample based on geographical differences, namely Java (column (4)) and non-Java (column (5)), considering that Java is the island with the largest contribution to the national economy in Indonesia (Statistics Indonesia, 2024). The results show that the *FINTECH* variable does not significantly influence bank efficiency. Overall, our robustness checks show that our baseline results are strong and that changes in control variables, the addition of new determinant variables, and split samples do not significantly alter the results.

CONCLUSION

While many papers investigate the impact of fintech development endogenously (within the banks) on their performance, we investigate fintech development exogenously (outside the bank) by analyzing the effect of fintech on the efficiency of Islamic local banks in Indonesia. Efficiency is measured using the DEA score calculated from input variables, including total deposits and fixed assets, and output variables, which are represented by total loans. Our study uses a sample of 161 Indonesian Islamic local banks, and we use 2020 as the period of the study (four quarters). Because we focus on the impact of fintech lending, we use provincial-level fintech lending as a proxy of fintech, and we see its effects on bank-level efficiency jointly with other control variables.

Our results show that the presence of fintech in the Indonesian lending market significantly impacts the efficiency of Islamic local banks. In Indonesia, fintech lenders can be seen as a potential threat to Islamic local banks because fintech lenders lend with relatively similar amounts of loans, and they also target relatively similar types of customers (e.g., customers with low credit ratings and poor collateral). The result is consistent in the various stages of robustness checks. In addition, we also find that fintech penetration is not significant for Islamic local banks with high-efficiency levels. To eliminate the negative impact of fintech, Islamic local banks should maintain their efficiency at a high level.

The results of this research yield several implications. First, policymakers can regulate the fintech and banking environment to encourage innovation while simultaneously monitoring and ensuring consumer protection. Second, while we empirically find that fintech can erode local banks' efficiency, we recommend each Islamic local bank collaborate with fintech companies to increase their operational efficiency. Banks can engage in collaboration or increase their involvement in digitalization and fintech to diversify their product offerings and reach a wider customer base, thereby enhancing efficiency and effectiveness in meeting customer needs. Third, banks need to enhance their risk management practices to effectively assess and mitigate risks associated with fintech platforms, thereby increasing efficiency.

Because local bank efficiency might also be highly correlated with local bank competition, future research may consider adding measurements such as the Lender Index and Boone Indicator to gauge the level of competition at the provincial level. Our study does not focus on this issue, and future empirical papers can focus on the competition issue to enrich the study on the efficiency issue, particularly at the provincial level, which still needs attention from academia.

ACKNOWLEDGMENTS

The earlier draft of this paper was presented at the 8th GAMAICI 2023 Conference at Universitas Gadjah Mada. We thank Dr. Aprilia Beta Suandi for giving constructive comments on this paper. This paper has been funded by Universitas Sebelas Maret through PKPTDN Research Grant Scheme No 1496/UN27.22/PT.01.03/2023. All errors remain with the authors.

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