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COVID-19 Crisis, Ownership and Bank Efficiency in Emerging Market Economies: An Empirical Study of Vietnam[1]

Abstract. Research on banking efficiency is abundant, yet studies typically focus on agency theory, which yields mixed findings, or analyse the impact of COVID-19 on performance without accounting for ownership differences. This paper investigates the effect of the COVID-19 pandemic on the efficiency of the Vietnamese banking system, with a focus on different ownership types. Using data from 28 Vietnamese banks over 2016 to 2022, a bootstrap variant of data envelopment analysis is employed to assess efficiency, and the Simar and Zelenyuk (2007) subgrouping test is used to compare bank performance by ownership and pandemic effects. Results show that private banks are significantly less efficient in providing intermediation services and generating profits, while state-owned and foreign banks perform better. Overall, Vietnamese banks demonstrated resilience during the pandemic, but private banks lagged behind, indicating a need for targeted oversight to enhance sector efficiency. Regression analyses incorporating control variables provide further insights. Credit growth has little impact on performance, nonperforming loans improve operational efficiency, larger banks are more efficient, and a higher deposits-to-assets ratio negatively affects efficiency. These findings suggest the need for policy measures such as careful assessment of bank performance, targeted efficiency interventions for private banks, balancing risk and efficiency in lending, promoting bank growth, and diversifying funding sources. The results may also offer lessons for other emerging economies, including ASEAN and Latin American countries.

Keywords: COVID-19 crisis, bank efficiency, ownership, data envelopment analysis (DEA), bootstrap, Vietnam

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Влияние кризиса COVID-19 и типа собственности на эффективность банков в развивающихся странах: эмпирическое исследование Вьетнама

Аннотация. Несмотря на то, что эффективность банков является предметом многочисленных исследований, в существующей литературе есть определенные пробелы: анализ либо фокусируется на теории агентства, что приводит к неоднозначным результатам, либо влияние пандемии коронавируса анализируется через банковские показатели без учета типа собственности. В данной статье исследуется воздействие пандемии на эффективность банковской системы Вьетнама с акцентом на типы собственности. На основе данных 28 вьетнамских банков за 2016–2022 гг. эффективность измерялась с помощью бутстрап-варианта анализа оболочки данных (DEA), а для сравнения групп по типу собственности и влиянию пандемии применялся тест кластеризации Симара и Зеленюка (Simar & Zelenyuk, 2007). Показано, что частные банки значительно уступают государственным и иностранным как в предоставлении посреднических услуг, так и в плане рентабельности. Несмотря на общую устойчивость вьетнамской банковской системы в период пандемии, частные банки показали отставание, что указывает на необходимость целенаправленного регулирования для повышения эффективности данного сегмента. Регрессионный анализ с контрольными переменными выявил дополнительные закономерности: рост кредитования оказывает незначительное влияние на эффективность, наблюдается неочевидная положительная связь между проблемными кредитами и эффективностью, более крупные банки работают эффективнее, чем более мелкие, а высокое соотношение депозитов к активам негативно сказывается на результативности. На основании этих выводов предлагаются следующие меры государственной политики: внедрение регулярной детальной оценки деятельности банков, разработка целевых программ повышения эффективности для частных банков, сбалансированный подход к рискам и доходности при кредитовании, поддержка роста банков и диверсификация источников финансирования. Результаты исследования могут представлять интерес для регулирующих органов других развивающихся стран, в частности государств АСЕАН и Латинской Америки.

Ключевые слова: кризис COVID-19, эффективность банков, собственность, метод DEA, бутстрап, Вьетнам

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Introduction

The novel coronavirus (COVID-19), whose outbreak started in Wuhan, China in December 2019, quickly spread globally. This pandemic has had devastating effects not only on public health but also on the global economy, disrupting supply chains, prompting lockdowns, and enforcing social distancing (Ashraf et al., 2022). As a result, business activities were halted, and the financial sector came under intense pressure. Previous studies have compared the COVID-19 crisis with financial crises such as the 1997 Asian Financial Crisis (AFC), the 2008 Global Financial Crisis (GFC), and the European Public Debt Crisis (Shabir et al., 2023). A key distinction is that the COVID-19 crisis was triggered by external factors, whereas these financial crises arose from internal ones (Batten et al., 2022). The unique nature of the COVID-19 crisis and its impact on the financial system therefore requires further investigation.

Banks, as key financial institutions, were heavily affected by the COVID-19 pandemic (Berger & Demirgüç-Kunt, 2021). Quarantine measures disrupted banking services and created difficulties for customers in repaying loans. Bank managers faced the challenge of optimizing operations amid job cuts, branch closures, rising non-performing loans, and declining revenues (Boubaker et al., 2023; Horvath et al., 2023). Consequently, management quality has become a critical factor in determining bank stability and resilience to the COVID-19 shock. Although the pandemic affected banks worldwide, regardless of location, development level, or ownership, effective management remains

essential in mitigating its adverse impacts (Borri & Di Giorgio, 2022).

