Jurnal Ekonomi Malaysia 58(3) 2024
http://dx.doi.org/10.17576/JEM-2024-5803-6

Fintech Renaissance: Powering Efficiency in Asian Banking Through Country Competitiveness

(*Kebangkitan Fintech: Meningkatkan Kecekapan Perbankan Asia melalui Daya Saing Negara*)

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ABSTRACT

The objective of the study is to examine Fintech innovations that boost bank efficiency while controlling for country competitiveness in Asia. The study employs cross-country data from a sample of 92 commercial banks in Asia and uses data envelopment analysis (DEA) to analyze the efficiency of banks from 2016 to 2022. The panel data regression utilized a fixed-effect model, which was run after a diagnostic check. The validated data satisfied the criteria for stationary, serial autocorrelation, heteroscedasticity, homogeneity, and multicollinearity. The findings show that Fintech significantly improves bank efficiency with the mediating effect of country competitiveness. Additionally, the results indicate that Fintech has a positive correlation with bank efficiency in developing countries. In developed countries, the correlation between Fintech and bank efficiency is also positive. In developing countries, the Fintech effect is greater when country competitiveness is considered, and the effect is much more pronounced in terms of magnitude due to competitiveness. The study contributes to the literature on the relationships between Fintech and bank efficiency by using country competitiveness as a mediating factor. The implication is derived from the empirical evidence that country competitiveness provides a supportive environment for enhancing efficiency in Asian banks.

Keywords: Fintech; innovations; efficiency; Asia; country competitiveness; banking.

ABSTRAK

Objektif kajian adalah untuk mengkaji inovasi Fintech yang meningkatkan kecekapan dalam bank sambil mengawal daya saing negara dalam sektor perbankan Asia. Kajian ini menggunakan data rentas negara dari sampel 92 bank perdagangan dalam sektor perbankan Asia, dan menggunakan analisis penyampulan data (DEA) untuk menganalisis kecekapan bank dari 2016 hingga 2022. Regresi data panel telah digunakan yang terdiri daripada model kesan tetap. Penemuan dapatan menunjukkan bahawa Fintech meningkatkan kecekapan bank dengan ketara dengan kesan pengantara daya saing negara. Selain itu, keputusan menunjukkan bahawa Fintech mempunyai korelasi yang positif dan signifikan dengan kecekapan bank di negara membangun. Di negara maju, korelasi antara Fintech dan kecekapan bank juga signifikan dan positif. Di negara membangun, kesan Fintech adalah lebih besar apabila daya saing negara dipertimbangkan, dan kesannya lebih ketara dari segi magnitud disebabkan oleh daya saing negara. Kajian ini menyumbang kepada literatur tentang hubungan antara Fintech dan kecekapan bank dengan menggunakan daya saing negara sebagai faktor pengantara.. Implikasi diperoleh daripada bukti empirikal bahawa daya saing negara menyediakan persekitaran sokongan dalam meningkatkan kecekapan bank-bank Asia.

Kata kunci: Fintech; inovasi; kecekapan; Asia; daya saing negara; perbankan.

JEL: O2, O3, O4, P2, P3, P4
Received 15 November 2023; Revised 29 September 2024; Accepted 3 December 2024; Available online 10 December 2024

INTRODUCTION

Financial technology has had a fascinating journey that has transformed the way consumers manage financial transactions today. In 2008, the development of Fintech aimed to disrupt traditional banking and financial services due to a global financial crisis that urged regulatory changes and increased scrutiny of the financial industry. As a result of developments in big data analytics, blockchain technology, crowdfunding, artificial intelligence (AI), and machine learning, Fintech has expanded rapidly. These developments have allowed Fintech to offer more individualized and effective financial services. The COVID-19 pandemic accelerated the adoption of digital payments and online banking as consumers demanded branchless services, and with that, Fintech captured nearly half of the global SMEs, including underbanked. The has been reflected in the US and Europe due to higher Fintech funding; however, Asia lags behind (CB Insights 2023). As a result, Fintech helped banks offer better services using advanced technologies, improved customer experiences, and eventually reduced costs, leading to improved bank efficiency in the US and Europe (Lee et al. 2021).

Another critical factor that has been included is country competitiveness, which can also improve bank efficiency in addition to Fintech adoption. Global competitiveness for regions like the US and Europe is resulting in stronger economies and higher rankings, where governments in the regions play a vital role in creating a supportive environment fostered by technological infrastructure, government efficiency, business efficiency, and economic performance. The last 10 years of data on Fintech funding trends by different regions of North America, Europe, and Asia are represented in Figure 1 (CB Insights 2023).

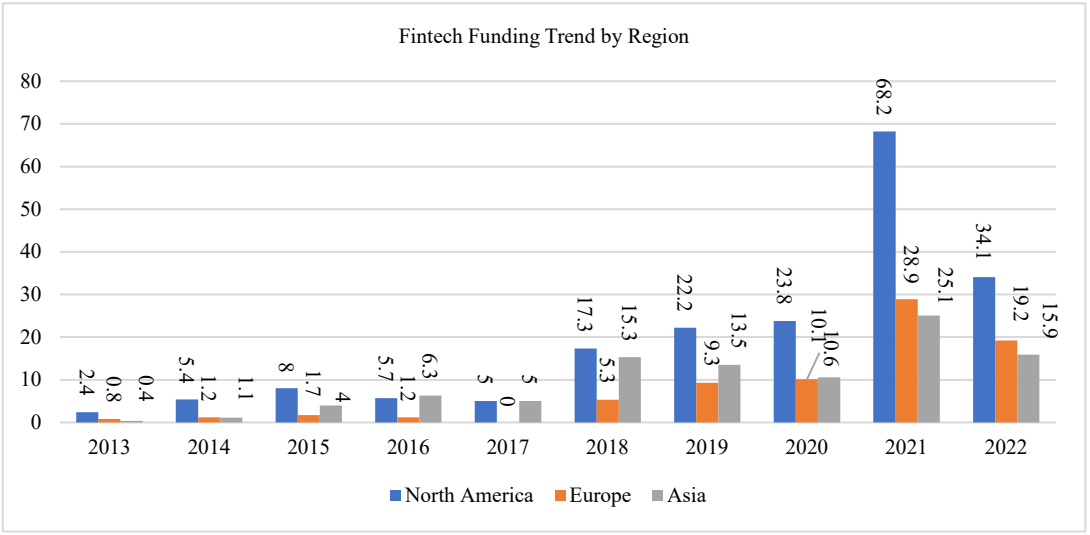

FIGURE 1. Fintech funding trend for 10 years

Figure 1 depicts Fintech funding trends for North America, Europe, and Asia from 2013 to 2022. In 2013, Fintech funding for all three regions was relatively low, with Asia at only $0.4 billion. However, this was just the starting point for what would become a significant growth trend. The first three years (2014–2016) showed a consistent increase in Fintech funding, indicating that this period marked the emergence and early growth of the Fintech industry in all three regions. In 2017, there was a slight decline in Fintech funding in Asia; however, 2018 saw a sharp increase, which temporarily interrupted the trend, and then Fintech funding declined for two consecutive years from 2018 to 2020 in Asia due to downward economic growth in 2019 driven by weak trade and investment (IMF 2019).

