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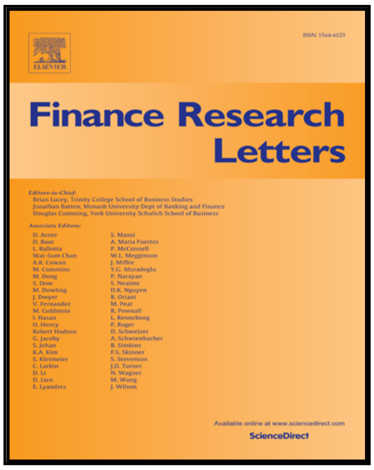

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PII: S1544-6123(25)00941-9
DOI: https://doi.org/10.1016/j.frl.2025.107682
Reference: FRL 107682

To appear in: *Finance Research Letters*

Received date: 26 March 2025
Revised date: 7 May 2025
Accepted date: 31 May 2025

Please cite this article as: Jing Chen , Fakarudin Kamarudin , Bany Ariffin Amin Noordin , Lau Wei Theng , Tim Zhou , Impact of Shadow Banking on Chinese Banks' Efficiency: The Moderating Effect of Ownership, *Finance Research Letters* (2025), doi: https://doi.org/10.1016/j.frl.2025.107682

Impact of Shadow Banking on Chinese Banks' Efficiency: The Moderating Effect of Ownership

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Abstract

This study examines the effect of shadow banking on the efficiency of Chinese banks and how ownership status moderates the relationship. It measures the technical efficiency score of a sample consisting of 160 Chinese commercial banks from 2011 to 2022 using data envelopment analysis via an intermediary approach. Using the ordinary least squares, feasible generalized least squares, and panel-corrected standard error estimation methods, the findings demonstrate that shadow banking significantly and positively affects bank efficiency for all banks in the sample. Furthermore, while foreign ownership strengthens this relationship, the inverse is true for joint-stock and city commercial banks. However, state-owned banks and rural commercial banks show insignificant moderating effects.

Keywords: Shadow banking, Technical efficiency, Bank ownership, Moderating effect

JEL Classification: G21, G23, G28, G32

1. Introduction

Banks provide the institutional infrastructure for financial intermediation and payment systems; therefore, banks' performance is vital for national economies (Antunes et al., 2024). In this regard, Tecles and Tabak (2010) observed that efficiency measures are among the best tools for quantifying and improving bank performance. Specifically, technical efficiency (TE) is an indicator of improvements in banking systems' efficiency and productivity, enabling the determination of the most efficient products and optimal quantities of bank inputs (Amornkitvikai & Charoenrat, 2024; Proaño-Rivera & Feria-Dominguez, 2024). Therefore, accurately measuring TE is vital for ensuring banks' sustainable growth.

Shadow banking has become a standard financial tool for commercial banks seeking arbitrage while avoiding traditional banking supervision (Wu & Shen, 2019). The Financial Stability Board (FSB) conceptualizes shadow banking as a form of credit intermediation facilitated by entities and activities operating beyond the perimeter of the formal banking system, alternatively termed non-bank credit intermediation (Oung, 2013). The 4 trillion CNY stimulus package in 2009 was the driving force of shadow banking's rapid growth after 2012, accelerating the development of China's corporate bond market (Ma & Hu, 2024). However, from 2017 onward[1], the Chinese government strengthened its supervision of shadow banking; therefore, its scale shrank slightly. Unlike the market-oriented shadow banking systems in the United States and Europe, shadow banking in China primarily relies on the basic function of banks as credit intermediaries (Allen & Gu, 2021). In China, most shadow banking activities originate from commercial banks, such as issuing wealth management products, trust loans and entrusted lending (Kang et al. 2024; Zhu et al. 2019). Notably, during its growth phase prior to 2017, low deposit rates and high reserve requirement ratios contributed to the expansion of shadow banking, as commercial banks engaged in such activities to enhance profitability (Acharya et al., 2019; Zhu et al., 2019)

[1] The regulation of shadow banking in China dates from the end of 2016. On April 27, 2018, China's central bank issued the New Asset Management Regulation to mitigating financial risks by bringing shadow banking further under regulatory control. As a result, shadow banking has become less influential, more constrained, and more transparent, aligning more closely with formal financial regulations.

China's commercial banking system consists of state-owned commercial banks (SOCBs), joint-stock commercial banks (JSCBs), city commercial banks (CCBs), rural commercial banks (RCBs), and foreign banks (FBs). Although these banks operate in the same market, each type has different ownership structures, market segmentation, and regulation requirements (Dong et al., 2016). Previous studies have shown that as a determinant of corporate governance, the structure of bank ownership influences bank efficiency (Adu et al., 2023).

This study aims to examine the impact of shadow banking on the TE of Chinese commercial banks, with particular emphasis on the moderating role of varying ownership structures. Utilizing a panel dataset of 160 commercial banks spanning the period from 2011 to 2022, the analysis investigates how differences in bank ownership influence the relationship between shadow banking activities and efficiency outcomes. The empirical findings indicate that shadow banking generally enhances TE; however, the magnitude and direction of this effect differ by ownership type. Specifically, FBs exhibit a stronger positive relationship, whereas JSCBs and CCBs experience a dampening effect. In contrast, SOCBs and RCBs do not demonstrate statistically significant moderating effects.

This research addresses a notable gap in the literature concerning the role of shadow banking in the development of Chinese commercial banks. Furthermore, it provides empirical insights into how and why ownership structure moderates the link between shadow banking and bank efficiency, thereby contributing to the growing body of literature on governance and performance in the banking sector. A deeper understanding of this relationship offers valuable implications for policymakers and financial regulators seeking to enhance the efficiency and stability of China's banking industry.

2. Literature and hypotheses

2.1. Direct impact of shadow banking on bank efficiency

In China, shadow banking is closely linked to commercial banks (Allen & Gu, 2021; Tan, 2017). However, there is lack of consensus regarding its influence on bank efficiency, with some studies observing a negative association (Chen et al., 2020; Ding et al., 2020) and others arguing that shadow banking positively influences bank efficiency. For example, Hou et al. (2018) found that an increase in shadow banking activities positively and significantly impact Chinese commercial banks' cost efficiency. Meanwhile, Fève et al. (2019) demonstrated that shadow banking activities do not face the same regulatory constraints as traditional business activities; thus, shadow banking improves efficiency due to regulatory asymmetry. Finally, Tian et al. (2024) noted that shadow banking helps correct bank credit misallocations, thereby improving efficiency.

These studies indicate that shadow banking influences bank efficiency, and Chinese commercial banks engage with shadow banking to chase benefits. As efficiency entails optimal resource usage, shadow banking activities may involve additional complexities and require more inputs with or without proportionally increasing outputs[2]. Moreover, as a financial innovation product, shadow banking is an essential aspect of financial reform; thus, we hypothesize that shadow banking positively impacts bank efficiency. Fig. 1 depicts this study's framework. We propose Hypothesis 1 as follows:

H1. Shadow banking positively affects bank efficiency in China.