The quality of management can be measured by using the efficiency standard. This criterion demonstrates the capability of managers when transforming inputs into outputs (Charnes et al., 1978). However, in the context of COVID-19 pandemic, bank managers had to overcome multiple challenges in utilizing inputs (for example, labour, assets, deposits) to generate outputs (for example, revenues, loans, investments and securities) (Gulati et al., 2023). Specifically, the lockdown and social distancing force bank staff to stay at home and work remotely. Customers, including enterprises and individuals, were unable to repay their loans due to the loss of jobs and disruption of business activities. The managers imitated the new conditions by cutting their interest rates, rescheduling repayment plans and using advanced technology such as artificial intelligence to allow remote banking transactions (Horvath et al., 2023; Li et al., 2021). Accordingly, the impact of COVID-19 on bank efficiency can be positive or negative, depending on governments' responses, quality of bank management and resilience to external shocks of the particular economies. For instance, there is evidence that Islamic Banks performed better than conventional ones (Boubaker et al., 2022; Rizwan et al., 2022), with banks in different countries/regions got affected differently (Ngo et al., 2025). Hence our first hypothesis is as follows:

H1: The COVID-19 pandemic has a significant effect on bank performance.

In emerging market economies, public ownership is prevailing in their banking systems. Subsequently, bank management and efficiency are strongly influenced by ownership (Le et al., 2019, 2022). The relationship between ownership and bank performance is explained by the agency problem, which arises from the separation of ownership and management and suggests why private banks often outperform state-owned banks (Altunbas et al., 2001; La Porta et al., 2002; Shleifer & Vishny, 1997). According to La Porta et al. (2002), the government, as the owner of state-owned banks, manages operations to pursue policy objectives rather than the interests of taxpayers, who are the actual owners. As a result, state-owned banks pursue not only profit but also political and social goals, sometimes prioritizing non-profit objectives. In contrast, private banks focus solely on profit, supported by managerial mechanisms that allow owners to directly participate in oversight through boards of directors or internal control systems, or indirectly through voting (De Andres & Vallelado, 2008). In theory, this governance system should enable private banks to perform better than state-owned banks. However, several studies report the opposite, finding that state-owned banks can be more efficient than private banks under various input/output approaches and estimation methods (Das & Ghosh, 2006; Denizer et al., 2007; Karas et al., 2010; Kraft et al., 2006; Le et al., 2019; Robin et al., 2019). These findings raise questions about the consistency and comprehensiveness of agency theory in the banking sector.

Overall, the current literature either focuses on agency theory, with inconclusive findings, or on the impact of COVID-19 on bank performance without considering ownership. This paper addresses this gap by examining how COVID-19 affected bank efficiency across different ownership types. We argue that ownership influences both management quality and efficiency, and may also shape how banks respond to the COVID-19 crisis (Kryzanowski et al., 2023; Boubaker et al., 2024). This leads to our second hypothesis:

H2: The efficiency of banks during the COVID-19 pandemic differs across ownership types.

Using a case study of the data set of 28 Vietnamese banks covering the years from 2016 to 2022, this study aims to evaluate the impact of COVID-19 on bank efficiency across different ownership types. Bootstrapped DEA is employed to accurately measure and analyse bank efficiency since it helps identify efficiency biases (Simar & Wilson, 2007). The results show that Vietnamese banks were, in fact, more efficient during the time of COVID-19 crisis when compared with the pre-COVID-19 period, under both the intermediation and operating approaches. Furthermore, private banks are less efficient than state-owned and foreign banks and their efficiency declines in the COVID-19 period.

The paper is organized as follows. Section 2 presents the methodological approach, Section 3 describes the data and proxies used, Section 4 discusses the empirical results, and Section 5 concludes with key findings.