Asia experienced a significant increase in Fintech funding in 2021, suggesting a transition towards digital financial services. This was a positive sign for the region. However, in 2022, Fintech funding declined again in Asia. Notably, Asia was in the second-leading position from 2015–2020, but Europe suddenly outperformed in the last two consecutive years (2021–2022), indicating a shift in Fintech funding. This raises concern for Asian Fintech funding as to whether it continues to decline and needs further analysis to understand its implications for Asian banking industry.

Increased economic performance, government efficiency in building high-quality institutions and upholding business regulations, business efficiency in creating value and productivity, and enhanced technological structure are all factors that contribute to a country's competitiveness (IMD Global Competitiveness Index 2023). Hence, a country's competitiveness in Fintech development is essential for driving economic growth and ensuring financial inclusion, which provides digital solutions which can encourage unbanked adults to access banks because financial inclusion has the potential to provide access, usage, and quality of financial services (World Bank 2021). This can help a bank position itself as a key player in the global financial landscape. While Fintech increases bank efficiency, the connection between the two is dynamic and shaped by competitiveness. Banks are forced to take a more customer-centric approach in a competitive market in order to draw in and keep customers. The adoption of a customer-centric approach by banks naturally enhances their operational

efficiency. Understanding a country's competitiveness promotes innovation in the banking industry by pushing for the expansion of services and more affordable access, all of which increase bank efficiency. The current study identifies a research gap in the assessment of country competitiveness using rankings within the Asian banking industry. The exploration of this gap is seen as a valuable opportunity to gain deeper insights into the dynamics of Fintech development and to enhance bank efficiency in the region.

The research aims to examine the impact of Fintech on bank efficiency within the Asian banking industry, highlighting the mediating and moderating effect of country competitiveness. The methodology is based on secondary data using purposive sampling of 92 banks from 15 Asian countries and yearly data from 2016-2022. A country is selected based on its inclusion in the IMD Global Competitiveness Index, and banks are selected based on their Fintech funding. The panel data regression model, which is fixed-effect, is used to estimate the data. The findings indicate that Fintech has a positive and significant effect on bank efficiency, and when country competitiveness is included, the magnitude of the effect is even greater.

The study contributes to the literature on Fintech and bank efficiency relationships using the mediating effect of country competitiveness in Asian banks. The study also contributes to the industry of Fintech and bank efficiency by eliminating the need for costs, optimizing operations, and improving customer experiences. According to the closest research (Farouk & Kabiru 2015; Yudaruddin 2022), the is not the case with the present analysis, though, as it considers Fintech funding, which impacts technical advancements in banks. Bank efficiency is also different from earlier research, which focused on the technical efficiency of banks in terms of inputs and outputs. The study's contribution is the way that country competitiveness impacts bank efficiency. Since economic performance, productivity in business with value creation, and technological structure are the main factors determining a country's competitiveness, a better-ranked country offers a supportive environment promoting bank productivity. As a result, it contributes to the Asian banks and also to the literature.

Fintech frequency has been used in research as a proxy for bank profitability, but the current study uses funding value as a proxy, which directly affects bank efficiency. The current study is different from previous ones in that efficiency is quantified using the data envelopment analysis (DEA) approach, and competitive advantage is mediated by country competitiveness (Farouk & Kabiru 2015; Yudaruddin 2022).

The rest of the paper has been organized as follows: Section 2 includes the literature review, research framework, and hypothesis development. The methodology section 3 follows, detailing sample and data, variable measurement, regression model selection for panel data, and diagnostic checks. The results section 4 presents descriptive statistics and results of fixed-effect models, including discussion. Finally, the conclusion is reached with recommendations for future research.

LITERATURE REVIEW

The resource-based perspective hypothesis utilizes the resources of the firm to create a competitive edge. Performance is viewed in the theory as one of the resources, exhibiting varying degrees of efficiency. Numerous studies have examined the effect of Fintech on bank performance (Chen et al. 2021; Hannoon et al. 2021; Yoon et al. 2023). Particularly in developing countries, Chen et al. (2021) examined the connection between Fintech and bank performance in China using primary data and discovered that perceived usefulness a Fintech-related factor has a positive impact on bank performance. Studies by Lee et al. (2021) in China, a developing country, found that Fintech innovation also boosts bank efficiency, and new technology has been demonstrated to improve bank efficiency. Moreover, Li et al. (2021) found that the efficiency of Chinese commercial banks is more significantly impacted by Fintech development. Similarly, Banna et al. (2023) found that Fintech, utilizing the DEA technique, favourably influences bank efficiency in six developed and eight developing countries.

However, in developed countries, Yoon et al. (2023) observed that Fintech significantly improves bank performance in both the least and most developed contexts. Further, according to research carried out on Bahrain's banking industry by Hannoon et al. (2021), Fintech has a favourable and substantial correlation with bank performance. The findings, which make use of the Data Envelopment Analysis (DEA) technique, demonstrate that bank performance is positively impacted by Fintech investments. However, a few other studies (Lee et al. 2021; Li et al. 2021; Lee et al. 2023; Banna et al. 2023) looked at the effect of Fintech on bank efficiency. Nonetheless, Lee et al. (2023) used DEA to investigate how Fintech affects overall bank efficiency and discovered that, in general, Fintech development reduces the efficiency of commercial banks.

The prior research by Yoon et al. (2023); Hannoon et al. (2021); and Banna et al. (2023) focused on developing nations such as Turkey, Malaysia, Indonesia, Iran, Pakistan, Nigeria, Bangladesh, and Sudan, and developed countries such as Bahrain, Qatar, Saudi Arabia, Kuwait, Brunei, and the United Arab Emirates. Their findings demonstrate that Fintech growth has a major influence on bank performance in both developed and developing countries. The objective of Chang et al.'s (2020) study on internet banking was to identify the variables influencing the use of the service. There is yet no information on the variables influencing online banking usage in Mongolia. The Technology Acceptance Model (TAM), the Theory of Planned Behaviour (TPB), and the E-service-quality model have all been used in the study to examine the variables affecting the utilization of online banking services provided by Mongolia's commercial banks. The outcomes show how reliable and successful the E-service quality approach is.

Fintech adoption contributes positively to various aspects of bank performance, and competitiveness impacts the performance of banks in Pakistan (Riaz et al. 2023). Fintech affects cost efficiency in China's banking industry, and findings also suggests that Fintech innovations not only improved the cost efficiency of banks, but also enhanced the technology used by banks (Lee et al. 2021). Further work (Wang et al. 2021) looked at the connection between competitiveness and bank efficiency. Al-Dmour et al. (2021) analysed big data and bank performance via the mediating role of competitiveness in commercial banks in the United Arab Emirates (UAE). The findings revealed that bank performance was positively influenced by big data.

