Bank Capital and Operational Efficiency: A Cross-country Analysis of Asian Banking Sectors[1]

Prem Bahadur Budhathoki, Padam Bahadur Lama, & Chhemanand Joshi

Abstract

This study examines how the bank capital affects efficiency in Asian banking sector. This study used quantitative approach and explanatory research design. This study used both developed and developing 21 Asian countries as a sample covering the period from 2004 to 2021. These sample data were extracted from World Bank, 2023. This study employed ordinary least squares (OLS), fixed-effect, and random-effect estimators, and the findings revealed that bank capital increases efficiency and outcomes are robust in all three regression models. This finding also supports the efficient-structure hypothesis and stated that higher capital offers the opportunity to invest in cost-reducing modern technologies and processes that reduce cost and increase efficiency. Similarly, bank stability and private credit to GDP increase bank efficiency and this effect is consistent in all three models. In contrast, bank diversification and remittance inflows decrease bank efficiency in Asian countries. Policymakers can utilize these findings to implement stricter capital adequacy ratios, ensuring that banks maintain adequate capital to absorb losses and promote efficiency. In addition, policymaker should monitor recent diversification trends and penalize practices that compromise core banking efficiency.

Prem Bahadur Budhathoki, Associate Professor, Saraswati Multiple Campus, Tribhuvan University, Nepal, Padam Bahadur Lama (Corresponding Author), Assistant Professor, Saraswati Multiple Campus, Tribhuvan University, Nepal, & Chhemanand Joshi, Associate Professor, Ghodaghodi Multiple Campus, Kailali, Nepal. Corresponding Email: padam.lama@smc.tu.edu.np

Introduction

The nexus between bank capital and operational efficiency has been disputed in theoretical and empirical literature. On the one hand, adequate capital protects depositors and borrowers from potential losses. It grants the opportunity to earn high marginal expected returns during tight economic periods by avoiding excessive short-term borrowing with high interest rates (Pringle, 1974). A strong capital base enhances public confidence by increasing the ability to absorb losses and offer grounds for management to take corrective action to protect banks from bankruptcy. Similarly, the interests of depositors, shareholders, and management could be aligned by holding excess capital because shareholders strictly monitor the risk exposure made by management, which reduces agency problems and agency costs and improves efficiency. The higher equity base reduces the perceived risk of depositors, lenders, and other capital providers, which lowers the cost of funds, improves overall competitiveness, and improves efficiency. Regulatory authorities impose minimum capital requirements based on credit, market, and operational risk, thereby mitigating risk and enhancing overall efficiency. Harmonization of regulatory rules for banks is essential both domestically and internationally. Banks maintaining lower regulatory capital gain competitive advantages, as the cost of equity is higher than that of deposits and borrowings, primarily due to tax benefits.

Furthermore, a strong equity base of banks provides an opportunity to expand their menu of services and diversification, such as the expansion of branches with negligible regulatory restrictions, which can improve bank efficiency through the benefits of economies of scale (Rose & Marquis, 2008). On the other hand, higher excess capital motivates managers to invest in risky projects, which creates hurdles for banks to expand their businesses. The regulatory authority also imposes fines and penalties for inadequate minimum capital ratio. In addition, market forces can impose higher funding costs for riskier banks due to inadequate capital, which increases the bank's cost of funds and weakens competitive capability, leading to bank inefficiency (Rose & Marquis, 2008). This excess cost can be offset against excess returns earned from the traditional loan market during the crisis period (Obadire et al., 2022).

On the one side, capital buffers protect banks from economic uncertainty and maintain stability. This helps to absorb unexpected default losses and prevent banks from insolvency. In addition, adequate capital allows banks to continue lending (Cardarelli et

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al., 2009; Nasim et al., 2024) and helps to maintain stable earnings without substantially increasing funding costs. It also reassures concerned stakeholders and preserves trust in the banking system. Conversely, capital buffers motivate banks to take more risks by investing in risky ventures and can boost efficiency during macroeconomic condition upturns.

Empirical evidence regarding bank capital's impact on profitability was found substantially using a sample from developed and developing nations. However, to the best of our knowledge, evidence of the influence of capital on efficiency is not found in the context of both developed and developing nations. Hence, this study tries to fill this void by offering the nexus between bank capital and cost efficiency based on the cross-country analysis.