2.2. Moderating effect of bank ownership

The principal-agent theory serves as a theoretical foundation for understanding governance dynamics in financial institutions. The separation of corporate ownership and control leads to agency problems (Jensen & Meckling, 1976), and differences in ownership structure can result in differences in bank operating strategies due to differences in customer preferences, information quality, and production methods (Luu et al., 2020). Given the diversity of ownership structures in China, they are expected to play varying roles in the relationship between shadow banking and bank efficiency.

According to Ding et al. (2020), shadow banking positively relates to profit inefficiency in FBs and SOCBs. Meanwhile, Fungáčová et al. (2020) found that

[2] According to the Cobb–Douglas production function, an increase in efficiency level helps the banking sector produce more output from a given input.

China’s Big Five suffer from low-cost efficiency. Fu and Heffernan (2009) determined that SOCBs hinder bank efficiency, whereas JSCBs favor bank efficiency; thus, JSCBs are significantly more profitable than SOCBs. Based on this discussion, we propose the following hypotheses:

H2a. State ownership has a significantly negative moderating influence on the relationship between shadow banking and Chinese bank efficiency.

H2b. Joint-stock ownership has a significantly positive moderating influence on the relationship between shadow banking and Chinese bank efficiency.

Dong et al. (2016) argued that CCBs usually generally focus on the usury market, and borrowers such as small- and medium-sized enterprises are charged relatively high interest rates; hence, CCBs exhibit greater profit efficiency. Moreover, Ding et al. (2020) determined that CCBs positively moderate the relationship between shadow banking and efficiency. Meanwhile, Zhou et al. (2021) demonstrated a U-shaped relationship between non-interest income and the performance of RCBs, which aim to support the agricultural sector and achieve sustainable development. Based on these conclusions, we propose the following hypotheses:

H2c. City commercial ownership has a significantly positive moderating effect on the relationship between shadow banking and Chinese bank efficiency.

H2d. Rural commercial ownership has a nonsignificant moderating effect on the relationship between shadow banking and Chinese bank efficiency.

The empirical evidence demonstrates that foreign ownership has a positive effect on bank efficiency, supporting the global advantage hypothesis (Berger et al., 2009; Kallel & Triki, 2024). Therefore, the following hypothesis is proposed:

H2e. Foreign ownership has a significantly positive moderating effect on the relationship between shadow banking and Chinese bank efficiency.

[**Insert Figure 1 about here**]

3. Data and methodology

3.1. Methodology

The study measures the impact of shadow banking on bank efficiency[3] and the moderating effect of ownership structure by employing a systematic statistical procedure. Pearson correlation coefficients and variance inflation factors (VIFs) were used to determine the presence of multicollinearity in the regressors. Our regression analysis started with ordinary least squares (OLS) to verify the robustness of the estimation, the Breusch–Pagan test for heteroskedasticity, the Wooldridge test for autocorrelation, and the Pesaran cross-sectional dependence (2021) test for

[3]Appendix A contains the complete operationalization of the data envelopment analysis (DEA) framework applied to assess bank efficiency

cross-sectional dependence in the data. Based on the results of the diagnostic tests, we use the feasible generalized least squares (FGLS) method. The specific models are presented below, with variable definitions provided in Appendix B.

For the direct effect (baseline model):

$$LNTE_{i,t} = \sigma + \beta_1 \boldsymbol{LNSB}_{i,t} + \beta_4 LNTA_{i,t} + \beta_5 LNETA_{i,t} + \beta_6 LNCAR_{i,t} + \beta_7 LNLATA_{i,t} + \beta_8 LNNPL_{i,t} + \beta_9 LNGDP_t + \beta_{10} LNCPI_t + \beta_{11} LNM2G_t + \beta_{12} POLDUM_t + \varepsilon_{i,t}$$

(1)

For the moderating effect:

$$LNTE_{i,t} = \sigma + \beta_1 \boldsymbol{LNSB}_{i,t} + \beta_2 OWNDUM_{i,t} + \beta_3 \boldsymbol{LNSB}_{i,t} \boldsymbol{OWNDUM}_{i,t} + \beta_4 LNTA_{i,t} + \beta_5 LNETA_{i,t} + \beta_6 LNCAR_{i,t} + \beta_7 LNLATA_{i,t} + \beta_8 LNNPL_{i,t} + \beta_9 LNGDP_t + \beta_{10} LNCPI_t + \beta_{11} LNM2G_t + \beta_{12} POLDUM_t + \varepsilon_{i,t}$$ ------ (2)

Here, $LNSB_{it}OWNDUM_{it}$ denotes interaction terms between shadow banking and ownership type as *LNSBSOCB*, *LNSBJSCB*, *LNSBCCB*, *LNSBRCB*, and *LNSBFB*. σ denotes a constant, β is the coefficient of each regressor, *i* represents individual banks and *t* denotes the year.

3.2. Sample and data

This study uses data from 2011 to 2022 for a sample of 160 commercial banks, encompassing 6 SOCBs, 12 national JSCBs, 89 CCBs, 38 RCBs, and 15 FBs. Yearly unbalanced data were used. Bank-specific determinants were collected from the annual reports of various banks, the Wind database, and the Bureau van Dijk Bankfocus database. Macroeconomic values were taken from the National Bureau of Statistics database and the People's Bank of China Annual Report. The data are timely, and the sample period covers of shadow banking's significant development and decline.

Table 1 provides the descriptive statistics of the selected variables. The average TE of all banks in the sample is 0.666 and the input waste is 0.334. The results indicate that, on average, Chinese banks are moderately efficient. The maximum and minimum values are 1 and 0.238, respectively, indicating considerable differences in bank efficiency. The average value of shadow banking was 36.2 and fluctuated between 0.1 and 994.9 during the sample period, reflecting differences among banks. Notably, the statistical values of M2G range from 8.1 to 13.8, indicating the relative volatility of China's financial market during the sample period.

Table 1

Descriptive statistics of all sample banks (2011–2022).

Variable	N	Mean	Median	Min	Max	Std Dev
Total Sample Commercial Banks						

TE	1538	0.666	0.661	0.238	1.000	0.185
SB	1538	36.200	19.400	0.100	994.900	65.8
TA	1538	1185000	171450	1035	39610000	3865000
ETA	1538	7.699	7.498	2.343	95.030	2.072
CAR	1538	13.742	13.260	5.580	59.610	2.621
LATA	1538	25.343	23.355	1.173	77.430	11.658
NPL	1538	1.592	1.415	0.011	51.870	1.270
GDP	1538	6.356	6.900	2.200	9.500	1.992
CPI	1538	−0.083	−0.389	−2.657	2.033	1.034
M2G	1538	10.729	11.300	8.100	13.800	2.082

Notes(s):

TE = Technical efficiency; SB = Shadow banking; SOCB = State-owned commercial banks; JSCB = Joint-stock commercial banks; CCB = City commercial banks; RCB = Rural commercial banks; FB = Foreign banks; TA = Bank size; ETA = Bank capitalization; CAR = Capital adequacy ratio; LATA = Liquidity; NPL = Credit risk; GDP = GDP growth; CPI = Inflation; M2G = Money supply growth; POLDUM = Regulatory overhaul

4. Result and discussion

4.1. Effect of shadow banking on bank efficiency (H1)

In Table 2, Models 3 and 4 demonstrate how shadow banking affects bank efficiency under the FGLS; multicollinearity is detected in the LNM2G and POLDUM regressors (Appendix C). The positive coefficients of LNSB are significant at the 1% level; demonstrating that shadow banking significantly and positively affects bank efficiency in China, providing statistical support to H1. When the commercial banks in the study sample engaged in shadow banking, they improved their input resource usage and increased outputs to enhance their TE. This finding is aligns with those of previous studies (Hou et al., 2018; Tan, 2017; Tian et al., 2024) demonstrating that shadow banking improves bank performance in China.