Wang et al. (2021) found that competitiveness and efficiency are positively related. There are numerous studies (Nguyen et al. 2017: Tian et al. 2019: Phan et al. 2019) that explored the association between competition and efficiency, but competition as country competitiveness using cross-country analysis appears to be a gap in this study that broadly impacts the relationships both at the bank and macro levels in Asia's banking industry.

Country competitiveness may serve as a crucial mediating role that can influence the effect of Fintech on bank efficiency. Maochun and Zhixu (2013) have shown that competitiveness improves the development of banks. In a highly competitive environment, banks may be more motivated to improve their efficiency by leveraging Fintech to stay ahead of their rivals. Mutuku (2020) has also shown that competition mediates the relationship between technology and bank performance. Given the likelihood of the above statement, the research anticipates discovering how country competitiveness mediates the effect of Fintech on bank efficiency in the Asian banking industry.

RESEARCH FRAMEWORK

The following Figure 2 shows how Fintech has an effect on bank efficiency with country competitiveness as a mediator.

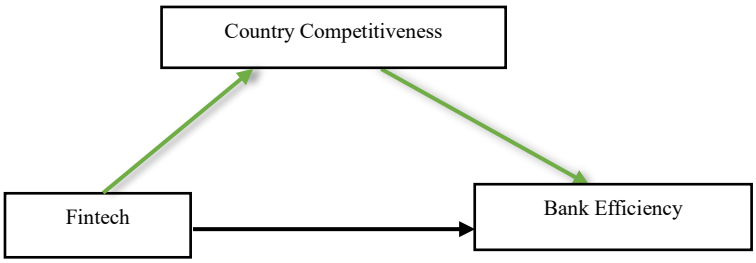

FIGURE 2. Research framework using mediation

H_1 Fintech has an essential impact on bank efficiency, mediating the effect of country competitiveness at the bank level.

H_2 Fintech has an essential impact on bank efficiency, mediating the effect of country competitiveness at the bank and macro-levels.

METHODOLOGY

DETERMINATION OF SAMPLE AND DATA

The research considered 15 Asian countries with financially sound banks that have Fintech funding. The IMD Global Index publishes competitiveness data for 16 Asian nations; however, Cambodia has limited data availability for bank-specific indicators and Fintech funding values. Since country competitiveness is employed in the study as both a mediating and moderating variable, the remaining 15 countries have been considered as the sample. Seven commercial banks from each country were selected, with observation years from 2016 to 2022, and data were collected using DataStream (Thomson Reuters 2023). Fintech investments are not frequently made in all 15 sampled nations; however, a few have more banks and generate more Fintech funding than others. Therefore, countries with more banks that make substantial Fintech investments were prioritized. In the research study, country competitiveness is the mediating variable, bank efficiency is the dependent variable, and Fintech is the independent variable, applying panel data of the chosen banks across 15 different countries. A purposive sampling technique (non-probability sampling method) was applied, with criteria for the sample determined beforehand, as listed in Table 1.

TABLE 1. Sample distribution

S/N	Country Name	Sample (Commercial bank)	Observations	%
1.	India	10	70	10.860
2.	China	10	70	10.860
3.	Malaysia	8	56	8.690
4.	Saudi Arabia	8	56	8.690
5.	Thailand	7	49	7.600
6.	UAE	7	49	7.600

7.	Qatar	7	49	7.600
8.	Jordan	7	49	7.600
9.	Philippines	6	42	6.520
10.	Indonesia	6	42	6.520
11.	Taiwan	5	35	5.430
12.	Hong Kong	3	21	3.260
13.	Singapore	3	21	3.260
14.	Japan	3	21	3.260
15.	South Korea	2	14	2.170
	Full sample	92	644	100

VARIABLE MEASUREMENT

The literature matrix, which includes variables, their measurements, data sources, and anticipated signs, is shown in Table 2 below:

TABLE 2. Literature matrix

Variables	Measurement	Data	Citations	Expected Sign
DV:				
Bank Efficiency	DEA Approach	Eikon DataStream	Abdulahi et al. (2023), Banna et al. (2023), Jelassi and Delhoumi (2021), Lee et al. (2023), Lee et al. (2021), Li et al. (2021).	Positive
IV:				
Fintech	Funding as a proxy	CB Insights and Crunchbase	Sapulette et al. (2021), Banna et al. (2023), Chen et al. (2021), Wang et al. (2023), Lee et al. (2021), Yoon et al. (2023), Li et al. (2021), Lee et al. (2021).	Positive
Competitiveness	IMD world competitiveness index as proxy	IMD World Competitiveness Index	Tang et al. (2023), Zoghlami & Bouchemia (2020), Tan (2019), Tang et al. (2023), Tan (2017)	Positive
Bank Specific Variables:				
Bank Size	Total Assets	Eikon DataStream	Abdulahi et al. (2023), Tan (2019), Tan (2017)	Positive/ Negative
Liquidity Risk	Total deposits over total loans	Eikon DataStream	Abdulahi et al. (2023), Tan (2019), Tan (2017)	Negative/Positive
Credit Risk	Total loans over total assets	Eikon DataStream	Abdulahi et al. (2023), Tan (2019), Tan (2017)	Positive/ Negative
Level of Capitalization	Equity as a ratio of total assets	Eikon DataStream	Xuan Ngo et al. (2021), Tan (2019), Tan (2017)	Positive
NPL	Non-performing loan	Eikon DataStream	Ferreira (2022) and Phung et al. (2022), Zoghlami & Bouchemia (2020)	Negative
Macro Variables:				
GDP growth	Economic growth	WDI of WB and IMF	Abdulahi et al. (2023), Saleh and Alaallah (2022), Zoghlami & Bouchemia (2020)	Positive
Inflation	CPI Index as a proxy	WDI of WB and IMF	Saleh and Alaallah (2022), Zoghlami & Bouchemia (2020)	Negative
Interest Rate	Lending rate	WDI of WB and IMF	Saleh & Alaallah (2022); Adhityo and Wibisono (2021)	Positive
COVID-19	Finally, COVID-19 is a dummy variable that takes 1 in binary when it is a COVID-19 period and 0 otherwise.	Binary number For the years of 2020-2022	Hill (2021), Benni (2021), Al-Khawaja et al. (2023), and Sapulette et al. (2021)	Positive/ Negative

BANK EFFICIENCY (DV)

There are several approaches used to specify the variables, such as production, value-added, intermediation, and operational approaches (Berger & Humphrey 1997). Remarkably, the intermediation approache is considered appropriate as banks act as intermediaries between savers and borrowers (Abdulahi et al. 2023). Consistent with earlier research (Abdulahi et al. 2023), this study employs input-oriented measures, which is more computationally demanding than the other two methods, and uses interest expenses, deposits, and total fixed assets as input variables, and interest income, non-interest income, and gross loan amount as output indicators. The variables utilized in a Data Envelopment Analysis (DEA) model to measure the efficiency of decision-making units (DMUs), like banks, are inputs and outputs. A DMU uses inputs, or resources, to create outputs. The products or services that a DMU produces with the inputs it has been given are called outputs.