Methodology

DEA Technical Efficiency

Consider an industry consisting of n firms. Each firm employs p inputs to produce q outputs. Let $x \in \mathbb{R}_+^p$ denote a $(1 \times p)$ vector of inputs and $y \in \mathbb{R}_+^q$ denote a $(1 \times q)$ vector of outputs. Under a given technology, the production set of the industry can be defined by:

$$\wp = \left\{ (x, y) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : x \ \ can \ \ produce \ \ y \right\} \quad (1)$$

Under the assumption of free disposability of inputs and outputs and variable returns to scale, the DEA estimate of the production set can be measured:

$$\hat{\wp} = \left\{ \begin{array}{l} (x,y) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : \sum_{k=1}^n z_k y_k^i \geq y^i, \\ i = 1,\ldots,q; \sum_{k=1}^n z_k x_k^j \leq x^j, \\ j = 1,\ldots,p; \\ \sum_{k=1}^n z_k = 1, z_k \geq 0 \end{array} \right\} \quad (2)$$

Simar and Wilson (2007) noted that the reciprocal of the distance function (δ) represents a Farrell-type measure of technical efficiency. The DEA output-oriented estimator of δ can be expressed as in Equation (3), where banks aim to maximize their outputs *y* (3.1) given inputs *x* (3.2 under the assumption of variable returns to scale (3.3):

$$\hat{\delta} = \delta\left(x,\ y \in \hat{\wp}\right) \quad (3)$$

$$= max\{\delta > 0 : \sum_{k=1}^n z_k y_k^i \geq \delta y^i,\ i \quad (3.1)$$

$$= 1,\ldots,q; \sum_{k=1}^n z_k x_k^j \leq x^j,\ j \quad (3.2)$$

$$= 1,\ldots,p; \sum_{k=1}^n z_k = 1, z_k \geq 0\} \quad (3.3)$$

To measure group efficiency, aggregate or mean efficiency scores can be used. Aggregate scores weight individual firms according to their contribution to total group output, whereas mean scores assign equal weight to all firms, regardless of their output share.

The Simar and Zelenyuk (2007) Test for Differences in Efficiency between Two Groups

We use a bootstrap-based test, proposed by Simar & Zelenyuk (2007), to investigate the equality of efficiency among different bank groups. In brief, if there are two bank groups, say A and Z, we can state the following set of hypotheses: $H_0 : \overline{\delta^A} = \overline{\delta^Z}$ against $H_1 : \overline{\delta^A} \neq \overline{\delta^Z}$ where $\overline{\delta^A}$ and $\overline{\delta^Z}$ are the ratios of weighted efficiency means (aggregate efficiencies) and non-weighted efficiency means (mean efficiencies) for groups A and Z, respectively. Due to the multiplicative nature of efficiency values, Simar and Zelenyuk (2007) were able to propose an RD ratio and its DEA estimate as $RD_{A,Z} = \frac{\overline{\delta^A}}{\overline{\delta^Z}}$ and $\widehat{RD}_{A,Z} = \frac{\overline{\hat{\delta}^A}}{\overline{\hat{\delta}^Z}}$, respectively. The bootstrap confidence intervals of the RD statistics can be used to test the above hypotheses. H0 can be rejected if the confidence interval for RDA, Z does not overlap with unity; otherwise, we do not reject the null. If the confidence interval lies above unity, then we can conclude that $\overline{\delta^A} > \overline{\delta^Z}$, which means that the efficiency score of group A is bigger than that of group Z, and group A is less efficient than group Z. If the confidence interval falls below one, the conclusion regarding the efficiency difference between the two groups is reversed (see Simar and Zelenyuk, 2007 for details).

Regression Models

To examine the relationship between bank ownership, COVID-19, and efficiency, the following equation is employed:

$$\delta_{it} = \alpha + \beta.COVID + \gamma.JSB + \theta.X_{it} + u_{it} \quad (4)$$

where δ_{it} is the inefficiency score of bank i at the year *t*; *COVID* is the dummy variable indicating a bank operating in the COVID-19 period; *JSB* is the dummy that indicates a private bank; X_{it} are control variables.

The interaction of *COV* and *JSB* dummies is added in Equation (4) to investigate the influence of the pandemic on a specific type of ownership. Equation (4) is rewritten as below.

$$\delta_{it} = \alpha + \beta.COVID + \gamma.JSB + \epsilon.(COVID \cdot JSB) + \\ + \theta.X_{it} + u_{it} \quad (5)$$

Several methods are utilized to regress bank efficiency on environmental variables, including pooled OLS, truncated regression proposed by Simar & Wilson (2007), and Feasible Generalized Least Squares (FGLS).

Simar and Wilson (2007) Method

It is argued that there may exist a relationship between the bank inputs and outputs of DEA calculations in Equation (3) and the environmental variables of efficiency regression in Equation (5); for example, foreign banks tend to have fewer branches and staff than domestic banks. To account for this issue, we used the double-bootstrap two-stage DEA approach of Simar & Wilson (2007), in which equations (3) and (5) were simultaneously and repeatedly estimated for B times (normally B > 1000). The averaged values of the coefficients for Equation (5) derived from such a bootstrapping

technique are thus bias-corrected and are closer to the 'true' coefficients. The bootstrap algorithm can be expressed as follows (for more details see Simar and Wilson (2007)).

Step 1: Calculate DEA efficiency using Equation (3).