Notably, LNM2G shows a significant negative association with TE, indicating that increasing LNM2G supply restricts banks' TE. Moreover, regulatory overhauls significantly and positively influence TE; thus, the current shadow banking control rules enhance bank efficiency. The new shadow banking regulations enhance bank efficiency by promoting transparency, improving asset-liability alignment, and reducing agency costs through more disciplined and regulated lending practices. This finding is consistent with those of Acharya et al. (2019).

Table 2

Empirical results on the direct effect based on the OLS and FGLS estimation method.

Variable	**Model 1 OLS**	**Model 2 OLS**	**Model 3 FGLS**	**Model 4 FGLS**
LNSB	0.073[a]	0.078[a]	0.038[a]	0.042[a]
	(0.008)	*(0.008)*	*(0.008)*	*(0.008)*
LNTA	−0.003	−0.005	0.015[a]	0.012[b]
	(0.005)	*(0.005)*	*(0.006)*	*(0.006)*
LNETA	−0.319[a]	−0.322[a]	−0.187[a]	−0.199[a]
	(0.040)	*(0.040)*	*(0.038)*	*(0.038)*
LNCAR	0.496[a]	0.468[a]	0.481[a]	0.471[a]
	(0.057)	*(0.057)*	*(0.048)*	*(0.048)*
LNLATA	0.045[a]	0.064[a]	0.003	0.014
	(0.017)	*(0.017)*	*(0.014)*	*(0.014)*
LNNPL	−0.009	0.005	0.012	0.019[b]
	(0.011)	*(0.011)*	*(0.009)*	*(0.009)*
LNGDP	−0.237[a]	−0.124[a]	−0.101[a]	−0.059[a]
	(0.016)	*(0.017)*	*(0.009)*	*(0.009)*
LNCPI	−0.013	−0.011	0.009	0.008
	(0.010)	*(0.010)*	*(0.006)*	*(0.006)*
LNM2G	−0.539[a]		−0.260[a]	
	(0.036)		*(0.030)*	
POLDUM		0.251[a]		0.115[a]
		(0.016)		*(0.013)*
Constant	0.6170[a]	−0.920[a]	−0.776[a]	−1.442[a]
	(0.208)	*(0.169)*	*(0.201)*	*(0.170)*
Breusch–Pagan (chi^2)	36.140[a]	49.720[a]		
Wooldridge test	222.648[a]	218.322[a]		
Pesaran CD (2021)	58.140[a]	49.830[a]		
Observations	1538	1538	1538	1538

Mean VIF	1.49	1.55		
R^2	0.290	0.294		
adj. R^2	0.286	0.290		
F-stat / Wald chi^2	69.25^a	70.79^a	297.77^a	309.27^a

Note(s): $^{a, b}$ and ^{c} indicate statistical significance at the 1%, 5% and 10% levels, respectively.
Standard errors are provided in parentheses.

4.2. Moderating effect of bank ownership on the relationship between shadow banking and bank efficiency (H2a–H2e)

This study considers bank ownership a moderating factor in exploring the influencing mechanisms and the potentially positive or negative impacts of shadow banking on commercial bank efficiency in China. The results with LNM2G are presented in Table 3, and the results with POLDUM are presented in Appendix D.

LNSBSOCB does not significantly moderate TE, indicating that SOCBs engaging with shadow banking do not witness a significant effect on efficiency. This result rejects H2a. A possible reason for this outcome is that SOCBs act as government agents, following political objectives rather than commercial considerations (Doan et al., 2018; Wu & Yuan, 2021). Furthermore, internal bureaucratic problems and inflexible organizational structures in large SOCBs may affect such banks' willingness to alter their existing models (Cao et al., 2024). Collectively, these factors limit the potential for shadow banking to enhance efficiency in SOCBs.

LNSBJSCB has a significant negative impact on TE, indicating that joint-stock ownership significantly weakens the positive relationship between shadow banking and TE. This result contradicts H2b. Elliott et al. (2015) suggested that JSCBs are subject to government as well as market pressures and operate in a semi-liberalized environment. The inefficiency of JSCBs is primarily due to inefficient performance at the productivity stage (Zha et al., 2016). This finding echoes that of Huang and Shen (2019), who found that the interaction term between shadow banking interbank activities and JSCBs negatively affects bank ratings.

Likewise, LNSBCCB has a significant negative effect on TE, and the significantly positive relationship between shadow banking and TE decreases in CCBs. This result is the opposite of Hypothesis H2c. Due to the mix of the local official promotion system and the governance structures of CCBs, local governments are tempted to retain effective control of CCBs. Therefore, specific political or group influences may override objective strategic decisions, exacerbating agency problems and undermining bank efficiency (Fang et al., 2019; Sun et al., 2013).

LNSBRCB is not statistically significant, confirming H2d. RCBs are generally small banks and engage in less complex shadow banking activities at a reduced scale (Acharya et al., 2019). Nonetheless, RCBs are still restrained by government intervention (Wang et al., 2021); thus, the impact of engaging in shadow banking on bank efficiency is limited. Consequently, shadow banking has a nonsignificant impact on RCBs.

LNSBFB is positive and significant at the 1% level, indicating that foreign ownership significantly strengthens the positive relationship between shadow banking and TE and confirming H2e. This finding can be attributed to foreign banks often establishing global best practices in banking, risk management, and corporate governance. The exposure of foreign banks to international standards increases efficiency and transparency. This finding supports the global advantage hypothesis, as the empirical efficiency observed by Kallel and Triki (2024) and Zhang et al. (2013) indicates that foreign ownership correlates with improved performance in host countries.

In summary, SOCBs and RCBs do not significantly moderate the relationship between shadow banking and TE. In contrast, JSCBs and CCBs have a significantly negative moderating effect. Finally, FBs positively moderate the relationship.