The study also computes the technical efficiency of banks year-by-year from 2016 to 2022, following earlier studies (Abdulahi et al. 2023; Jelassi & Delhoumi 2021). The output-oriented approach has been used in the study to assess the

performance in converting inputs into outputs. Given that an output-oriented approach aligns with the bank main objective, it makes sense to utilize it to evaluate how well banks transform inputs into outputs. The approach ensures that bank efficiency is focused on improving positive outcomes. The intent of applying the DEA approach is to maximize the amount of output that can be generated with the same amount of input. It makes sense to use DEA to assess bank efficiency because of the efficiency-focused approach to managing several inputs and outputs. The attributes make DEA an effective method for enhancing bank efficiency.

The objective is to determine the bank's efficiency in producing outputs with the minimum possible inputs. Table 3 represents descriptive statistics on the inputs and outputs used to calculate bank efficiency followed by developed and developing countries in Table 4 and 5 respectively:

TABLE 3. Descriptive statistics

Variable	Obs.	Mean	Std. Dev	Min	Max
II	644	17209.90	111598.30	9.81	1285885.00
NII	644	4780.62	28150.22	1.95	325059.80
Loan	644	370992.20	2443855.00	118.53	2.67
Iexp	644	7433.47	47672.27	7.69	552931.10
Deposits	644	556386.70	3831055.00	306.89	4.28
Fixed Assets	644	4020.03	22481.02	0.25	235065.00

Note: II is interest income, NII is net interest income, and Iexp is interest expenses.

TABLE 4. Descriptive statistics for developed countries

Variable	Obs.	Mean	Std. Dev	Min	Max
II	315	26554.09	157967.50	9.81	1285885.00
NII	315	7082.04	39691.90	1.95	325059.80
Loan	315	595854.50	3458576.00	118.53	2.67
Iexp	315	10798.58	67342.89	7.69	552931.10
Deposits	315	917085.70	5425476.00	306.89	4.28
Fixed Assets	315	5826.22	31356.43	0.25	235065.00

Note: II is interest income, NII is net interest income, and Iexp is interest expenses.

TABLE 5. Descriptive statistics for developing countries

Variable	Obs.	Mean	Std. Dev	Min	Max
II	329	8263.33	19025.80	46.78	146180.60
NII	329	2577.14	5941.63	2.94	48646.49
Loan	329	155698.40	402376.60	905.43	3313922.00
Iexp	329	4211.55	9614.28	8.43	82023.27
Deposits	329	211036.60	590158.20	1240.61	4781207.00
Fixed Assets	329	2290.70	6585.60	11.26	50355.16

Note: II is interest income, NII is net interest income, and Iexp is interest expenses.

Technical efficiency (TE) is a metric used to quantify how well a DMU is able to maximize output given a certain input.

$$Min\ \theta_j = \frac{\sum_{r=0}^{p} u_{ra} y_{ra}}{\sum_{i=0}^{q} v_{ia} x_{ia}} \qquad \ldots\ldots\ldots(1)$$

where "v" and "u" stand for input and output weights, respectively, "x" and "y" stand for inputs and outputs, "q" and "p" stand for input and output numbers, respectively, and 'θ_j' denotes the DMU's efficiency. The DEA model's efficiency scores, which are used to assess bank performance from 2016 to 2022, are displayed in Table 6.

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TABLE 6. Summary of efficiency scores for developed and developing countries

	Technical Efficiency (%)							
	2016	2017	2018	2019	2020	2021	2022	Total
Number of efficient banks	51.00	43.00	38.00	45.00	43.00	46.00	49.00	315.00
Number of inefficient banks	41.00	49.00	54.00	47.00	49.00	46.00	43.00	329.00
Number of banks	92.00	92.00	92.00	92.00	92.00	92.00	92.00	644.00
Average efficiency	65.37	64.55	60.75	66.17	72.25	70.67	76.77	476.53

Table 6 presents data indicating the number of inefficient banks in Asia from 2016 to 2022, based on the assumption of technical efficiency. In 2016, there were 41 inefficient banks, followed by 49 in 2017, 54 in 2018, 47 in 2019, 49 in 2020, 56 in 2021, and 43 in 2022. The average efficiency scores for the banks during the period were 65.37%, 64.55%, 60.75%, 66.17%, 72.25%, 70.67%, and 76.77%, respectively. The figures highlight the improvement of the average technical efficiency of banks across the years, with potential enhancements of 34.63%, 35.45%, 39.25%, 33.83%, 27.75%, 29.33%, and 23.23%, respectively. Asian banks should focus on the factors influencing their technical efficiency.

FINTECH

Fintech has been investigated as a stand-alone variable in several studies (Lee et al. 2021; Lee et al. 2023; Paulette et al. 2021). Data from CB Insights and Crunchbase (CB Insights 2023; Crunchbase 2023) were used to create a variety of indicators, including financing, R&D spending, Fintech headlines, and funding frequency. Consequently, Fintech financing value is used as a proxy in the analysis. Fintech financing is measured by the amount of money that Asian banks sample banks invested in Fintech technologies between 2016 and 2022. The financing represents a value in dollars that a sample of banks invests yearly in Fintech adoption. Banks have a direct investment in Fintech innovations, which is used as a funding value because it has a direct effect on banks' efficiency. Hence, funding value is considered a proxy for Fintech.

COUNTRY COMPETITIVENESS (MEDIATING VARIABLE)

The mediation effect is the method by which an intermediate variable (M) creates a causal relationship between an independent variable (X) and a dependent variable (Y). The mediating variable (M), independent variable (X), and dependent variable (Y) are connected by the following equation:

$$M = a + bX + e \quad (2)$$

$$Y = a + eX + dM + e \quad (3)$$

The intermediary variable demonstrates an indirect impact, which can be formulated through equations (2) and (3). The overall influence of X on Y incorporates the combined effect of both direct and indirect pathways. In this context, the parameter 'c' denotes the direct effect in the presence of competition which mediates the relationship between Fintech and bank efficiency.

Competitiveness serves as a crucial mediating role that influences the effect of Fintech on bank efficiency. As country competitiveness becomes more prevalent, creates a supportive environment for long-term value creation by banks, and the adoption of Fintech becomes more customary, leading to improved efficiency. Country competitiveness is a widely recognized and comprehensive measure that evaluates the competitiveness of countries on a global scale. The competitiveness factors assess economic performance, business efficiency, government efficiency, and technological infrastructure, which are relevant to Fintech in the banking industry. The IMD Global Competitiveness Index has been used as a proxy for competitiveness. If researchers posit that country competitiveness mediates the relationship between Fintech and bank efficiency, thereby strengthening its impact, it follows that the banking sector in Asia should strategically invest in Fintech initiatives to secure a competitive advantage. Such investments are likely to facilitate further improvements in overall bank efficiency. The statement is supported by Feldmann et al. (2019), who used data from the Global Innovation Index to investigate innovation and global competitiveness in their study. Researchers showed that sustainability significantly mediates innovation and global competitiveness. On the other hand, Maochun and Zhixu (2013) conducted research on competitiveness by examining the growth and competitiveness of Chinese banks. The findings were followed by Mulyani (2020), who looked at the effect of Fintech development on Chinese bank competitiveness, and it was concluded that the results had practical importance for enhancing the competitiveness of Chinese commercial banks.