The remaining sections of the study arearrangedas follows. The second section presents theoretical and empirical studies. Section three presents methods. The section three and four are for results and discussion. Section five ended with a conclusion.

Literature Review

Theoretical review

This efficient structure hypothesis (ESH) and risk absorption hypothesis (RAH) could explain the nexus between bank capital and efficiency. ESH states that banks with superior management, modern technology, and cost-efficiency gain market shares and profitability, leading to higher market concentration. Demsetz (1973) argued that higher capital enables banks to invest in cost-reducing technologies and processes, thus enhancing efficiency. More capital provides resources for innovation and the benefit of economies of scale, improving operational efficiency and lowering average cost. Hence, banks with better technology or lower costs capture more market shares. Similarly, RAH states that higher capital allows banks to absorb shocks and maintain efficiency during economic downturns. In addition, more capital prevents banks from liquidity crises and operation disruptions by the risk of sudden withdrawals (Diamond &Dybvig, 1983). Hughes and Mester (1998) posited that increased bank capital acts as a buffer against insolvency and enhances public confidence by signaling reduced risk to depositors, thereby safeguarding banks from liquidity crises.

Additionally, increased capital levels result in larger banks, which benefit from diversification and lower risk management costs. According to Berger and Bouwman

(2013), a capital increase consistently enhances banks' survival probability. Furthermore, capital allows small banks to increase market share and improve overall profitability.

Empirical studies

Several previous studies examined the nexus between bank capital and profitability in the context of both developed and developing nations. However, this study examined the nexus between capital and efficiency using a sample of 21 Asian countries. Hence, this section explored the empirical evidence on the relation between (i) bank capital and efficiency, (ii) diversification and efficiency, (iii) remittance and efficiency, (iv) bank stability and efficiency, and (v) banking sector development and efficiency.

Bank capital and efficiency

The empirical evidence concerning the nexus between capital and efficiency remains inconclusive. The efficiency indicators also vary, including cost efficiency, profit efficiency, and investment efficiency. The outcomes may have varied due to the methodology employed in the study. The following are key studies, along with their significant findings.

Gardener et al. (2011) explored the factors of bank efficiency using the sample South East Asian banks covering the periods from 1998 to 2004. Using the Tobit estimator, the outcome showed that bank capital enhances efficiency by decreasing NPL and increasing bank stability. Findings are supported by the arguments that a higher level of capital increases banks' ability to absorb more losses, which also decreases bankruptcy costs. Grigorian and Manole (2006) explored the determinants that impact banks' efficiency using a sample of transition economies from 1995 to 1998. Using Tobit regression, the finding revealed that a higher capital ratio, which was measured by equity and capital adequacy ratio, improved bank efficiency. This finding supports the argument that well-capitalized banks could attract more deposits at lower interest rates. In addition, higher capital levels protect banks from bankruptcy and save on bankruptcy costs. Similarly, the bank manager nearer to bankruptcy likely pursues the fulfillment of personal goals, which also increases bank costs and reduces efficiency.

Bitar et al. (2018) examined the influence of capital ratio on efficiency using a large sample of OECD banks from 1999 to 2013. Using OLS, the finding revealed that the capital ratio negatively and significantly impacts the cost-to-income ratio. In other words, a higher capital ratio enhances banks' efficiency. This finding is supported by the

arguments that a higher capital ratio protects managers, shareholders, and depositors, reducing agency problems, decreasing agency costs, and improving banks' efficiency. Hendrawan et al. (2023) investigated the influence of a capital buffer on profitability using a sample of Indonesian banks covering the period from 2010 to 2020. Employing the system GMM, they found that bank capital enhances bank stability by reducing potential losses; however, it reduces profit efficiency, which ROA and ROE measured. They argued that a higher capital ratio increases funding costs, loan loss reserves, and monitoring costs, which increases banks' inefficiency. Sahul Hamid (2017) investigated the influence of concentration on a bank's efficiency by taking a sample of five Asian countries from 2001 to 2013. Using the GMM estimator, the finding revealed that capital favorably affects bank efficiency, which ROAA and ROAE measured. This study also found that efficient banks could reduce the cost-to-income ratio. Furthermore, this study found that the cost-to-income ratio is directly related to the NPL ratio. This indicates that inefficient banks invest in ventures and boost banks' losses.