Step 2: Bootstrap B=2000 times of the following steps,

Step 2a: Estimate the coefficients using Equation (5).

Step 2b: Generate the random error ε (i.i.d.) and use it to predict the outputs $\hat{y}$ using Equation (5).

Step 2c: Re-estimate DEA efficiency using Equation (3) using the new outputs $\hat{y}$ and old inputs *x*.

Step 3: Calculate the bias-corrected DEA efficiency and coefficients as averages of the bootstrap results.

Data and Choice of Inputs/Outputs

Despite substantial research efforts there is still a lack of agreement in identifying the outputs and inputs of banks in literature (Gulati et al., 2023; Kenjegalieva et al., 2009). Depending on the banks' functions and operations, two approaches to inputs/outputs are widely used in previous studies: the intermediation and the operation approaches. The intermediation approach views banks as intermediaries transferring funds between savers and investors and relies on labour, capital and deposits as inputs to generate loans and other nontraditional assets (securities and investments) as outputs. The operation approach considers banks as businesses that pursue profit through maximizing revenues as well as minimizing costs in their operations. Accordingly, interest income and non-interest income can be utilized as outputs, while interest expenses and non-interest expenses are treated as inputs.

In the first stage, input-output combinations are used to construct the production frontier and measure bank efficiency. In the second stage, environmental variables potentially affecting efficiency are identified. Considering the COVID-19 pandemic, several variables are included. The dummy variable COV captures the pandemic's impact, taking the value of one for banks operating during 2020–2022. To assess ownership effects, the dummy JSB represents private banks. Control variables capture other characteristics of Vietnamese banks: total assets measure scale effects, credit growth rate reflects changes in lending activity, and the deposits-to-assets ratio proxies the banks' ability to attract capital from firms and consumers

For the empirical analysis, data were collected from annual reports of 28 Vietnamese banks, including four state-owned commercial banks (SOCBs), four foreign banks (FBs), and 20 private banks (JSBs). The balanced dataset spans 2016–2022, covering both pre-COVID-19 (2016–2019) and COVID-19 (2020–2022) periods, yielding 196 bank-year observations. Statistical descriptions of the variables are presented in Tables 1 and 2, highlighting heterogeneity among

Table 1

Descriptive Statistics of the Variables

Variables	Min	Max	Mean	S.D.
Inputs and outputs (in million VND)				
Labour expenses	112,054	16,138,750	2,996,414	3,546,515
Fixed assets	29,538	11,436,627	2,810,441	3,327,110
Deposits	7,528,859	1,627,735,786	261,722,881	355,655,469
Loans	7,234,992	1,483,995,823	237,928,489	328,874,719
Non-traditional assets	356,161	241,354,320	49,406,572	51,384,830
Interest expense	139,647	68,625,103	12,576,315	16,025,771
Non-interest expense	158,766	31,515,723	6,766,455	7,903,952
Interest income	462,902	127,833,464	22,948,844	28,368,595
Non-interest income	77,881	23,981,489	4,601,857	6,085,705
Regressors				
COV	0.0000	1.0000	0.4286	0.4961
JSB	0.0000	1.0000	0.7143	0.4529
dC	–0.1132	0.5935	0.1736	0.1043
LLPR	0.0006	0.3781	0.1043	0.0763
LogA	7.1287	9.3265	8.2575	0.5204
DA	0.4279	0.9281	0.6936	0.1174

Notes: COV represents the COVID-19 dummy variable. JSB _ a dummy represents Joint Stock Banks (private banks). LogA represents the logarithm 10 form of bank assets. DA represents the deposits-to-assets ratio. LLPR represents the loan loss provisioning cost to total cost ratio. dC represents the credit growth rate. (Source: Authors' estimates based on banks' financial reports)

Table 2

Correlation Matrix

	COV	JSB	dC	LLPR	LogA	DA
COV	1.0000					
JSB	0.0012	1.0000				
dC	–0.2712	0.0843	1.0000			
LLPR	0.0444	–0.0737	–0.1543	1.0000		
LogA	0.1896	–0.2436	–0.0152	0.3478	1.0000	
DA	–0.0298	–0.1993	–0.2267	–0.0518	0.2103	1.0000

Notes: COV represents the COVID-19 dummy variable. JSB, a dummy represents Joint Stock Banks (private banks). LogA represents the logarithm 10 form of bank assets. DA represents the deposits-to-assets ratio. LLPR represents the loan loss provisioning cost to total cost ratio. dC represents the credit growth rate. (Source: Authors' estimates)

banks. For example, due to commercialization and development of the Vietnamese banking system (Ngo & Tripe, 2017; Le et al., 2019, 2022),[1] many rural bank branches were transformed into urban joint-stock banks in the early 2010s, which are considerably smaller than state-owned banks. As discussed in Section 2.4, this heterogeneity justifies the use of bootstrap DEA in our analysis.