BANK-LEVEL VARIABLES

Empirical studies by Abdulahi et al. (2023) showed the benefit of liquidity risk to bank efficiency. Previous studies by Abdulahi et al. (2023) have shown a positive and significant association between technological efficiency and credit risk. According to recent research by Ferreira (2022) banks that exhibit positive and significant profitability and economic growth are not likely to have high, non-performing loan (NPL) values. In fact, there is a notable negative link between NPLs and profitability. Xuan Ngo et al. (2021) examined equity capital on the profitability of Vietnamese banks, and their finding indicates that there is a positive and significant relationship between them. According to Zoghlami & Bouchemia (2020), bank solvency is negatively related to non-performing loans indicating banks with higher capital have less exposure to credit risk. Tan (2019) examined competition and profitability in the Chinese banking industry, and those findings indicate that bank size is significantly and negatively correlated to Chinese bank profitability. The study also found that credit risk has a negative correlation to bank profitability, and liquidity has a positive relation and capital has a negative relation to bank profitability. Tan (2017) investigated how competition affected the profitability of shadow banking. The study's conclusions show that the Chinese shadow banking business is positively correlated to bank size, positively correlated to capital, negatively correlated to credit risk, and negatively correlated to liquidity.

MACRO-LEVEL VARIABLES

According to Saleh and Alaallah (2022), a negative correlation is between inflation and bank performance, and a positive correlation between economic growth, interest rates, and bank performance. Adhityo and Wibisono (2021) found that rises in interest rates affect low-income banks more negatively than high-income banks. Hill (2021) noted that the outbreak of

the COVID-19 pandemic brought about substantial transformations in the Chinese financial services sector. Benni (2021) and Al-Khawaja et al. (2023) conducted a comprehensive investigation into digital finance during the pandemic, concluding that the crisis accelerated financial digitization. A prior study (Zoghlami & Bouchemia 2020) of competition in the banking industry from the MENA region found that GDP growth has a positive effect on bank profitability and that is a positive association between inflation and bank performance. Tan (2019) found that inflation has a positive correlation and that GDP growth has a negative correlation with Chinese bank profitability. Tan (2017) investigated the effect of competition on the profitability of shadow banking, and the findings indicate that inflation has a positive correlation and that GDP growth has a negative correlation with shadow bank profitability.

The evidence implies that Fintech has a positive impact on the economy and has gained immense importance as a catalyst for economic growth, trade enhancement, and global prosperity (Wang et al. 2024). The emergence of Fintech has had an incredible impact on the economy. A previous study (Cai et al. 2024) discovered a significant positive association between the adoption of Fintech and increases in rural household wages, particularly in the areas of wage and property incomes, thereby reducing the income gap between urban and rural areas. Increasing competitiveness in business is essential for driving a development of the country within global economic and technological chains. Fintech concurrently increases competitiveness by expanding market share, investing more in R&D, and removing financing limits. According to Tang et al. (2023), adopting Fintech positively and significantly increases a business's competitiveness. Fintech is therefore a double-edged sword since it boosts competitiveness in the respective industry and increases economic power as well. The concern is whether improvements in banking sector efficiency impact economic growth or the other way around. Accurately positioning the banking sector within an economy and assessing the function of banking as it transitions from microeconomic domains to macroeconomic channels depends on the study. One such investigation was carried out by Suleyman and Mehmet (2022). The results indicate a somewhat positive correlation between bank efficiency and economic expansion.

REGRESSION MODELS

The time series and cross-sectional data are used to evaluate the regression model using the panel data regression approach. The macroeconomic factors are external, impacting a bank's efficiency and relating to the overall economic environment, whereas bank-specific factors are internal to the banks and reflect their operational and strategic decisions. To understand a bank's efficiency and make smart business decisions, one needs to look at both macro and micro factors. The study developed multiple regression Models 1 and 2 as follows, in compliance with the specified conditions:

$$Beffi_{jt} = \alpha + \beta_1 FT_{jt} + \beta_2 Com_{jt} + \beta_3 Bsize_{jt} + \beta_4 LiqRisk_{jt} + \beta_5 CRisk_{jt} + \beta_6 Lcap_{jt} + \beta_7 NPL_{jt} + \mu_{jt} \quad \text{..... (4)}$$

$$Beffi_{jt} = \alpha + \beta_1 FT_{jt} + \beta_2 Com_{jt} + \beta_3 Bsize_{jt} + \beta_4 LiqRisk_{jt} + \beta_5 CRisk_{jt} + \beta_6 Lcap_{jt} + \beta_7 NPL_{jt} + \beta_8 GDPgrowth_{jt} + \beta_9 CPI_{jt} + \beta_{10} IRate_{jt} + \beta_{11} Covid_{jt} + \mu_{jt} \quad \text{..... (5)}$$

REGRESSION MODEL FOR DEVELOPED AND DEVELOPING COUNTRIES

$$Beffi_{jt} = \alpha + \beta_1 FT_{jt} + \beta_2 Com_{jt} + \beta_3 Bsize_{jt} + \beta_4 LiqRisk_{jt} + \beta_5 CRisk_{jt} + \beta_6 Lcap_{jt} + \beta_7 NPL_{jt} + \beta_8 GDPgrowth_{jt} + \beta_9 CPI_{jt} + \beta_{10} IRate_{jt} + \beta_{11} Covid_{jt} + \mu_{jt} \quad \text{..... (6)}$$

Where, $Beffi_j$ denotes bank efficiency, FT as Fintech, Com as competitiveness, Bsize as bank size, LiqRisk as liquidity risk, CRisk as credit risk, Lcap as level of capitalization, NPL as non-performing loan, GDP growth as real GDP growth, CPI as consumer price index, IRate as interest rate, COVID as a binary variable, j as number of banks, t as a year, α as Intercept, β_1 - β_{10} as slope parameters, and μ as Error term.

With 92 banks from 15 countries included in the sample and seven years of data, there are a total of 644 observations. Since Fintech is a firm-specific variable, the same observations are also utilized to run Model 1 with micro-factors to assess the influence of bank-specific factors, and Model 2 with macro-factors to observe the broader effects of the macroeconomic environment, as country competitiveness is a macro-factor.

DIAGNOSTIC CHECK

Table 7 displays the results of the multicollinearity and normality tests. After performing the Fisher-type unit-root test, which is based on the Augmented Dickey-Fuller tests, the results are normal. Multicollinearity between the variables is not detected in the research when the VIF test for collinearity is applied. The results of the multicollinearity and normality tests are shown in Table 7.