Table 3

Empirical results on the moderating effect of ownership structure based on the FGLS.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
LNSB	0.031[a]	0.046[a]	0.066[a]	0.036[a]	0.008
	(0.008)	*(0.008)*	*(0.011)*	*(0.009)*	*(0.008)*
SOCB	−0.621[a]				
	(0.101)				
LNSBSOCB	−0.032				
	(0.052)				
JSCB		−0.471[a]			
		(0.049)			
LNSBJSCB		−0.137[a]			
		(0.027)			
CCB			0.036		
			(0.026)		
LNSBCCB			−0.043[a]		

			(0.013)		
RCB				−0.091[b]	
				(0.037)	
LNSBRCB				−0.008	
				(0.016)	
FB					0.343[a]
					(0.032)
LNSBFB					0.087[a]
					(0.023)
LNTA	0.063[a]	0.048[a]	0.021[a]	0.009	0.023[a]
	(0.007)	*(0.007)*	*(0.006)*	*(0.006)*	*(0.006)*
LNETA	−0.195[a]	−0.172[a]	−0.172[a]	−0.196[a]	−0.296[a]
	(0.037)	*(0.037)*	*(0.038)*	*(0.038)*	*(0.038)*
LNCAR	0.545[a]	0.444[a]	0.518[a]	0.504[a]	0.462[a]
	(0.047)	*(0.047)*	*(0.048)*	*(0.048)*	*(0.046)*
LNLATA	0.017	0.005	−0.000	0.001	−0.005
	(0.014)	*(0.014)*	*(0.014)*	*(0.014)*	*(0.014)*
LNNPL	0.009	0.006	0.007	0.014	0.032[a]
	(0.009)	*(0.009)*	*(0.009)*	*(0.009)*	*(0.009)*
LNGDP	−0.088[a]	−0.089[a]	−0.102[a]	−0.103[a]	−0.088[a]
	(0.009)	*(0.009)*	*(0.009)*	*(0.009)*	*(0.009)*
LNCPI	0.005	0.008	0.009	0.008	0.007
	(0.005)	*(0.006)*	*(0.006)*	*(0.006)*	*(0.006)*
LNM2G	−0.214[a]	−0.215[a]	−0.260[a]	−0.266[a]	−0.219[a]
	(0.029)	*(0.030)*	*(0.030)*	*(0.030)*	*(0.030)*
Constant	−2.014[a]	−1.440[a]	−1.018[a]	−0.660[a]	−0.839[a]
	(0.219)	*(0.212)*	*(0.205)*	*(0.201)*	*(0.196)*
N	1538	1538	1538	1538	1538
Wald chi^2	533.680[a]	432.600[a]	375.620[a]	321.470[a]	480.190[a]

Note(s): [a, b] and [c] indicate statistical significance at the 1%, 5% and 10% levels, respectively.
Standard errors are presented in parentheses.

4.3. Robustness checks

To ensure greater robustness in the estimation, we used the panel-corrected standard error (PCSE) method to control for heteroskedasticity, autocorrelation, and cross-sectional dependence in the residual. PCSE is utilized following Breitung et al. (2022) and Smaoui and Ghouma (2020) because fixed effects and estimations using the generalized method of moments tend to produce unreliable inferences when the panel data exhibit cross-sectional dependence. The results in Table 4 are qualitatively consistent with the primary conclusions using FGLS, confirming that the empirical results are robust.

Table 4

Robustness checks on the moderating effect of ownership structure based on PCSE.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
LNSB	0.038[a]	0.041[a]	0.032[a]	0.045[a]	0.074[a]	0.034[a]	0.009
	(0.012)	*(0.012)*	*(0.012)*	*(0.012)*	*(0.011)*	*(0.012)*	*(0.013)*
SOCB			−0.415[a]				
			(0.130)				
LNSBSOCB			0.021				
			(0.059)				
JSCB				−0.460[a]			
				(0.061)			
LNSBJSCB				−0.136[a]			
				(0.032)			
CCB					−0.008		
					(0.032)		
LNSBCCB					−0.059[a]		
					(0.012)		
RCB						−0.077[c]	
						(0.041)	
LNSBRCB						−0.000	
						(0.017)	
FB							0.278[a]
							(0.052)
LNSBFB							0.071[b]
							(0.028)
LNTA	0.013	0.012	0.048[a]	0.049[a]	0.025[a]	0.010	0.019[c]
	(0.010)	*(0.010)*	*(0.013)*	*(0.013)*	*(0.009)*	*(0.010)*	*(0.010)*
LNETA	−0.195[a]	−0.209[a]	−0.213[a]	−0.160[a]	−0.192[a]	−0.201[a]	−0.307[a]
	(0.051)	*(0.051)*	*(0.051)*	*(0.050)*	*(0.049)*	*(0.053)*	*(0.051)*
LNCAR	0.518[a]	0.512[a]	0.559[a]	0.472[a]	0.539[a]	0.539[a]	0.501[a]
	(0.065)	*(0.064)*	*(0.066)*	*(0.063)*	*(0.062)*	*(0.063)*	*(0.063)*
LNLATA	0.015	0.023	0.026	0.016	0.010	0.010	0.005
	(0.020)	*(0.020)*	*(0.020)*	*(0.019)*	*(0.020)*	*(0.020)*	*(0.020)*
LNNPL	0.017	0.025[b]	0.012	0.011	0.016	0.021[c]	0.041[a]

	(0.012)	*(0.013)*	*(0.012)*	*(0.011)*	*(0.012)*	*(0.012)*	*(0.013)*
LNGDP	−0.113[a]	−0.067[c]	−0.104[a]	−0.101[a]	−0.109[a]	−0.113[a]	−0.100[a]
	(0.037)	*(0.035)*	*(0.035)*	*(0.034)*	*(0.037)*	*(0.038)*	*(0.034)*
LNCPI	−0.001	−0.001	−0.000	−0.002	−0.001	−0.001	−0.002
	(0.021)	*(0.021)*	*(0.020)*	*(0.019)*	*(0.021)*	*(0.021)*	*(0.020)*
LNM2G	−0.284[b]		−0.252[b]	−0.241[b]	−0.276[b]	−0.288[b]	−0.244[b]
	(0.112)		*(0.107)*	*(0.103)*	*(0.111)*	*(0.113)*	*(0.106)*
POLDUM		0.131[a]					
		(0.049)					
Constant	−0.792[c]	−1.561[a]	−1.644[a]	−1.517[a]	−1.095[a]	−0.729[c]	−0.798[c]
	(0.422)	*(0.275)*	*(0.450)*	*(0.465)*	*(0.413)*	*(0.425)*	*(0.408)*
N	1538	1538	1538	1538	1538	1538	1538
R^2	0.519	0.518	0.541	0.552	0.538	0.531	0.535
Wald chi^2	116.49[a]	128.21[a]	643.15[a]	396.87[a]	297.71[a]	167.78[a]	175.06[a]

Note(s): [a, b] and [c] indicate statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are presented in parentheses.

Conclusion

This study aims to measure the impact of shadow banking on bank efficiency and the moderating influence of banks' ownership structures. It employs data envelopment analysis (DEA) to calculate TE and considers five types of ownership in Chinese commercial banks as moderating variables. Based on FGLS and PCSE estimations, this study finds that shadow banking significantly and positively affects banks' TE. Meanwhile, the analysis of the moderating effects of different types of bank ownership structures yield mixed results. Specifically, SOCBs and RCBs have nonsignificant moderating effects whereas JSCBs and CCBs have significant negative moderating effects. Therefore, the participation of JSCBs and CCBs in shadow banking may adversely impact their TE. Conversely, FBs demonstrate a positive moderating effect, suggesting that involvement in shadow banking improves these banks' efficiency. The findings provide practical implications for formulating and subdividing shadow banking–related policies and strategies in Chinese banks. Additionally, this study contributes to the existing literature on bank governance by demonstrating the moderating effect of ownership structure on the relationship between shadow banking and bank efficiency.