Results

Bank Efficiency Comparisons

Private Banks Versus State-Owned and Foreign Banks

The Simar and Zelenyuk (2007) method is applied to provide deeper insights into differences in efficiency across bank groups. This approach allows us to quantify efficiency levels and the magnitude of differences between them. Table 3 presents the results, with Agg.Eff. and M.Eff. representing aggregate and mean efficiency measures, respectively. Under the intermediate approach, the bootstrap values of Agg.Eff. and M.Eff. are 1.1652 and 1.2938, while under the operational approach, they are 1.2133 and 1.3473.2 These results indicate that banks could increase the volume of intermediate services by 16.52 % using the aggregate measure or 29.38 % using the mean measure. Similarly, the ability to generate bank profits could improve by 21.33 % under the aggregate measure or 34.73 % under the mean measure.

The RD_ag, presented in Table 3, is the ratio of JSBs aggregate efficiency scores to SOCBs and foreign bank aggregate efficiency scores. Table 3 shows that at 1 % level of significance, RD_ag fluctuates between 1.0245 and 1.2060 for the intermediation setting, and between 1.0164 and 1.2341 for the operation approach. All intervals are above one, indicating that JSBs underperformed compared to SOCBs and foreign banks in both providing intermediate services and maximizing profits. At the 1 % significance level, RD_mean—the ratio of JSBs' mean efficiency scores to those of SOCBs and foreign banks—ranges from 1.0813 to 1.2660 under the intermediation approach and from 1.1026 to 1.3132 under the operational approach (Table 3). These values, being above one, again confirm the superior efficiency of SOCBs and foreign banks over JSBs, regardless of the input/output approach used.

These findings contrast with studies suggesting that private banks are more efficient than SOCBs (e.g., Bonin et al., 2005; Fries & Taci, 2005). However, they align with research in emerging market economies, such as China and Vietnam, where SOCBs outperform their counterparts (Antunes et al., 2024; Boubaker et al., 2024; Denizer et al., 2007; Karas et al., 2010; Kraft et al., 2006).

Bank Efficiency Before and During the COVID-19 Pandemic

Table 4 demonstrates estimates of aggregate and mean efficiency of Vietnamese banks before and during the pandemic. Under the intermediation approach, aggregate efficiency scores for the two periods are 1.1859 and 1.1324, respectively, while the mean efficiency scores are 1.2849 and 1.2252. Under the operation approach, aggregate efficiency scores are 1.2722 before COVID-19 and 1.1499 during COVID-19, with mean scores of 1.3704 and 1.2913, respectively. In all cases, inefficiency is higher in the pre-COVID-19 period, which means that banks performed more efficiently during the pandemic.

[1] See also the Decree No. 59/2009/ND-CP on "Organization and operation of Commercial Banks" and the Decision No. 254/QD-TTg on approving the scheme on "Restructuring the credit institutions system in the 2011–2015 period" released by the Vietnamese Government in 2009 and 2012, respectively.

[2] This study examined banks' output-oriented efficiency, where higher scores (above one) indicate lower efficiency.

Table 3

Comparison of Vietnamese Bank Efficiency between JSBs and the Others (SOCBs and Foreign Banks)

	Intermediation Approach							Operating Approach						
	DEA Est.	Std. Error	Bias Correction Est.	Confidence Interval Bounds				DEA Est.	Std. Error	Bias Correction Est.	Confidence Interval Bounds			
				95 %		99 %					95 %		99 %	
Agg. Eff. JSBs	1.1761	0.0543	1.2442	1.1932	1.2998	1.1724	1.3136	1.2004	0.0348	1.2887	1.2100	1.3469	1.1821	1.3599
Agg. Eff. Others	1.0711	0.0226	1.1221	1.0696	1.1629	1.0526	1.1853	1.0908	0.0232	1.1358	1.0801	1.1724	1.0520	1.1786
Agg. Eff.	1.1202	0.0469	1.1652	1.1486	1.2207	1.1355	1.2311	1.1434	0.0209	1.2133	1.1660	1.2472	1.1490	1.2543
M.Eff. JSBs	1.2211	0.0992	1.3945	1.2473	1.3622	1.2301	1.3779	1.2940	0.0413	1.4152	1.3281	1.4836	1.3059	1.5020
M.Eff. Others	1.0952	0.0219	1.1565	1.1053	1.1894	1.0897	1.1966	1.0981	0.0184	1.1529	1.1112	1.1830	1.0956	1.1890
M.Eff.	1.1851	0.0826	1.2938	1.2276	1.3103	1.2150	1.3222	1.2380	0.0289	1.3473	1.2876	1.3955	1.2705	1.4073
RD_ag	1.0980	0.0955	1.1088	1.0483	1.1859	1.0245	1.2060	1.1005	0.0394	1.1371	1.0555	1.2076	1.0164	1.2341
RD_ mean	1.1346	0.0352	1.2059	1.1012	1.2451	1.0813	1.2660	1.1698	0.0412	1.2152	1.1315	1.2911	1.1026	1.3132