Ogunmola et al. (2022) investigated the influence of Basel III capital requirements on efficiency using a sample of US banks from 2011 to 2019. This study used two-step bootstrapped truncated regression, and the findings showed that Tier 1 and Tier 2 capital ratios adversely affected US operating efficiency. This indicates that high capital ratio increases funding costs and increase inefficiency (Karapappas, 2023). Osei-Assibey and Asenso (2015) examined the impact of regulatory capital on bank efficiency using a sample of banks in Ghana covering the period from 2002 to 2012. Using the GMM estimator, the finding revealed that the minimum capital ratio improved bank credit and improved operating efficiency. In contrast, excess capital leads managers to participate in risky business activities and thus increase NPL ratios. In a nutshell, the concurrent literature poses inconclusive evidence on the nexus between bank capital and efficiency. Hence, this study poses a clear picture by offering clear insight into this issue and proposes the following this first research hypothesis.

H_1: *The bank capital positively and significantly affects the bank efficiency in Asian countries.*

Diversification and efficiency

The empirical evidence pertaining to the nexus between diversification and efficiency remains inconclusive. The indicators of diversification also vary, including revenue, funding, and geographical diversification. The outcomes may have varied due to

the methodology employed in the study. The following are key studies, along with their significant findings.

Nguyen (2018) investigated how diversification influences efficiency using a sample of six ASEAN nations covering 2007 to 2014. This study used fixed-effect estimators, and the outcome revealed that income diversification adversely affects bank efficiency in ASEAN nations. This indicates that moving from mainstream lending businesses to fee-based revenue streams(Budhathoki et al., 2024a) could increase banks' overhead costs In contrast, Doan et al. (2018) explored the determinants of bank efficiency using a sample of 83 nations covering the period from 2003 to 2012. Using the Tobit estimator, the findings revealed that income diversification improves cost efficiency; however, this boosts the volatility of non-interest income. Harimaya and Ozaki (2021) examined how diversification influences bank efficiency using a sample of 272 Shinkin banks in Japan from 2009 to 2017. Using OLS and one-step GMM estimators, the finding revealed that loan diversification enhances efficiency in Shinkin banks. They found that more concentration on mortgage lending poses more default losses.

Similarly, income diversification positively affects efficiency in Shinkin banks. This indicates that moving toward fees and commission-based activities improved banks' efficiency. High competition in the loan market with lower lending rates decreases interest income and increases loan default. Wu et al. (2020) investigated how diversification influences bank efficiency and risk using a relatively large sample of 1000 banks from emerging economies from 2000 to 2016. Using the GMM system, the finding revealed that income diversification improves bank stability. This indicates that fees and commission-based bank activities could increase overhead costs, thus increasing inefficiency. Setiadi and Danarsari (2024) investigated the influence of income diversification on efficiency, measured by profitability and stability, using a sample of 86 banks from 2013 to 2020. Using GMM, the finding revealed that income diversification positively impacts efficiency.

Furthermore, this study showed that income diversification improves bank stability in Indonesia. Nisar et al. (2018) analyzed the influence of diversification on efficiency and stability using a sample of SAARC nations covering the period from 2000 to 2014. Using OLS, fixed-effect, and system GMM estimators, findings revealed that income diversification positively impacts both efficiency (profitability) and stability.

However, while breaking down non-interest income into fees and commission income, other income, fees, and commission income negatively impact banks' efficiency, other non-interest income positively impacts banks' efficiency in South Asian nations. Using the GMM estimator, Sahul Hamid (2017) found that diversification does not increase bank efficiency.

The concurrent literature provides inconclusive evidence of the nexus between diversification and efficiency. Hence, this study offers clear insight into this issue and proposes this second research hypothesis.

H_2: *Bank diversification positively and significantly affects efficiency in banks of Asian countries.*

Remittance and efficiency

The empirical evidence in relation to the link betweeninward remittance and efficiency remains inconclusive. The outcomes may have varied due to the methodology employed in the study. The following are key studies, along with their significant findings.