TABLE 7. Diagnostic check

	ADF test-based unit-root test	VIF for multicollinearity	The Breusch-Godfrey LM test for autocorrelation	LM test for heteroskedasticity using Breusch-Godfrey	Endogeneity	FE model selection using Hausman test	Mediation (RIT)
Model 1	Results are normal since p<0.05	Range = 1.07-3.55	p-value = (0.071) Chi2 = 6.395	p-value = (0.091) Chi2 = 4.640	p-value = (0.617) Durbin = 0.615	p-value = (0.00) *** Chi2 = 2.40	37%
Model 2	Results are normal since p<0.05	Range = 1.07-3.55	p-value = (0.061) Chi2 = 9.622	p-value = (0.197) Chi2 = 1.660	p-value = (0.617) Durbin = 0.615	p-value = (0.00) *** Chi2 = 2.20	37%
Model 3 (Developing Country)	Results are normal since p<0.05	Range = 1.15-5.03	p-value = (0.071) Chi2 = 3.264	p-value = (0.594) Chi2 = 0.280	p-value = (0.739) Durbin = 0.110	p-value = (0.00) *** Chi2 = 163.810	32%
Model 3 (Developed Country)	Results are normal since p<0.05	Range = 1.07-2.17	p-value = (0.061) Chi2 = 3.505	p-value = (0.225) Chi2 = 1.470	p-value = (0.583) Durbin = 0.299	p-value = (0.00) *** Chi2 = 41.610	44%

In Table 7, the p-value result in Model 1 is not significant, providing evidence of no autocorrelation. On the other hand, for the heteroskedasticity test, the p-value result in Model 1 is greater than 5%, indicating that there is no evidence of heteroskedasticity. Furthermore, when the variables are exogenous and the p-values are not significant ($p > 0.05$), endogeneity has been detected using the Durbin-Watson and Hausman tests. Thus, the model does not have an endogeneity problem. The mediation test yields a 37 percent indirect impact-to-total effect ratio, which is satisfactory for mediation in the model. Lastly, the Hausman test is satisfied ($p < 0.01$) when the fixed effects (FE) model is run.

REGRESSION MODELS SELECTION FOR PANEL DATA

According to Dougherty (2016), the Hausman test has been applied to choose which regression models to use fixed effects (FE) or random effects (RE) offering a definitive assessment of the model's fit and quality (Ceesay & Moussa 2021). The fixed-effect and random-effect models are assessed using the Durbin-Wu-Hausman (DWH) test, which is sometimes referred to as the Hausman test (Hoang & Thanh 2023).

RESULTS: DESCRIPTIVE STATISTICS OF VARIABLES

The research, descriptive statistics of each variable are shown in Table 8, Table 9, and Table 10. More than three standard deviations may be seen in the initial data set for the descriptive statistics below, showing a large variance in the variables.

TABLE 8. Descriptive statistics

Variable	Obs.	Mean	Std. Dev	Min	Max
Beffi	644	0.680	0.233	0.198	1
FT	644	255.103	1093.592	0	10700
Com	644	27.309	15.37684	1	58
LiqRisk	644	1.038	1.816	.211	28.75
CRisk	644	35611.51	147234.4	1.363	165
BSize	644	593285.2	360	676.1	3.45
LCap	644	0.122	0.101	0.007	1
NPL	644	3177.775	8006.53	2.19	73838.08
GDPgrowth	644	0.029	0.038	-.095	0.087
CPI	644	0.021	0.020	-.025	0.081
IRate	644	0.052	0.025	.008	0.118
COVID	644	0.284	0.451	0	1

Note: Beffi is bank efficiency, FT is Fintech, Com is competitiveness, Liqrisk is liquidity risk, Crisk iscredit risk, Bsize is bank size, Lcap is level of capitalization, NPLis non-performing loan, CPI is consumer price index, and Irate is interest rate.

TABLE 9. Descriptive statistics for developed countries

Variable	Obs.	Mean	Std. Dev	Min	Max
Beffi	315	0.743	0.208	0.218	1.000
FT	315	348.335	1453.277	0.000	10700.000
Com	315	17.917	11.196	1.000	39.000
LiqRisk	315	1.221	2.519	0.211	28.762
CRisk	315	44830.030	195397.000	1.363	1653799.000
BSize	315	925057.500	5090846.000	676.1	3.450

LCap	315	0.134	0.137	0.007	1.000
NPL	315	3896.624	9721.676	2.190	73838.080
GDPgrowth	315	0.017	0.032	-0.065	0.087
CPI	315	0.013	0.018	-0.025	0.061
IRate	315	0.036	0.014	0.008	0.067
COVID	315	0.282	0.450	0.000	1.000

Note: Beffi is bank efficiency, FT is Fintech, Com is competitiveness, Liqrisk is liquidity risk, Crisk is credit risk, Bsize is bank size, Lcap is level of capitalization, NPL is non-performing loan, CPI is consumer price index, and Irate is interest rate.

TABLE 10. Descriptive statistics for developing countries

Variable	Obs.	Mean	Std. Dev	Min	Max
Beffi	329	0.621	0.240	0.198	1.000
FT	329	165.839	553.425	0.000	5367.000
Com	329	36.300	13.330	13.000	58.000
LiqRisk	329	0.862	0.573	0.404	9.682
CRisk	329	26785.260	76070.150	66.714	558530.100
BSize	329	275630.900	719147.300	1787.900	5742860.000
LCap	329	0.111	0.044	0.048	0.490
NPL	329	2489.515	5849.780	26.120	46643.710
GDPgrowth	329	0.042	0.039	-0.0951	0.087
CPI	329	0.029	0.018	-0.011	0.081
IRate	329	0.066	0.025	0.017	0.118
COVID	329	0.285	0.452	0.000	1.000

Note: Beffi is bank efficiency, FT is Fintech, Com is competitiveness, Liqrisk is liquidity risk, Crisk is credit risk, Bsize is bank size, Lcap is level of capitalization, NPL is non-performing loan, CPI is consumer price index, and Irate is interest rate.

As illustrated in Tables 8, 9, and 10, Fintech, competitiveness, credit risk, bank size, and non-performing loans stand out from the rest of the variables, in particular because of their extremely high standard deviations and wide gaps between their lowest and highest values. Data filtering is, therefore, necessary. For both graphical and non-graphical methods of looking for outliers, STATA is utilized. After the outliers are removed, there are only 613 observations overall, and each variable's volatility has less than one standard deviation.