Appendices

Appendix A. Assessing efficiency

This study measures banks' TE using DEA (Charnes et al., 1978). The DEA estimators are consistent and converge faster than the estimators of other frontier methods. This study measures banks' TE using the following ratio:

$Maximize\ efficiency\ of\ unit\ m = \sum_{r=1}^{s} u_r y_{rm}$

Subject to $\sum_{i=1}^{p} v_i x_{im} = 1$

$\sum_{r=1}^{s} u_r y_{rm} - \sum_{i=1}^{p} v_i x_{im} \leq 1, m = 1,2,3 \dots \dots n$ (A.1)

$u_r \geq \varepsilon, r = 1,2, \dots s$

$v_i \geq \varepsilon, i = 1,2, \dots p$

where

$v_i =$ the weight assigned to input i

$x_{im} =$ the level of input i used by unit m

$u_r =$ the weight assigned to output r

$y_{rm} =$ the level of output r produced by unit m

$\varepsilon =$ a small number ($i.e.$, with order of10^{-6}) that ensures neither input

nor output is given zero weight

Appendix B. Variable definitions

Table B.1 Description of the variables

Variables	Symbol	Description
Dependent variable		
Bank efficiency	LNTE	This study employs log technical efficiency to measure bank efficiency in the regression analysis. Following Kamarudin et al. (2013), Sufian and Kamarudin (2014), Hsiao et al. (2015), Phung et al. (2022) and Mergoni et al. (2024), we use the nonparametric data envelopment analysis (DEA) frontier analysis method developed by Charnes et al. (1978) to measure TE. The bank's TE score remains between 0 and 1. If the unit's efficiency value is equal to 1, the DMU (decision-making unit) is perfectly efficient in maximizing the output using inputs. However, if the efficiency value of the unit is less than 1, the DMU is relatively inefficient. We use the intermediation approach for input and output selection in computing the TE score (Kamarudin et al., 2016; Kamarudin et al., 2022; Proença et al., 2023) The outputs are loans and investment; whereas the inputs are deposits, labor, and physical capital. The specific steps and calculating process of the TE are described in Appendix A.
Independent variable		
Shadow banking	LNSB	This log shadow banking variable is constructed following previous studies (Ding et al., 2020; Nguyen et al., 2023; Zhang et al., 2023), measured as the proportion of interbank loans, trusted account loans, financial products, or investment receivables to gross loans of banks as follows: $SB_{i,t} = \frac{LAB_{i,t}+TAL_{i,t}+ARI_{i,t}}{GL_{i,t}}$, where $SB_{i,t}$ = the shadow banking of the i-th bank in the period t $LAB_{i,t}$ = the loans and advances to banks of the i-th bank in the period t $TAL_{i,t}$ = the trust account loans of the i-th bank in the period t $ARI_{i,t}$ = the accounts receivable investment of the i-th bank in the period t $GL_{i,t}$ = the gross loans of the i-th bank in the period t
Moderating variables		
State-owned commercial banks	SOCB	Dummy variable equaling 1 for state-owned banks and 0 if otherwise
Joint-stock commercial banks	JSCB	Dummy variable equaling 1 for joint-stock banks and 0 if otherwise

City commercial banks	CCB	Dummy variable equaling 1 for city commercial banks and 0 if otherwise
Rural commercial banks	RCB	Dummy variable equaling 1 for rural commercial banks and 0 if otherwise
Foreign banks	FB	Dummy variable equaling 1 for foreign banks and 0 if otherwise
Control variables		
Bank-specific characteristics		
Bank size	LNTA	Log ($Total\ Assets$) (Kamarudin et al., 2022)
Bank capitalization	LNETA	Log ($\frac{Equity}{Total\ Assets}$) (Luo et al., 2024)
Capital adequacy ratio	LNCAR	Log ($\frac{Capital}{Risk-weight\ assets}$) (Kang et al., 2024)
Liquidity	LNLATA	Log ($\frac{Liquidity\ Assets}{Total\ Assets}$) (Mamat et al., 2024)
Credit risk	LNNPL	Log ($\frac{\text{Nonperforming Loans}}{Gross\ Loans}$) (Kang et al., 2024)
Macroeconomic factors		
GDP growth	LNGDP	log ($\frac{Real\ GDP_t - RealGDP_{t-1}}{Real\ GDP_{t-1}}$) (Chen & Lu, 2021)
Inflation	LNCPI	log ($\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$) (Luo et al., 2024)
Money supply growth	LNM2G	log ($\frac{M2\ at\ end\ of\ year\ _t - M2\ at\ end\ of\ year_{t-1}}{M2\ at\ end\ of\ year_{t-1}}$) (Kang et al., 2024)
Regulatory overhaul	POLDUM	Takes the value of 1 for the regulatory overhaul from 2017 and 0 if otherwise (Zhang et al., 2023)

Appendix C. Multicollinearity Test

The Pearson correlation matrix (Panel A of Table C.1) and the variance inflation factor (VIF) test (Panel B of Table C.1) were used to detect the presence of multicollinearity in the regressors. A correlation coefficient exceeding 0.80 between two regressors indicates multicollinearity issues in the regression. As shown in Table C.1, the Pearson correlation coefficient between LNM2G and POLDUM is significantly high, at 0.821, indicating the presence of multicollinearity between these two variables. Furthermore, the VIF values of POLDUM and LNM2G are above 5 and below 5 for other methods.

Table C.1 Multicollinearity test: correlation matrix for the explanatory variable and VIF.

Panel A										
	LNSB	LNTA	LNETA	LNCAR	LNLATA	LNNPL	LNGDP	LNCPI	LNM2G	POLDUM
LNSB	1.000	−0.028	−0.018	0.142[a]	0.595[a]	−0.336[a]	0.256[a]	−0.065[b]	0.256[a]	−0.380[a]
LNTA		1.000	−0.292[a]	−0.174[a]	−0.110[a]	0.037	−0.106[a]	0.015	−0.077[a]	0.138[a]
LNETA			1.000	0.681[a]	−0.011	0.025	−0.141[a]	0.023	−0.171[a]	0.223[a]
LNCAR				1.000	0.140[a]	−0.176[a]	−0.100[a]	0.003	−0.118[a]	0.172[a]
LNLATA					1.000	−0.245[a]	0.254[a]	−0.017	0.188[a]	−0.342[a]
LNNPL						1.000	−0.140[a]	0.068[a]	−0.284[a]	0.252[a]
LNGDP							1.000	−0.182[a]	0.050[c]	−0.460[a]
LNCPI								1.000	−0.051[b]	0.103[a]
LNM2G									1.000	−0.821[a]
POLDUM										1.000

Panel B										
VIF	1.76	1.17	2.14	2.13	1.67	1.28	2.28	1.04	5.67	7.43

Note(s): [a, b] and [c] indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Appendix D. Moderating effect of bank ownership using POLDUM

Table D.1 Empirical results on the moderating effect of bank ownership using POLDUM