Cooray (2012) investigated how migrant remittance affects efficiency using a sample of 94 non-OECD nations. Using OLS and GMM estimators, the findings revealed that remittance increases bank size, fosters banking sector development, increases liquidity, decreases overhead costs, and decreases NIM. These findings supported the arguments that remittance inflow boosts banks' deposits at lower interest rates, which increases size and liquidity. However, remittance inflow could reduce loan demand, decreasing lending rates and NIM. Bettin and Zazzaro (2012) examined the nexus between remittances and economic growth by employing financial development as a moderating role using a sample of 66 developing nations from 1970 to 2005. Using the GMM system, findings revealed that remittances positively affect the economic growth in developing nations. However, banking inefficiency would moderate this effect and negatively affect economic growth. This finding indicates that in an immature banking system, entrepreneurs who do not have easy access to credit should borrow at higher interest rates. In contrast, a well-developed banking system attracts remittance in formal channels and reduces the size, risk, maturity, and information mediation problem.

In summary, the concurrent literature provides inconclusive evidence on the nexus between remittance and efficiency. Hence, this study offers clear insight into this issue and proposes thisthird research hypothesis.

H_3: *Remittance capital positively and significantly affects bank efficiency in Asian countries.*

Bank stability and efficiency

The empirical evidence regarding the relationship between stability and efficiency remains inconclusive. The outcomes may have varied due to the methodology employed in the study. The following are key studies, along with their significant findings.

Le (2020) investigated the bidirectional nexus between efficiency (profit) and stability using a sample of Vietnamese banks from 2006 to 2017. This study employed the simultaneous equations model, and the findings showed that bank stability favorably affects bank efficiency. Furthermore, this study found that efficiency improves loan growth in Vietnamese banks. This finding is supported by the arguments that efficient banks can attract more deposits and grant more credits. In addition, efficiency can absorb economic shocks by making a strong capital base. Nguyen and Le (2022) examined the nexus between profitability, efficiency, and credit growth using five Southeast Asian 79 banks from 2006 to 2019. Using SEM and GMM, findings showed that bank stability positively affects bank efficiency, and bank efficiency also favorably impacts bank stability. Similarly, credit growth adversely affects bank efficiency. This indicates that credit growth weakens bank stability by increasing credit risk (loan default). In contrast, Budhathoki et al. (2024b) found that efficiency adversely affects the bank stability. Al-Khouri and Arouri (2016) examined the bidirectional relationship between loan growth, stability, and profitability using a sample of 59 GCG banks from 2004 to 2012. Using 2SGMM, bank stability increases profitability via rapid credit expansion due to high capital and liquidity.

In summary, the concurrent literature provides inconclusive evidence of the nexus between stability and efficiency. Hence, this study offers clear insight into this issue and proposes this fourth research hypothesis.

H_4: *Bank stability positively and significantly affects bank efficiency in Asian countries.*

Banking sector development and efficiency

The empirical evidence regarding the relationship between banking sector development and efficiency remains inconclusive. The outcomes may have varied due to the methodology employed in the study. The following are key studies, along with their significant findings.

Tan and Floros (2012) explored the factors of profitability (efficiency) using a sample of 101 Chinese banks from 2003 to 2009. Using the GMM system, findings revealed that banking sector development (BSD) positively affects profit efficiency, which ROA and NIM measure. This indicates that the demand for a menu of services increases in the developed banking sector, leading to more competition that needs to adopt cost-efficient strategies to maintain sufficient profitability. Al-Harbi (2019) explored the factors that affect profitability using a sample of 52 OIC nations from 1989 to 2008. Using a fixed-effect estimator, the findings revealed that the banking sector positively affects the capital adequacy ratio due to heavy regulation. However, BSD negatively affects diversification. It indicates that BSD lowers the risk. Less involved in non-traditional banking] [regulator may restrict participation in non-traditional business].

In summary, the concurrent literature presents inconclusive evidence on the nexus between banking sector development and efficiency. Hence, this study offers clear insight into this issue and proposes this following final research hypothesis.

H_5: *The banking sector development negatively and significantly affects the bank efficiency in Asian countries.*

Figure 1 presents the theoretical framework from reviewed theories and empirical evidence.