RESULTS: FIXED-EFFECT MODEL

Table 11 represents the FE model results:

TABLE 11. Panel data regression model (Fixed-effect)

Variables	Model 1 (FE)	Model 2 (FE)
logFT	0.014**	0.021***
	(0.006)	(0.006)
logCom	0.054	0.153***
	(0.051)	(0.055)
logLiqRisk	0.057	0.068**
	(0.029)	(0.030)
logCRisk	0.069	0.102
	(0.158)	(0.163)
logBSize	0.199***	0.015
	(0.072)	(0.084)
logLcap	2.00***	1.51***
	(0.455)	(0.494)
logNPL	0.159***	0.096***
	(0.033)	(0.036)
GDPgrowth		0.043***
		(0.014)
IRate		-0.174***
		(0.034)
COVID		-0.033***
		(0.012)
Constant		-0.607
		0.427
Observations	593	593
R-squared	6.700	13.260
F-statistics/wild test	10.770	13.270
P-value	0.000	0.000

Standard errors are expressed in parentheses, while p-values are shown in square brackets.
*** p < 0.01; ** p < 0.05; * p < 0.10

RESULTS AND DISCUSSION

According to Model 1, if the value of the coefficient of each variable is considered zero (0), then bank efficiency will decrease by 0.607 units. Each variable can be expressed based on the results from Table 11 as follows:

Fintech (FT) has a considerable encouraging outcome on bank efficiency. The Model 2 study indicates that a one percent increase in Fintech investment raises bank efficiency by 0.021 units, assuming that every other independent variable in the model remains constant. A one percent rise in Fintech investment results in a 0.014-unit gain in bank efficiency, according to the paper, which also displays a positive and substantial association between Fintech and bank efficiency using bank-level parameters. Hannoon et al. (2021) evaluated the influence of Fintech on bank financial performance using primary survey data, while Yudaruddin (2022) found that Fintech greatly enhanced bank performance when he examined the number of Fintech companies to gauge the industry's impact. In line with the earlier research previously mentioned, this study investigates whether Fintech funding value positively affects bank efficiency.

Country competitiveness (Com) has an important and positive result on bank efficiency. Assuming that all other independent variables in the model remain constant, a one percent rise in the variable designated as "Com" corresponds to a 0.153-unit increase in bank efficiency (Model 2). The report also shows that country competitiveness is positively associated with bank efficiency at the bank-level factors according to Model 1, indicating that a one percent increase in country competitiveness will raise bank efficiency by 0.054 units. H1 and H2 examine how Fintech affects bank efficiency with the mediating effect of country competitiveness, using bank and macro-level factors, providing strong evidence to support the relationships.

In keeping with the earlier research mentioned above, this study explores whether the mediation impact of country competitiveness utilizing Fintech funding value has a favourable influence on bank efficiency. From the regression model's results, it can be inferred that in the Asian banking sector, improved bank efficiency is mediated by country competitiveness and Fintech funding.

Liquidity risk significantly improves bank efficiency. If the remaining independent variables in the model remain constant, a one percent rise in liquidity risk results in a 0.063-unit improvement in bank efficiency. The study's findings are consistent with earlier research (Abdulahi et al. 2023). Using bank-level factors, the paper also shows that liquidity risk has a limited positive impact on bank efficiency. Bank efficiency and bank size have a strong positive correlation; that is, provided all other independent variables in the model remain constant, the bank's efficiency will increase by 0.015 units for every 1% increase in bank size. According to Abdulahi et al. (2023), the results align with the prior studies. The study also shows that bank size has a minor positive effect on bank efficiency at the bank level. A higher level of capitalization results in dramatically increased bank efficiency. In Model 2, there exists a correlation between a 1% rise in capitalization and a 1.51-unit gain in bank efficiency, assuming that all other independent variables remain constant. Additionally, the study demonstrates that, on a bank-by-bank basis, the level of capitalization considerably increases bank efficiency. However, Models 1 and 2 yield conflicting findings regarding the significant positive influence of non-performing loans on bank efficiency at the macro and bank levels.

In Model 2, a 1% increase in GDP growth corresponds to a 0.043-unit boost in bank efficiency, assuming that all other independent variables remain constant. This suggests that there is a strong correlation between bank efficiency and GDP growth. The results of the new study agree with those of previous studies (Saleh & Alaallah 2022). Despite the study's contradictory conclusions, interest rates and bank efficiency have a substantial negative association. Although earlier research (Hill 2021) showed that a banks expansion significantly increased the adoption of digital financial applications, the pandemic had a negative link with bank efficiency.

RESULT: FURTHER INVESTIGATION ON DEVELOPING AND DEVELOPED COUNTRIES

Table 12 presents the results of the Fixed Effects (FE) model:

TABLE 12. Panel data regression model (Fixed-effect)

Variables	Model for Developing Country (FE)	Model for Developed Country (FE)
logFT	0.022**	0.024**
	(0.027)	(0.048)
logCom	0.016**	0.197***
	(0.040)	(0.003)
logLiqRisk	0.062	0.116
	(0.055)	(0.182)
logCRisk	0.263	-0.132
	(0.155)	(0.730)
logBSize	0.133	0.180
	(0.182)	(0.156)
logLcap	1.793	2.038**
	(0.002)	(0.003)
logNPL	0.032	0.136
	(0.550)	(0.113)
GDPgrowth	0.086***	0.012
	(0.001)	(0.473)
IRate	-0.334***	-0.062
	(0.000)	(0.331)
COVID	-0.081***	0.060
	(0.001)	(0.060)

Constant	-1.210*	-1.212
	(0.032)	(0.090)
Observations	3250	268
R-squared	27.830	05.390
F-statistics/wild test	10.570	5.190
P-value	0.000	0.000

Note: Standard errors are expressed in parentheses, while p-values are shown in square brackets.
*** p < 0.01; ** p < 0.05; * p < 0.10
Note: Beffi is bank efficiency, FT is Fintech, Com is competitiveness, Liqrisk is liquidity risk, Crisk is credit risk, Bsize is bank size, Lcap is level of capitalization, NPL is non-performing loan, CPI is consumer price index, and IRate is interest rate.

DISCUSSION

Fintech (FT) has a considerable impact on bank efficiency. The results for the model of a developing country (Model 3) indicate that a one-percent increase in Fintech funding raises bank efficiency by 0.022 units ($p < 0.05$). The impact is shown when every other independent variable in the model remains constant and is relevant to prior studies (Lee et al. 2021; Li et al. 2021; Chen et al. 2021; Banna et al. 2023). Using the model for a developed country (Model 3), a one-percent rise in Fintech funding results in a 0.024-unit gain in bank efficiency ($p < 0.05$), which also displays a positive and substantial association between Fintech and bank efficiency, aligned with prior studies (Banna et al. 2023; Hannoon et al. 2021; Yoon et al. 2023).

Compared to both models, Fintech has a considerable and positive effect on bank efficiency; however, the impact is somewhat greater in developed countries (0.024 units) than in developing countries (0.022 units). The slight discrepancy may be attributed to disparities in country competitiveness and the current technological infrastructure. The statistical significance of the results reported by both models highlights the robustness of the relationship between Fintech funding and bank efficiency across different economic contexts. Both models support the broad view that Fintech improves bank efficiency and are consistent with earlier research. The studies cited for developed countries (Banna et al. 2023; Hannoon et al. 2021; Yoon et al. 2023) and developing countries (Lee et al. 2021; Li et al. 2021; Chen et al. 2021; Banna et al. 2023) demonstrate that even though the contexts differ, the overall impact remains positive.