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
			FGLS				Robustness checks based on the PCSE			
LNSB	0.033[a]	0.049[a]	0.068[a]	0.040[a]	0.010	0.035[a]	0.048[a]	0.076[a]	0.037[a]	0.013
	(0.008)	*(0.008)*	*(0.011)*	*(0.009)*	*(0.008)*	*(0.012)*	*(0.012)*	*(0.011)*	*(0.013)*	*(0.014)*
SOCB	−0.621[a]					−0.418[a]				
	(0.098)					*(0.129)*				
LNSBSOCB	−0.039					0.009				
	(0.051)					*(0.058)*				
JSCB		−0.464[a]					−0.461[a]			
		(0.049)					*(0.059)*			
LNSBJSCB		−0.139[a]					−0.139[a]			
		(0.026)					*(0.032)*			
CCB			0.029					−0.013		
			(0.026)					*(0.033)*		
LNSBCCB			−0.043[a]					−0.058[a]		
			(0.013)					*(0.012)*		
RCB				−0.085[b]					−0.051	
				(0.035)					*(0.042)*	
LNSBRCB				−0.008					0.009	
				(0.016)					*(0.017)*	
FB					0.345[a]					0.269[a]
					(0.032)					*(0.052)*

LNSBFB					0.091^{a}					0.069^{b}
					(0.023)					*(0.028)*
LNTA	0.059^{a}	0.044^{a}	0.018^{a}	0.006	0.020^{a}	0.043^{a}	0.047^{a}	0.023^{b}	0.008	0.017
	(0.007)	*(0.007)*	*(0.006)*	*(0.006)*	*(0.006)*	*(0.014)*	*(0.013)*	*(0.010)*	*(0.010)*	*(0.011)*
LNETA	−0.204^{a}	−0.181^{a}	−0.183^{a}	−0.207^{a}	−0.307^{a}	−0.220^{a}	−0.170^{a}	−0.207^{a}	−0.212^{a}	−0.314^{a}
	(0.037)	*(0.037)*	*(0.038)*	*(0.038)*	*(0.038)*	*(0.052)*	*(0.051)*	*(0.050)*	*(0.052)*	*(0.051)*
LNCAR	0.536^{a}	0.436^{a}	0.506^{a}	0.493^{a}	0.453^{a}	0.549^{a}	0.466^{a}	0.534^{a}	0.529^{a}	0.500^{a}
	(0.047)	*(0.047)*	*(0.048)*	*(0.048)*	*(0.046)*	*(0.065)*	*(0.063)*	*(0.062)*	*(0.062)*	*(0.062)*
LNLATA	0.026^{c}	0.013	0.010	0.012	0.004	0.033^{c}	0.024	0.019	0.018	0.013
	(0.014)	*(0.014)*	*(0.014)*	*(0.015)*	*(0.014)*	*(0.020)*	*(0.020)*	*(0.020)*	*(0.020)*	*(0.020)*
LNNPL	0.015^{c}	0.012	0.015	0.022^{b}	0.038^{a}	0.019	0.019	0.025^{b}	0.028^{b}	0.046^{a}
	(0.009)	*(0.009)*	*(0.009)*	*(0.009)*	*(0.009)*	*(0.012)*	*(0.012)*	*(0.013)*	*(0.013)*	*(0.013)*
LNGDP	−0.054^{a}	−0.055^{a}	−0.060^{a}	−0.060^{a}	−0.053^{a}	−0.063^{c}	−0.063^{b}	−0.065^{c}	−0.067^{c}	−0.061^{c}
	(0.008)	*(0.008)*	*(0.009)*	*(0.009)*	*(0.008)*	*(0.033)*	*(0.032)*	*(0.035)*	*(0.036)*	*(0.033)*
LNCPI	0.004	0.007	0.008	0.008	0.006	0.000	−0.002	−0.001	−0.001	−0.001
	(0.005)	*(0.006)*	*(0.006)*	*(0.006)*	*(0.006)*	*(0.020)*	*(0.019)*	*(0.021)*	*(0.021)*	*(0.020)*
POLDUM	0.093^{a}	0.094^{a}	0.110^{a}	0.115^{a}	0.098^{a}	0.115^{b}	0.111^{b}	0.126^{a}	0.132^{a}	0.114^{b}
	(0.013)	*(0.013)*	*(0.013)*	*(0.013)*	*(0.013)*	*(0.046)*	*(0.045)*	*(0.049)*	*(0.050)*	*(0.046)*
Constant	−2.544^{a}	−1.963^{a}	−1.676^{a}	−1.354^{a}	−1.393^{a}	−2.273^{a}	−2.166^{a}	−1.832^{a}	−1.517^{a}	−1.462^{a}
	(0.189)	*(0.181)*	*(0.178)*	*(0.171)*	*(0.168)*	*(0.320)*	*(0.321)*	*(0.262)*	*(0.269)*	*(0.276)*
N	1538	1538	1538	1538	1538	1538	1538	1538	1538	1538
R^2						0.5406	0.5487	0.532	0.529	0.533
Wald chi^2	547.81^{a}	438.83^{a}	372.00^{a}	327.21^{a}	493.72^{a}	667.78^{a}	410.22^{a}	281.83^{a}	174.95^{a}	181.88^{a}

Note(s): $^{a, b}$ and ^{c} indicate statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are presented in parentheses.

References

Acharya, V. V., Qian, J., Su, Y., & Yang, Z. (2019). In the shadow of banks: Wealth management products and issuing banks' risk in China. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3401597

Adu, D. A., Zoynul Abedin, M., & Hasan, M. (2023). Bank ownership structures and sustainable banking initiatives : The moderating effect of governance mechanism. *International Review of Financial Analysis*, *89*, 102736. https://doi.org/10.1016/j.irfa.2023.102736

Allen, F., & Gu, X. (2021). Shadow banking in China compared to other countries. *Manchester School*, *89*(5), 407–419. https://doi.org/10.1111/manc.12331

Amornkitvikai, Y., & Charoenrat, T. (2024). The impact of female chief executive officers, ownership, and globalization on ASEAN manufacturers' technical efficiency performance. *Research in Globalization*, *8*, 100206. https://doi.org/10.1016/j.resglo.2024.100206

Antunes, J., Hadi-Vencheh, A., Jamshidi, A., Tan, Y., & Wanke, P. (2024). Cost efficiency of Chinese banks: Evidence from DEA and MLP-SSRP analysis. *Expert Systems with Applications*, *237*(PA), 121432. https://doi.org/10.1016/j.eswa.2023.121432

Berger, A. N., Hasan, I., & Zhou, M. (2009). Bank ownership and efficiency in China: What will happen in the world's largest nation? *Journal of Banking and Finance*, *33*(1), 113–130. https://doi.org/10.1016/j.jbankfin.2007.05.016

Boachie, C. (2020). Corporate governance and financial performance of banks in Ghana: The moderating role of ownership structure. *International Journal of Emerging Markets*, *18*(3), 607–632. https://doi.org/10.1108/IJOEM-09-2020-1146

Breitung, J., Kripfganz, S., & Hayakawa, K. (2022). Bias-corrected method of moments estimators for dynamic panel data models. *Econometrics and Statistics*, *24*, 116–132. https://doi.org/10.1016/j.ecosta.2021.07.001

Cao, Q., Zhu, T., & Yu, W. (2024). ESG investment and bank efficiency: Evidence from China. *Energy Economics*, *133*(June 2023), 107516. https://doi.org/10.1016/j.eneco.2024.107516

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *70*, 429–444. https://doi.org/10.1016/j.rser.2016.12.030

Chen, S., Härdle, W. K., & Wang, L. (2020). Estimation and determinants of Chinese banks' total factor efficiency: A new vision based on unbalanced development of Chinese banks and their overall risk. *Computational Statistics*, *35*(2), 427–468. https://doi.org/10.1007/s00180-019-00951-6