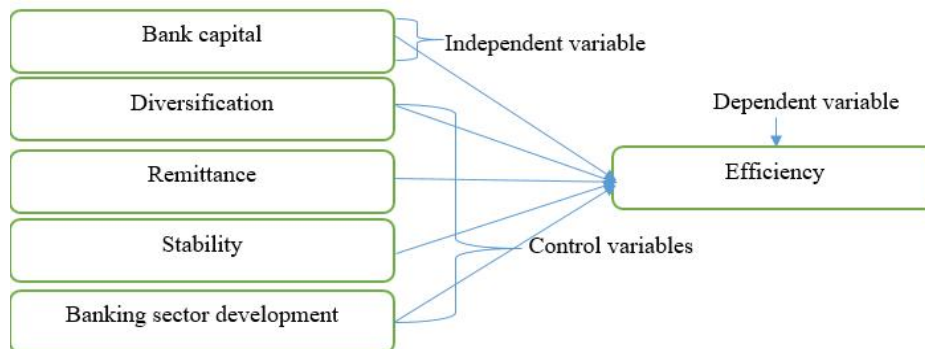Figure1:*Conceptual framework*

Source:*developed by authors based on the variables sourced from Harimaya and Ozaki (2021), Bitar et al. (2018), Setiadi and Danarsari (2024), Cooray (2012), and Al-Khouri and Arouri (2016).*

Methods

This research employed a quantitative approach and an explanatory design to investigate the impact of bank capital on efficiency. This research design primarily

examined the causal relationship between capital and efficiency. Nonetheless, this research also examined the influence of diversification, remittance, stability, and banking sector development (BSD) on efficiency in selected 21 Asian countries. These countries include Afghanistan, Bangladesh, China, Hong Kong, Indonesia, India, Japan, Cambodia, Korea, Rep., Lao PDR, Macao SAR, Myanmar, Mongolia, Malaysia, Nepal, New Zealand, Pakistan, Philippines, Singapore, Thailand, and Vietnam. This study included banks in developing and developed Asian countries from 2004-2021. The using a sample of both developed and developing countries improve the generalizability of the study's findings. The inclusion of countries with diverse levels of economic growth, political systems, social contexts, and institutional frameworks increases the likelihood that the findings will be widely applicable rather than limited to a particular set of economies. The secondary data for this study are drawn from World Bank (2023). The selected study variables, their symbol, measurements, and use of variables in previous studies are presented in Table 1. The dependent variable is a cost-to-income ratio, which is measured by bank operating costs divided by total income. The independent variable is a capital ratio, which is measured as capital divided by total assets. The first control variable is diversification, measured by non-interest income divided by total income. The second variable is remittance, which is measured as remittance inflow divided by GDP. The third control variable is stability, which the Z-score measures. The final control variable is banking sector development, which is measured as private credit is divided by GDP.

Table 1

Variable description

Variables	Symbol	Measurements	Past studies
Efficiency	CTIR	Cost divided by total income	Bitar et al. (2018) Harimaya and Ozaki (2021)
Bank capital	BCTTA	Capital divided by total assets	Bitar et al. (2018), Ose-Assibey and Asenso (2015)
Diversification	NIITI	Non-interest income divided by total income	Sahul Hamid (2017), Setiadi and Danarsari (2024), Nisar et al. (2018)
Remittance	RTGDP	Remittances divided by GDP	Cooray (2012) Bettin and Zazzaro (2012)
Stability	Z-score	(ROA + Equity/Total assets)/$_{ROA}$	Nisar et al. (2018), Le (2020), Nguyen and Le

			(2022), Al-Khouri and Arouri (2016)
Banking sector development	PCTGDP	Private credit divided by GDP	Gardener et al. (2011), Al-Khouri and Arouri (2016)

Model specification

This study employed POLS, fixed-effect (FE), and random-effect (RE) estimators to investigate the impact of bank capital on efficiency in Asian banking industries. The baseline POLS model for this study is as follows.

$$\ln CTIR_{it} = \beta_{0} + \beta_{1}\ln BCTTAit + \beta_{1}\ln NIITI_{it} + \beta_{2}\ln RTGDP_{it} + \beta_{3}\ln Z\text{-score}_{it} + \beta_{4}\ln PCTGDP_{it} + \epsilon_{it} \ldots..(1)$$

The FE model posits that each individual country possesses a unique intercept while maintaining time-invariant properties of the entities (Gujarati & Porter, 2015). The underlying FE model for this investigation is as follows.