Notes: Agg.Eff. JSBs and Agg.Eff. Others represent the aggregate efficiency scores of JSBs and of other banks (state-owned and foreign banks), respectively, while Agg.Eff. denotes the aggregate efficiency score for the entire sample. M.Eff. JSBs and M.Eff. Others are the mean efficiency scores of JSBs and other banks, respectively, with M.Eff. representing the mean score for the full sample. RD_ag is the ratio of the aggregate efficiency of JSBs to that of other banks, and RD_mean is the corresponding ratio of mean efficiency scores. For each significance level, two columns report the upper and lower bounds of the estimators. (Source: Authors' estimates)

At the 5 % significance level, RD_ag, the ratio of aggregate efficiency during and before the pandemic, ranges from 0.8522 to 0.9898 under the intermediation approach and from 0.8225 to 0.9806 under the operating approach. Since both intervals lie below one, the aggregate measure indicates that Vietnamese banks were more efficient during the COVID-19 period. However, the RD_mean results, based on mean efficiency, are not statistically significant.

Overall, across different efficiency measures and approaches, the Simar and Zelenyuk (2007) test supports Hypothesis 1, showing that the COVID-19 pandemic had a significant and positive impact on bank performance in Vietnam.

Bank Efficiency and its Determinants

Since the relationships among DEA efficiency estimates are complex and unknown, conventional inference methods such as OLS and Tobit tend to yield biased results (Simar and Wilson, 2007). To obtain unbiased estimates, we employ Feasible Generalized Least Squares (FGLS) and the bootstrap truncated regression models developed by Simar and Wilson (2007) in the second-stage analysis.

Tables 5 and 6 report the statistical relationships between bank efficiency and environmental variables. In Table 5, the coefficients of the COV dummy are negative and significant in models (4) to (6), indicating that the COVID-19 pandemic had a positive effect on intermediation efficiency. Table 6 shows similar results for operating efficiency, providing further support for Hypothesis 1 that the pandemic had a significant effect on bank performance.

The JSB dummy is positive and significant at the 1 percent level across all models in Tables 5 and 6, which means that private banks underperformed relative to state-owned and foreign banks under both the intermediation and operating approaches. To examine how the pandemic influenced the ownership–efficiency relationship, we include an interaction term between COV and JSB. The coefficients of this interaction term are positive in models (4) to (6) in both tables, suggesting that private banks became less efficient during the COVID-19 period compared with the pre-pandemic period. Thus, while the Vietnamese banking sector as a whole became more efficient during the

Table 4

Comparison of Vietnamese Bank Efficiency between Pre – and During-COVID-19 Periods

	Intermediation Approach							Operating Approach						
	DEA Est.	Std Error	Bias Correction Est.	Confidence Interval Bounds				DEA Est.	Std. Error	Bias Correction Est.	Confidence Interval Bounds			
				95 %		99 %					95 %		99 %	
Agg. Eff. COV	1.0875	0.0223	1.1324	1.0852	1.1757	1.0632	1.2009	1.1018	0.0260	1.1499	1.0882	1.1868	1.0587	1.1931
Agg. Eff. Pre-COV	1.1546	0.0741	1.1859	1.1580	1.2797	1.1249	1.2895	1.1947	0.0402	1.2722	1.1776	1.3356	1.1387	1.3498
Agg. Eff.	1.1202	0.0206	1.6464	1.1402	1.2143	1.1281	1.2302	1.1434	0.0227	1.2079	1.1574	1.2451	1.1348	1.2540
M.Eff. COV	1.1622	0.0328	1.2252	1.1585	1.2809	1.1301	1.2981	1.2006	0.0334	1.2913	1.2204	1.3456	1.1909	1.3640
M.Eff. Pre-COV	1.2022	0.0806	1.2849	1.2334	1.3478	1.2074	1.3624	1.2661	0.0417	1.3704	1.2845	1.4398	1.2597	1.4550
M.Eff.	1.1851	0.0219	1.2565	1.2186	1.3065	1.2088	1.3227	1.2380	0.0322	1.3375	1.2690	1.3902	1.2522	1.4047
RD_ag	0.9419	0.0508	0.9194	0.8522	0.9898	0.8343	1.0192	0.9222	0.0393	0.9002	0.8225	0.9806	0.7914	1.0041
RD_ mean	0.9909	0.0543	0.9938	0.9123	1.0657	0.8837	1.0861	0.9743	0.0341	0.9926	0.9278	1.0600	0.9042	1.0824