Chen, X., & Lu, C. C. (2021). The impact of the macroeconomic factors in the bank efficiency: Evidence from the Chinese city banks. *North American Journal of Economics and Finance*, *55*, 101294. https://doi.org/10.1016/j.najef.2020.101294

Ding, N., Fung, H. G., & Jia, J. (2020). Shadow banking, bank ownership, and bank efficiency in China. *Emerging Markets Finance and Trade*, *56*(15), 3786–3804. https://doi.org/10.1080/1540496X.2019.1579710

Doan, A.-T., Lin, K. L., & Doong, S. C. (2018). What drives bank efficiency? The interaction of bank income diversification and ownership. *International Review of Economics and Finance*, *55*, 203–219. https://doi.org/10.1016/j.iref.2017.07.019

Dong, Y., Firth, M., Hou, W., & Yang, W. (2016). Evaluating the performance of Chinese commercial banks: A comparative analysis of different types of banks. *European Journal of Operational Research*, *252*(1), 280–295. https://doi.org/10.1016/j.ejor.2015.12.038

Elliott, D., Kroeber, A., & Qiao, Y. (2015). Shadow banking in China: A primer. *Economic Studies at Brookings*, (March).

Fang, J., Lau, C. K. M., Lu, Z., Tan, Y., & Zhang, H. (2019). Bank performance in China: A perspective from bank efficiency, risk-taking and market competition. *Pacific Basin Finance Journal*, *56*, 290–309. https://doi.org/10.1016/j.pacfin.2019.06.011

Fernandes, F. D. S., Stasinakis, C., & Bardarova, V. (2018). Two-stage DEA-truncated regression: Application in banking efficiency and financial development. *Expert Systems with Applications*, *96*, 284–301. https://doi.org/10.1016/j.eswa.2017.12.010

Fève, P., Moura, A., & Pierrard, O. (2019). Shadow banking and financial regulation: A small-scale DSGE perspective. *Journal of Economic Dynamics and Control*, *101*, 130–144. https://doi.org/10.1016/j.jedc.2019.02.001

Fu, X. (Maggie), & Heffernan, S. (2009). The effects of reform on China's bank structure and performance. *Journal of Banking and Finance*, *33*(1), 39–52. https://doi.org/10.1016/j.jbankfin.2006.11.023

Fungáčová, Z., Klein, P. O., & Weill, L. (2020). Persistent and transient inefficiency: Explaining the low efficiency of Chinese big banks. *China Economic Review*, *59*. https://doi.org/10.1016/j.chieco.2019.101368

Hou, X., Li, S., Guo, P., & Wang, Q. (2018). The cost effects of shadow banking activities and political intervention: Evidence from the banking sector in China. *International Review of Economics and Finance*, *57*(November 2015), 307–318. https://doi.org/10.1016/j.iref.2018.01.019

Hsiao, C., Shen, Y., & Bian, W. (2015). Evaluating the effectiveness of China's financial reform–The efficiency of China's domestic banks. *China Economic Review*, *35*, 70–82. https://doi.org/10.1016/j.chieco.2015.05.006

Huang, Y. L., & Shen, C. H. (2019). Effect of interbank activities on bank risk: Why is China different? *Quarterly Review of Economics and Finance*, 308–327. https://doi.org/10.1016/j.qref.2019.01.002

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X

Kallel, H., & Triki, M. (2024). Foreign ownership, bank efficiency and stability: Whether the institutional quality of countries is important? *International Journal of Finance and Economics*, *29*(1), 632–653. https://doi.org/10.1002/ijfe.2701

Kamarudin, F., Sufian, F., & Nassir, A. M. (2016). Global financial crisis, ownership and bank profit efficiency in the Bangladesh's state owned and private commercial banks. *Contaduria y Administracion*, *61*(4), 705–745. https://doi.org/10.1016/j.cya.2016.07.006

Kamarudin, F., Nordin, B.A.A., & Nassir, A.M. (2013). Price efficiency and returns to scale of banking sector in Gulf Cooperative Council countries: Empirical evidence from Islamic and conventional banks. *Economic Computation and Economic Cybernetics Studies and Research*, 47(3):215–236.

Kamarudin, F., Anwar, N.A.N., Nassir, A.M., Sufian, F., Tan, K.M., & Hussain, H.I. (2022). Does country governance and bank productivity nexus matters? *Journal of Islamic Marketing*, 13(2): 329-380. https://doi.org/10.1108/jima-05-2019-0109

Kang, K., Zariyawati, M. A. M. D. H. Y., Soh, W. N., & Li, Y. (2024). Interest rate liberalization and the stability of the Chinese banking system : Exploring chained mediation effects of deposit competitiveness and wealth management products. *Finance Research Letters*, *62*, 105222. https://doi.org/10.1016/j.frl.2024.105222

Luo, H., Kamarudin, F., & Nor, N.M. (2024). The impact of economic uncertainty on bank efficiency—the moderating role of country governance. *Heliyon*, *10*(6): E27905 https://doi.org/10.1016/j.heliyon.2024.e27905

Luu, H. N., Nguyen, L. Q. T., Vu, Q. H., & Tuan, L. Q. (2020). Income diversification and financial performance of commercial banks in Vietnam: Do experience and ownership structure matter? *Review of Behavioral Finance*, *12*(3), 185–199. https://doi.org/10.1108/RBF-05-2019-0066

Ma, Y., & Hu, X. (2024). Shadow banking and SME investment: Evidence from China's new asset management regulations. *International Review of Economics and Finance*, *93*, 332–349. https://doi.org/10.1016/j.iref.2024.03.033

Mamat, H.N., Kamarudin, F., Ali, M., & Hussain, H.I. (2024). Impact of Islamicity on the productivity of conventional and Islamic banks in selected southeast Asian countries. *Pacific-Basin Finance Journal*, 87, 102492 https://doi.org/10.1016/j.pacfin.2024.102492

Mergoni, A., Emrouznejad, A., & De Witte, K. (2024). Fifty years of Data Envelopment Analysis. *European Journal of Operational Research*. Advance online publication. *(forthcoming)* https://doi.org/10.1016/j.ejor.2024.12.049

Nguyen, N. T., Nguyen, A. T., Le, T. T. H., & To, H. T. N. (2023). The impact of bank competition on bank stability in Vietnam : The moderating role of shadow banking. *Cogent Business & Management*, *10*(2). https://doi.org/10.1080/23311975.2023.2241208

Oung, V. (2013). *Cambodia's financial system: Challenges and opportunities* [Paper presentation]. IMF Seminar on Macroeconomic Policy Issues for Low-Income Countries, Washington, DC, United States. International Monetary Fund. https://www.imf.org/external/np/seminars/eng/2013/sta/pdf/Vichett_Oung2.pdf

Pesaran, M. H. (2021). General diagnostic tests for cross-sectional dependence in panels. *Empirical Economics*, *60*(1), 13–50. https://doi.org/10.1007/s00181-020-01875-7

Phung, Q. T., Van Vu, H., & Tran, H. P. (2022). Do non-performing loans impact bank efficiency? *Finance Research Letters*, *46*, 102393. https://doi.org/10.1016/j.frl.2021.102393