$$\ln CTIT_{it} = a_{1i} + \beta_{1}\ln BCTTAit + \beta_{1}\ln NIITI_{it} + \beta_{2}\ln RTGDP_{it} + \beta_{3}\ln Z\text{-score}_{it} + \beta_{4}\ln PCTGDP_{it} + \epsilon_{it} \ldots\ldots (2).$$

The RE model posits that country-specific effects are stochastic and uncorrelated with the predictor variables (Gujarati & Porter, 2015). The foundational RE model for this investigation is as follows.

$$\ln CTIR_{it} = a + \beta_{1}\ln BCTTAit + \beta_{1}\ln NIITI_{it} + \beta_{2}\ln RTGDP_{it} + \beta_{3}\ln Z\text{-score}_{it} + \beta_{4}\ln PCTGDP_{it} + u_{i} + \epsilon_{it}$$

where, CTIT denote efficiency measure. BCTTA represents bank capital. NIITI, RTGDP, Z-score, and PCTGDP represent control variables. β_{0} denotes the constant term. u_{it} represents error term. β_{1} denotes coefficient of the predictor variable. $\beta_{1}, \beta_{2}, \beta_{3},$ and β_{4} represent the coefficients of the control variables. μ_{i} capture individual specific effect. ϵ_{it} represents the error term. Finally, i and t denote country and time, respectively. a denotes global intercept term. u_{i} is the random individual effect. a_{i} denotes the individual-specific effect.

Results

Table 2 provides descriptive statistics for variables used in the regression analysis of the impact of bank capital on bank efficiency in Asian nations. The finding from the CTIR revealed that a high standard deviation (SD) relative to the average suggests significant variability in bank efficiency across the sample. The minimum and maximum values indicate that some banks operate far more efficiently (low CTIR) than others, with inefficiencies peaking at 86.744. Similarly, findings from bank capital revealed that

banks hold widely varying capital levels, as indicated by the large SD. The minimum value (2.776) suggests that some banks operate with very low capital buffers while others maintain high capital (44.783). Results of NIITI showed that the reliance on fee-based income has a substantial difference in Asian economies. The minimum (10.709) implies that some banks give less priority to non-traditional fee-based services, while the maximum (71.475) implies that some banks heavily prioritize non-traditional businesses. Findings from remittance income reveal that some countries receive negligible and others rely heavily on remittances (max = 27.626). Similarly, the bank stability measure, Z-score, signals severe instability in some banks, while the high value denotes robust stability. The SD indicates moderate variability, reinforcing the nexus between stability (higher Z-score) and improved efficiency. Finally, the finding of PCTGDP revealed that it varies enormously across countries, from minimal (3.173) to incredibly high (280.339). Higher SD signals vast differences in the maturity of the financial system in the selected sample of Asian countries.

Table 2

Summary statistics

Variables	Mean	SD	Min	Max
CTIR	49.432	10.955	21.917	86.744
BCTTA	19.163	9.675	2.776	44.783
NIITI	31.164	10.607	10.709	71.475
RTGDP	3.411	4.989	0.000	27.626
Z-score	16.482	9.070	-17.749	62.309
PCTGDP	82.277	55.465	3.173	280.339

Note: CTIR denotes the cost-to-income ratio. BCTTA represents the bank capital to total assets ratio. NIITI denotes noninterest income to total income. RTGDP denotes the remittance to GDP ratio. The Z-score represents the bank stability indicator. Finally, PCTGDP denotes the ratio of private sector credit to GDP.

The outcome of the correlation analysis is presented in Table 3. Findings revealed that the bank capital negatively relates to the cost-to-income ratio. It indicates that as bank capital increases, bank efficiency also increases. In contrast, the bank diversification measure, NIITI, positively correlates with the cost-to-income ratio. This indicates that banks' diversification from traditional loan businesses to fee-based businesses decreases their efficiency. Similarly, remittance income is positively but insignificantly correlated with the cost-to-income ratio.

In contrast, the bank stability measure, Z-score, negatively correlates with the cost-to-income ratio. It indicates that a higher level of bank stability increases the bank's efficiency. Finally, PCTGDP has negatively correlated with the cost-to-income ratio. This indicates that the banking sector's development positively affects banking efficiency in Asian countries. Furthermore, the correlation between all the predictor variables is below 0.8. This indicates that no multicollinearity issues were found. Similarly, all the VIF of predictor variables are below 5, which showed no multicollinearity issues for further analysis.