When country competitiveness is included in the model for developing countries, it indicates that a one-percent increase in Fintech funding raises bank efficiency by 0.024 units and is statistically significant at $p < 0.05$. Hence, the magnitude of the effect of Fintech funding is higher when country competitiveness is included in developing countries and aligns with prior studies (Riaz et al. 2023). Conversely, when country competitiveness is included in the model for developed countries, it indicates that a one-percent increase in Fintech funding raises bank efficiency by 0.197 units ($p < 0.01$), which is relevant to prior studies (Al-Dmour et al. 2021). In the model, the magnitude of the effect of competitiveness is greater on bank efficiency. Overall, it can be concluded that the Fintech funding effect is higher in developed countries compared to developing countries, and the effect is again greater in developed countries when country competitiveness is included compared to developing countries.

A one-percent increase in Fintech funding without considering competitiveness impacts bank efficiency by 0.022 units in developing countries and 0.024 units in developed countries. The effect rises to 0.024 units for developing countries and 0.197 units for developed countries with increased country competitiveness. Both models provide statistically significant findings; however, when country competitiveness is considered, the significance level in developed countries is higher ($p < 0.01$) than in developing countries ($p < 0.05$).

Country competitiveness increases the impact of Fintech funding in developing countries, but only slightly (from 0.022 to 0.024 units). In developed countries, country competitiveness significantly raises the influence (from 0.024 to 0.197 units). The striking difference highlights the differential dynamics between developed and developing countries, with developed countries enjoying greater benefits from competitiveness at the country level. The findings support the notion that country competitiveness enhances the returns on Fintech funding, aligning with the findings of Riaz et al. (2023) for developing countries and Al-Dmour et al. (2021) for developed countries.

If all other independent variables remain constant, a 1% rise in GDP growth in developing nations is associated with a 0.086-unit ($p < 0.001$) improvement in bank efficiency in the model; in developed countries, this relationship is not statistically significant. However, compared to wealthy countries, the effect size is larger in emerging nations. In developing countries, interest rates have a negative and substantial impact on bank efficiency, while in developed nations, this effect is negligible. The COVID-19 pandemic negatively impacted bank efficiency in developing countries, contrasting with its minor beneficial impact on wealthier nations.

In developing countries, bank efficiency is highly dependent on GDP growth, whereas developed countries are generally unaffected. Higher interest rates detrimentally impact bank efficiency in developing countries, while their effect in developed countries is minimal. The epidemic has worsened bank efficiency in developing countries compared to a slight improvement in developed countries. The results are consistent with previous studies (Goswami et al. 2019; Saleh & Alaallah 2022), which showed a positive correlation between GDP growth and bank performance. The results support the idea that economic expansion fosters a more effective banking industry.

CONCLUSION

The finding is that Fintech (FT) enhances bank efficiency significantly ($p<0.01$), and this improvement increases even more ($p<0.01$) when country competitiveness is included as a mediator. The implications are that Asian banks are more motivated to innovate and enhance customer service by using economical solutions due to country competitiveness. The pressure from competition drives the creation of simplified procedures and effective technology, which improve the customer experience and reduce operational costs, further enhancing bank efficiency. Further study indicates that wealthy nations see a greater Fintech effect than developing nations. The effect is considerably greater in developed countries than in developing ones when country competitiveness is taken into account for both types of countries. Future studies may consider different measures for Fintech proxies over longer periods to provide a more comprehensive analysis to the banking industry.

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APPENDIX

Dougherty (2016) states that the Hausman test is used to determine the practical procedure of selecting FE or RE regression, and the Breusch-Pagan LM test is used to determine RE or OLS. Similar to this, the Hausman test has been used to select between fixed effects (FE) and random-effects (RE) regression models, providing a conclusive evaluation of model quality and fitness (Ceesay & Moussa, 2021). The first step in choosing the right regression model for panel data is determining whether or not the observations are drawn from a random sample. If so, a fixed-effects model should be used; if not, both the fixed-effect and the random effect should be investigated. The appropriate model is then selected using the Lagrange multiplier approach (LM), which allows one to select between the random-effects model and the pooled OLS model. The Durbin–Wu–Hausman (DWH) test, often known as the Hausman test, is used to evaluate the fixed-effect and random-effect models (Hoang & Thanh, 2023). In addition, a test for the existence of random effects is carried out. The random-effects model is chosen if random effects are detected; if not, the pooled OLS model is employed in as in Figure 3.

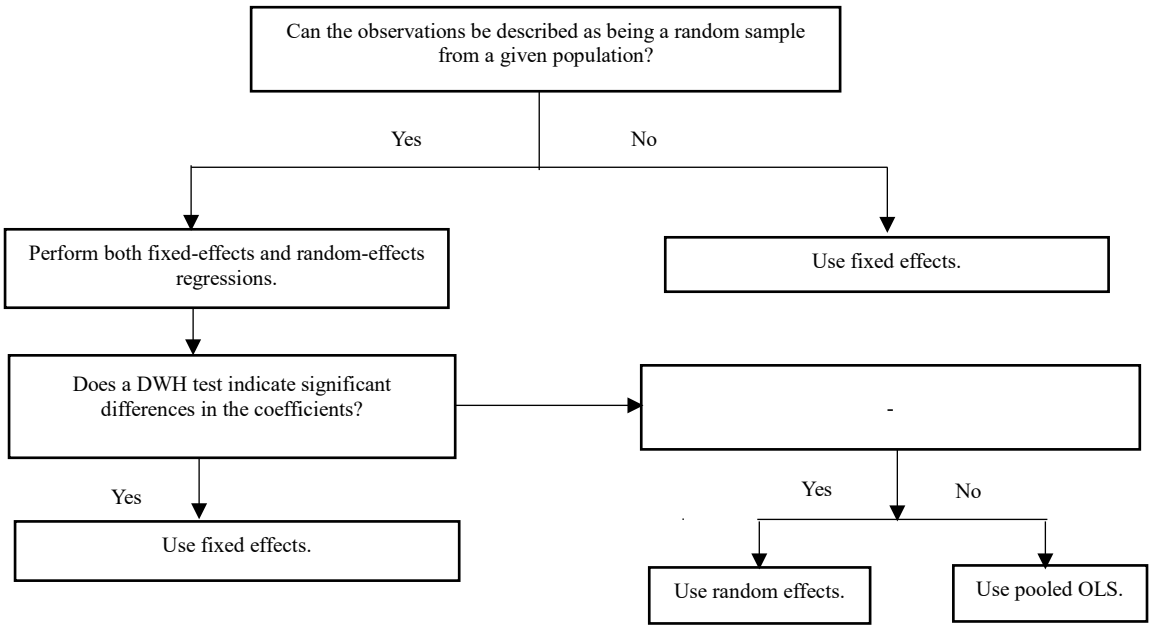

FIGURE 3. Regression model selection procedure for panel data adapted from (Dougherty 2016).