Notes: Agg.Eff. COV and Agg.Eff. Pre-COV are aggregate efficiency scores during and before the pandemic; Agg.Eff. refers to the full sample. M.Eff. COV and M.Eff. Pre-COV are mean efficiency scores during and before the pandemic; M.Eff. is the full-sample mean. RD_ag is the ratio of aggregate efficiency in the pandemic to the pre-pandemic period, and RD_mean is the corresponding ratio using mean scores. For each significance level, two columns present the lower and upper bounds of the estimated intervals. (Source: Authors' estimates)

pandemic, private banks experienced a decline in efficiency.

These findings confirm Hypothesis 1 regarding the significant impact of the pandemic on bank efficiency and support Hypothesis 2 that ownership types responded differently to the COVID-19 shock.

Credit was substantially affected by the COVID-19 pandemic; however, regression results show no significant link between credit growth and bank efficiency. Nonperforming loans, proxied by the loan-loss provisioning to total cost ratio, are positively associated with operating efficiency, suggesting that banks engaging in riskier lending may achieve higher profitability. Bank size is positively related to efficiency under both approaches, as larger banks can provide more intermediation services and earn higher profits using the same input levels as smaller banks. Finally, the deposits-to-assets ratio is negatively correlated with both intermediation and operating efficiency, indicating that banks relying more heavily on deposits may show lower efficiency.

Model Validation and Robustness Checks

To ensure the validity of the empirical findings, we conducted a series of diagnostic tests and model comparisons. First, the risk of multicollinearity was assessed through the mean Variance Inflation Factor (VIF). All models returned low average VIF values (ranging from 1.21 to 1.56) which are under the conventional threshold of 10, indicating no multicollinearity concerns among explanatory variables.

To evaluate potential autocorrelation, the Wooldridge test for panel data was applied, strongly rejecting the null hypothesis of no first-order serial correlation ($F = 79.394$, $p = 0.001$ in Table 5; $F = 5.060$, $p = 0.033$ in Table 6). This aligns with DEA theory, where efficiency scores are inherently dependent due to their calculation (see Equation 3). To address this, the two-stage double-bootstrap method of Simar and Wilson (2007) is used, with results reported in models (2) and (5) of Tables 5 and 6. Additionally, the panel model employs Feasible Generalized Least Squares (FGLS) with correction for groupwise heteroskedasticity, accommodating both autocorrelation and heteroskedasticity.

Table 5

The Impact of COVID-19, Ownership on Intermediation Efficiency

	Pooled OLS (1)	Bootstrap DEA (2)	FGLS (3)	Pooled OLS (4)	Bootstrap DEA (5)	FGLS (6)
Constant	1.433*** (.143)	1.752*** (.301)	1.450*** (.098)	1.445*** (.145)	1.762*** (.298)	1.490*** (.101)
COV	–.014 (.018)	–0.025 (.034)	–.010 (.010)	–.041* (.025)	–0.097* (.087)	–.028* (.015)
JSB	.138*** (.017)	0.218*** (.050)	.132*** (.011)	.123*** (.024)	0.187*** (.055)	.119*** (.013)
COV*JSB				.119*** (.023)	0.087* (.0577)	.121*** (.013)
dC	–.035 (.102)	–0.003 (.148)	.012 (.070)	–.037 (.103)	–0.005 (.147)	–.005 (.071)
LLPR	.015(.148)	–0.182 (.233)	.022 (.064)	.022 (.147)	–0.159 (.231)	.040 (.064)
LogA	–.110*** (.019)	–0.177*** (.038)	–.111*** (.012)	–.110*** (.019)	–0.175*** (.037)	–.116*** (.012)
DA	.824*** (.072)	1.143*** (.179)	.816*** (.047)	.830*** (.072)	1.141*** (.177)	.833*** (.049)
Mean VIF	1.21			1.56		
Wooldridge test	F–statistic = 79.394 p–value = 0.001			NA		
Pesaran test	CD–statistic = –0.827 p–value = 0.408			CD–statistic = –0.904 p–value = 0.366		
AIC	–254.482	NA	–254.482	–253.378	NA	–253.378
Observations	196	196 (B = 2000)	196	196	196 (B = 2000)	196

Notes: Pooled OLS, the Simar–Wilson (2007) truncated regression, and FGLS are used to regress bank efficiency on environmental variables. *, **, and *** denote significance at the 10 %, 5 %, and 1 % levels. COV is the COVID-19 dummy; JSB the Joint Stock Bank dummy; LogA the base-10 log of assets; DA the deposits-to-assets ratio; LLPR the loan-loss provisioning cost ratio; dC the credit growth rate. VIF is the variance inflation factor, AIC the Akaike information criterion, and NA indicates unavailable values. (Source: Authors' estimates)