Table 3

Correlation matrix

Variables	CTIR	BCTTA	NIITI	RTGDP	Z-score	PCTGDP
CTIR	1					
BCTTA	-.326***	1				
	(.000)					
NIITI	.205***	-.090	1			
	(.000)	(.113)				
RTGDP	.044	.115**	-.109*	1		
	(.449)	(.049)	(.062)			
Z-score	-.473***	.013	.054	.214***	1	
	(.000)	(.820)	(.349)	(.000)		
PCTGDP	-.341***	.175***	.082	-352***	-.134**	1
	(.000)	(.002)	(.158)	(.000)	(.021)	
VIF		1.100	1.040	1.190	1.030	1.160

Note: CTIR denotes the cost-to-income ratio. BCTTA represents the bank capital to total assets ratio. NIITI denotes noninterest income to total income. RTGDP denotes the remittance to GDP ratio. The Z-score represents the bank stability indicator. Finally, PCTGDP denotes the ratio of private sector credit to GDP. ***, **, and * denote coefficients are significant at the 1%, 5%, and 10%, respectively.

The outcome of regression analysis has been presented in Table 4. Results of F-statistics indicate that all three regression models' predictors collectively contribute to explaining the variability in bank efficiency. In other words, the value of F-statistics suggests that the model does explain the variability well. The outcomes of the Breuch-Pagan, Chow, and Hausman tests showed that the fixed-effect model is far better than the OLS and random-effect models. However, the results of OLS and random-effect models are presented here to check the robustness check. The value of R-square (.407) indicates that the bank capital and other control variables jointly explain a 40.7 percent variation in

the bank efficiency. The regression coefficient of BCTTA showed a negative impact on CTIR. This indicated that holding higher capital increases bank efficiency in Asian countries. Conversely, the bank diversification measure, NIITI, increases the cost-to-income ratio. It indicates that moving from a traditional loan business to a modern fees-based business decreases bank efficiency in Asian countries. Similarly, remittance income increases banks' cost-to-income ratio. This indicates that a higher level of remittance received by banks decreases banks' efficiency.

In contrast, a measure of bank stability, the Z-score, is negatively associated with the cost-to-income ratio. This indicates that higher banking stability increases banking efficiency in Asian countries. Similarly, as a measure of banking sector development, PCTGDP decreases banks' cost-to-income ratio. This indicates that banking sector development enhances bank efficiency in Asian nations.

Regression analysis

Table 4

Regression results

| | Dependent variable: CTIR | | |
	OLS	FE	RE
BCTTA	-.090***	-.092***	-.089***
	(.000)	(.000)	(.000)
NIITI	.157***	.161***	.157***
	(.000)	(.000)	(.000)
RTGDP	.004***	.004*	.004***
	(.000)*	(.073)	(.000)
Z-score	-.129***	-.134***	-.123**
	(.000)	(.000)	(.050)
PCTGDP	-.001***	-.001***	-.001***
	(.000)	(.000)	(.000)
Constant	4.020***	4.028***	4.021***
	(.000)	(.000)	(.000)
F-statistics	37.17***	37.840***	20.749***
	(.000)	(.000)	(.000)
R-square	.396	.407	.407
Breuch-Pagan test	280.824***		
	(.000)		
Chow test		192.865***	

	(.000)
Hausman	13.362**
	(.020)

Note: CTIR denotes the cost-to-income ratio. BCTTA represents the bank capital to total assets ratio. NIITI denotes noninterest income to total income. RTGDP denotes the remittance to GDP ratio. The Z-score represents the bank stability indicator. Finally, PCTGDP denotes the ratio of private sector credit to GDP. OLS denotes the ordinary least square regression model. FE denotes fixed-effect regression, and RE denotes the random-effect regression model. ***, **, and * denote coefficients are significant at the 1%, 5%, and 10%, respectively.