Proença, C., Augusto, M., & Murteira, J. (2023). The effect of earnings management on bank efficiency: Evidence from ECB-supervised banks. *Finance Research Letters*, *51*. https://doi.org/10.1016/j.frl.2022.103450

Smaoui, H., & Ghouma, H. (2020). Sukuk market development and Islamic banks' capital ratios. *Research in International Business and Finance*, *51*(17), 101064. https://doi.org/10.1016/j.ribaf.2019.101064

Sufian. F., & Kamarudin, F. (2014). The impact of ownership structure on bank productivity and efficiency: Evidence from semi-parametric Malmquist Productivity Index. *Cogent Economics and Finance*, 2(1):1–27. https://doi.org/10.1080/23322039.2014.932700

Sun, J., Harimaya, K., & Yamori, N. (2013). Regional economic development, strategic investors, and efficiency of Chinese city commercial banks. *Journal of Banking and Finance*, *37*(5), 1602–1611. https://doi.org/10.1016/j.jbankfin.2012.12.013

Tan, Y. (2017). The impacts of competition and shadow banking on profitability: Evidence from the Chinese banking industry. *North American Journal of Economics and Finance*, *42*, 89–106. https://doi.org/10.1016/j.najef.2017.07.007

Tecles, P. L., & Tabak, B. M. (2010). Determinants of bank efficiency: The case of Brazil. *European Journal of Operational Research*, *207*(3), 1587–1598. https://doi.org/10.1016/j.ejor.2010.06.007

Tian, X., Tu, G., & Wang, Y. (2024). The real effects of shadow banking: Evidence from China. *Management Science*, *70*(12), 8217–9119. https://doi.org/10.1287/mnsc.2022.00953

Wang, W., Hueng, C. J., & Wei, W. (2021). Government intervention in Chinese rural commercial banks–A helping hand or a grabbing hand? *Applied Economics Letters*, *28*(3), 249–253. https://doi.org/10.1080/13504851.2020.1749760

Wu, G., & Yuan, H. (2021). The impact of Fintech on the profitability of state-owned commercial banks in China. *Journal of Physics: Conference Series*, *1955*(1), 0–5. https://doi.org/10.1088/1742-6596/1955/1/012007

Wu, M. W., & Shen, C. H. (2019). Effects of shadow banking on bank risks from the view of capital adequacy. *International Review of Economics and Finance*, *63*, 176–197. https://doi.org/10.1016/j.iref.2018.09.004

Zha, Y., Liang, N., Wu, M., & Bian, Y. (2016). Efficiency evaluation of banks in China: A dynamic two-stage slacks-based measure approach. *Omega (United Kingdom)*, *60*, 60–72. https://doi.org/10.1016/j.omega.2014.12.008

Zhang, Jianhua, Jiang, C., Qu, B., & Wang, P. (2013). Market concentration, risk-taking, and bank performance: Evidence from emerging economies. *International Review of Financial Analysis*, *30*, 149–157. https://doi.org/10.1016/j.irfa.2013.07.016

Zhang, Jing, Bi, Z., Hu, M., & Meng, Q. (2023). Shadow banking and commercial bank : evidence from China. *Applied Economics*, *55*(1), 72–89. https://doi.org/10.1080/00036846.2022.2055741

Zhou, Y., Peng, Y., & Latief, R. (2021). The impact of non-interest business development on the performance of Chinese rural commercial banks. *Emerging Markets Finance and Trade*, *57*(7), 1859–1877. https://doi.org/10.1080/1540496X.2019.1711369

Zhu, F., Chen, J., Chen, Z., & Li, H. (2019). Shadow banking shadowed in banks' balance sheets: Evidence from China's commercial banks. *Accounting and Finance*, *59*(5), 2879–2903. https://doi.org/10.1111/acfi.12558

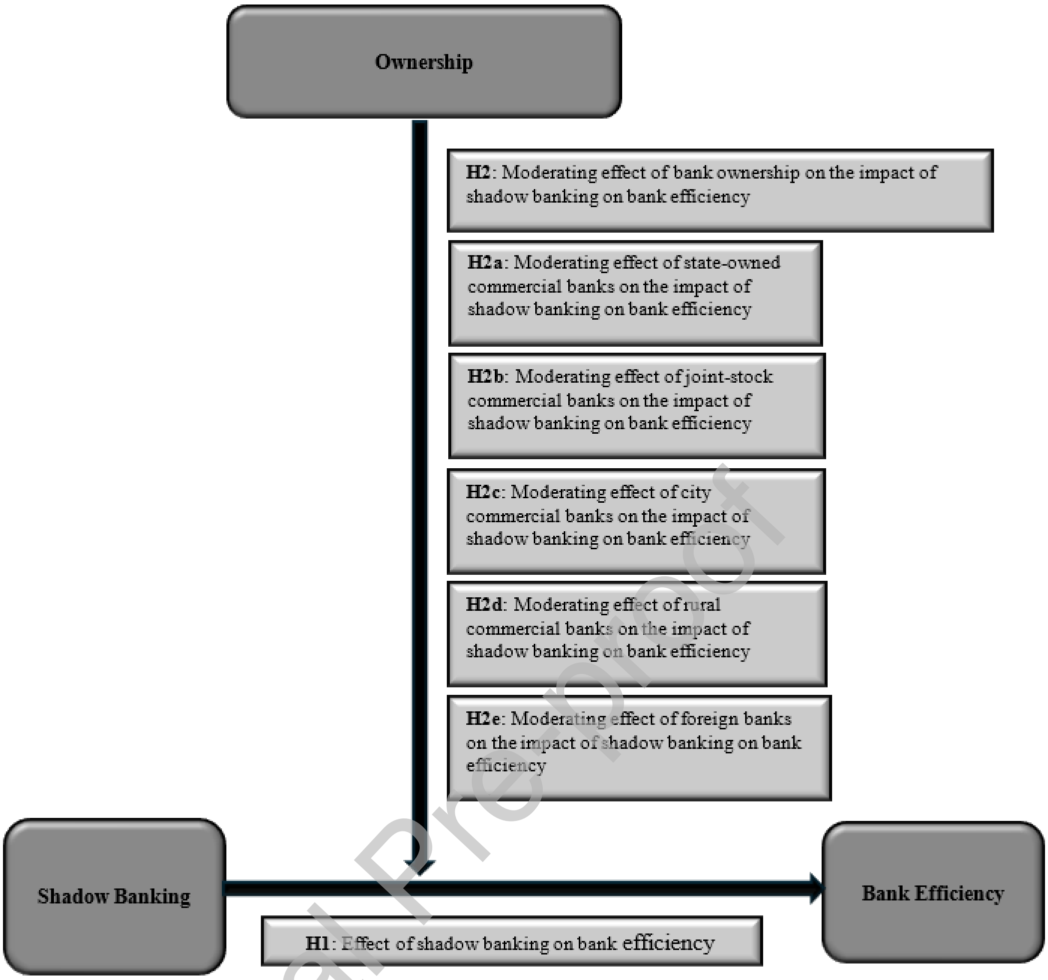

Figure 1: Research framework for the moderating effect of ownership on shadow baking to bank efficiency