Table 6

The Impact of COVID-19, Ownership on Operating Efficiency

	Pooled OLS (1)	Bootstrap DEA (2)	FGLS (3)	Pooled OLS (4)	Bootstrap DEA (5)	FGLS (6)
Constant	1.127*** (.132)	1.099*** (.234)	1.067*** (.102)	1.111*** (.131)	1.082*** (.233)	1.090*** (.104)
COV	–.057*** (.019)	–0.069*** (.025)	–.038*** (.011)	–.021 (.033)	–0.022 (.064)	–.037* (.023)
JSB	.204*** (.019)	0.301*** (.038)	.203*** (.014)	.225*** (.023)	0.317*** (.046)	.204*** (.018)
COV*JSB				.153*** (.025)	0.056* (.047)	.168*** (.018)
dC	–.0755 (.103)	–0.119 (.113)	–.020 (.046)	–.072 (.102)	–0.119 (.112)	–.031 (.050)
LLPR	–.597*** (.114)	–0.899*** (.186)	–.556*** (.073)	–.606*** (.111)	–0.901*** (.184)	–.559*** (.077)
LogA	–.027* (.016)	–0.029 (.028)	–.030** (.013)	–.026* (.016)	–0.029 (.028)	–.031** (.013)
DA	.418*** (.083)	0.510*** (.110)	.489*** (.048)	.409*** (.083)	0.509*** (.109)	.478*** (.051)
Mean VIF	1.21			1.56		
Wooldridge test	F–statistic = 5.060 p–value = 0.033			NA		
Pesaran test	CD–statistic = 1.410 p–value = 0.159			CD–statistic = 1.356 p–value = 0.175		
AIC	–262.873	NA	–262.873	–262.679	NA	–262.679
Observations	196	196 (B = 2000)	196	196	196 (B = 2000)	196

Notes: Pooled OLS, the Simar–Wilson (2007) truncated regression, and FGLS are used to regress bank efficiency on environmental variables. *, **, and *** indicate significance at 10 %, 5 %, and 1 % levels. COV is the COVID-19 dummy; JSB the Joint Stock Bank dummy; LogA the base-10 log of assets; DA the deposits-to-assets ratio; LLPR the loan-loss provisioning ratio; dC the credit growth rate. VIF is the variance inflation factor, AIC the Akaike information criterion, and NA indicates unavailable value. (Source: Authors' estimates)

The Pesaran test for cross-sectional dependence was also conducted, yielding p-values of 0.408 and 0.366 in Table 5 and 0.159 and 0.175 in Table 6. These results indicate that the null hypothesis of cross-sectional independence cannot be rejected, suggesting that cross-sectional dependence is unlikely to bias the panel estimates.

Model performance was further compared using the Akaike Information Criterion (AIC). The AIC differences between models in Tables 5 and 6 are all below 2, confirming that the models are comparable.

Overall, the combined evidence from diagnostic testing and model selection criteria supports the validity of the estimation results and affirms the reliability of the conclusions drawn from the panel models.

Conclusion

Agency theory suggests that bank ownership affects performance, yet studies examining its role during the COVID-19 pandemic remain limited. This paper addresses this gap using data from the Vietnamese banking system (2016–2022), where ownership plays a key role in business operations and performance (Ngo et al., 2019; Boubaker et al., 2024). Using the Simar and Zelenyuk (2007) subgrouping test, the study finds that private banks underperformed in comparison with state-owned and foreign banks in both intermediation services and profit generation. While Vietnamese banks generally demonstrated resilience during the pandemic, private banks were an exception, highlighting the need for stricter oversight to improve overall banking efficiency.

Regression results with various control variables provide further insights. Credit growth had no significant effect on performance, while nonperforming loans, proxied by the loan-loss provisioning to total cost ratio, enhanced operating efficiency. Bank size positively affected both intermediation and operating efficiency, whereas a higher deposits-to-assets ratio had a negative impact.

These findings carry significant implications for policy and regulatory measures. Bank performance assessments should be approached cautiously, as government and central bank support during and after the pandemic may overstate efficiency. Targeted policies to improve efficiency and competition in private banks are needed. Banks should balance risk and efficiency when engaging in lending, increase their size to improve operational efficiency, and diversify funding sources to reduce reliance on deposits. These implications may also apply to other emerging economies with conditions similar to Vietnam, including ASEAN and Latin American countries.

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All authors declare that they have not used Artificial Intelligence (AI) tools for the creation of this article.

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