Discussion

Findings revealed that bank capital (BCTTA) favorably affects bank efficiency in Asian nations. This finding is similar to the findings of Grigorian and Manole (2006), Gardener et al. (2011), and Bitar et al. (2018). This outcome contrasts with the findings of Ogunmola et al. (2022) and Hendrawan et al. (2023). This finding supported the efficient-structure hypothesis and stated that higher capital offers the opportunity to invest in cost-reducing modern technologies and processes that reduce cost, thus enhancing efficiency. The finding parallels the insights from more capital, which prevents banks from operation disruptions, absorbs default losses, protects them from liquidity crises, offers diversification opportunities, reduces agency costs, and enhances public confidence, which enhances efficiency. Similarly, finding showed that diversification (NIITI) adversely influences efficiency in Asian nations. This outcome is in agreement with the research of Nguyen (2018) and Setiadi and Danarsari (2024). Doan et al. (2018), Wu et al. (2020), and Harimaya and Ozaki (2021). However, this finding diverges from the conclusions of Doan et al. (2018), Wu et al. (2020), and Harimaya and Ozaki (2021). A plausible interpretation of this finding is that more traditional loan businesses pose more default losses, and moving toward fees and commission-based activities can improve banks' efficiency. In addition, high competition in the loan market with lower interest rates decreases interest income and increases default losses, which could be compensated by fees and the commission-based menu of services.

Similarly, remittance (RTGDP) adversely affects the bank efficiency in Asian banking industries. This contrasts markedly with the conclusions drawn by Cooray (2012) and Bettin and Zazzaro (2012). This outcome likely reflects the fact that remittance inflow can reduce loan demand, which decreases loan rates and NIM and increases inefficiency. In contrast, stability (Z-score) favorably affects bank efficiency in

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Asian nations. This conclusion is consistent with the results documented by Al-Khouri and Arouri (2016), Le (2020), and Nguyen and Le (2022). This outcome likely reflects the ability of efficient banks to attract more deposits, grant more credit, and absorb economic shocks by building a strong capital base and holding more liquidity. Similarly, banking sector development (PCTGDP) favorably affects the efficiency of Asian banks. This outcome is in agreement with the research of Tan and Floros (2012). However, the result conflicts with the outcomes reported by Al-Harbi (2019). This result is based on the growing demand for a menu of services in the developed banking industry. This fuels greater competition, requiring the adoption of cost-effective policies to preserve profitability.

Conclusion

The primary focus of this study is to examine bank capital's impact on efficiency by taking the sample data from selected Asian nations. This study used a fixed-effect model. However, OLS and random-effect models are employed for robustness checks. The findings of R-squares from fixed-effect demonstrate that approximately 40.7 percent of the variation in bank efficiency is jointly explained by bank capital and control variables. Findings reveal that higher bank capital enhances efficiency, as evidenced by its negative nexus with the cost-to-income ratio. Conversely, diversification into non-traditional fee-based activities and remittance income reduce efficiency. This suggests that shifting from traditional lending toward modern fee-based services or remittance-driven revenue streams may introduce operational complexities that reduce efficiency. Notably, banking stability and banking sector development reveal a significant inverse nexus with cost-to-income ratio, implying that bank stability and the developed banking sector are pivotal drivers of efficiency. Strong capital base, banking sector development, and stability have played a pivotal role in enhancing efficiency in Asian economies. However, non-traditional bank businesses and remittance inflows deteriorate banking efficiency in Asian economies. Hence, policymaker and bank managers must improve capital base and reduce reliance on fee-based income to improve operational efficiency, fostering a stable and efficient banking environment in Asian nations.

This study relies on a fixed-effect estimator that limits the analysis of time-invariant factors that may affect bank efficiency. In addition, the low R-square value indicates that this study excluded important factors such as macroeconomic conditions, technological adoption, governance quality, and others that could play significant roles.

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Furthermore, this study explored one-way causation from bank capital to efficiency and does not establish the impact of bank efficiency on bank capital. Finally, this study is limited to Asian banking industries, which limits generalizability to regions with differing financial systems, such as Europe, the USA, and Africa.

Due to these study's limitations, future studies could be done by incorporating macroeconomic indicators, regulatory variables, and technological factors to improve explanatory power. In addition, the second-generation estimators, such as instrumental variable (IV) or difference-in-difference (DiD), could address endogeneity issues and increase explanatory power. Similarly, further study can be replicated by taking non-Asian nations as a sample and can use a non-linear estimator to examine the threshold effect of predictor variables on the response variables. Finally, further study could use mixed methods (for example, interviews with bank managers) to uncover why diversification and remittance reduced efficiency in Asian banking industries.

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