Advanced International Journal of Business, Entrepreneurship and SME's
EISSN: 2682-8545
Volume: 8 Issue: 29 (September 2026) PP. 2314-2328



ADVANCED INTERNATIONAL JOURNAL OF BUSINESS, ENTREPRENEURSHIP AND SMES (AIJBES)
www.gaexcellence.com/aijbes

DEVELOPMENTS IN THE EFFICIENCY AND RETURNS TO SCALE OF THE KEY ASEAN ECONOMIES BANKING SECTORS

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Article Info:

Article history:
Received date: 20.07.2026
Revised date: 19.08.2026
Accepted date: 27.09.2026
Published date: 30.09.2026

Abstract:

How much of bank inefficiency in ASEAN reflects resource management, and how much is linked to operating at the wrong scale? This study examines this question for 189 commercial banks in Singapore, Malaysia, Thailand, Indonesia, the Philippines, and Vietnam over 2013–2021. We estimate an input-oriented Data Envelopment Analysis (DEA) frontier under constant returns to scale (CRS) and variable returns to scale (VRS) and use the non-increasing returns to scale (NIRS) specification to distinguish increasing from decreasing returns to scale. Thailand recorded the highest mean technical efficiency (0.599), while the Philippines recorded the lowest (0.348). Vietnam has the highest mean pure technical efficiency (0.795), whereas Malaysia has the strongest mean scale efficiency (0.913). At the income-group level used in this study, the middle-income banking sectors achieve a higher mean technical efficiency than the high- and low-income groups. Returns to scale are dominated by decreasing returns to scale: 1,235 of 1,523 bank-year observations are classified as DRS, compared with 88

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume: 8 Issue: 29 (September 2026) PP. 2314-2328

To cite this document:

Shukur, N. A., Rahim, N. H. A., Shariff, S. S. M., Johan, N. J. M., & Sufian, F. (2026). Developments In the Efficiency and Returns to Scale of The Key Asean Economies Banking Sectors. *Advanced International Journal of Business Entrepreneurship and SMEs, 8* (29), 2314-2328.

DOI: 10.35631/AIJBES.829133

under IRS and 200 at CRS. The pattern indicates that scale mismatch is an important source of inefficiency and that expansion is not equally appropriate for all banks. By placing the six banking systems on one frontier, this study provides a directly comparable view of efficiency and scale conditions across ASEAN before and during the COVID-19 period.

Keyword:

ASEAN, Banks, Country Income Level, Data Envelopment Analysis, Returns to Scale

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Introduction

In developing and emerging economies, banks often carry much of the burden of financial intermediation because capital markets are comparatively less developed. Therefore, their ability to channel funds from savers to productive uses matters for both growth and financial stability (Deidda and Fattouh, 2008; Beck et al., 2000; Levine et al., 2000; Levine and Zervos, 1998; Levine, 1998; Stulz, 2001). However, international evidence also shows that banks in developing economies frequently operate below the efficiency levels observed in more mature financial systems (Berger and Humphrey, 1997; Berger et al., 2000; Berger, 2007).

The efficiency issue is relevant beyond the profitability of an individual bank. A bank that remains well inside the best-practice frontier may be more exposed to competitive pressure and less able to absorb adverse shocks. At the system level, persistent inefficiency can weaken the intermediation process and add to financial-sector vulnerability. This concern is supported by earlier evidence that banks that later failed tended to display weak efficiency (Wheelock and Wilson, 1995; Barr et al., 1994; Berger and Humphrey, 1992). Therefore, identifying the source of inefficiency is useful for both bank management and regulators concerned with the durability of the banking system.

Operating scale is one possible source of this problem. Banks differ considerably in size, and inefficient performance may arise because a bank has not yet become large enough to capture scale economies or, conversely, because it has expanded beyond an efficient scale (Alfaihani et al., 2024). These two situations call for different responses. Further expansion can be

counterproductive when a large bank already faces diseconomies of scale, whereas premature downsizing may prevent a smaller bank from reaching a more efficient operating size. Distinguishing increasing, constant, and decreasing returns to scale is therefore important when considering expansion, consolidation, and capacity decisions (Grženta et al., 2023).
Research on ASEAN banking efficiency has generally been organized country by country. Studies of Thailand, Malaysia, Indonesia, the Philippines, and Vietnam provide useful national evidence, but their results are produced from different samples and separate frontiers. This makes direct comparison across banking systems difficult. Comparative evidence on the nature of returns to scale across the six major ASEAN banking sectors is especially limited. We address this issue by estimating technical efficiency, pure technical efficiency, scale efficiency, and returns to scale for banks in Singapore, Malaysia, Thailand, Indonesia, the Philippines, and Vietnam on a common frontier for 2013-2021. The sample period also captures the years before and during the COVID-19 pandemic.

Two questions guided the analysis. The first is whether efficiency differs across the six banking sectors and country income groups used in this study. The second is whether the observed inefficiency is associated with the operating scale, and specifically whether banks are positioned under increasing, constant, or decreasing returns to scale. Using a common cross-country frontier makes these comparisons on the same measurement basis rather than relying on the results from separate national studies.

Literature Review

Theories Underpinning Bank Production

The concept of productive efficiency has its roots in the work of Koopmans (1951) and of Farrell (1957), although in both studies, the authors take different angles. For Koopmans, a technically efficient production point is one where it is impossible to produce more without producing less of one good or more of one or more inputs. Farrell then devised an operational framework which divorced the concepts of technical efficiency from allocative efficiency and compared performance against the efficient frontier. In this case, technical efficiency refers to quantity of output produced from an input bundle, while allocative efficiency relates to input proportions when an input is combined in a cost minimizing way.

There has since been the development of frontier estimation both in parametric and non-parametric directions. Parametric strand started with Aigner and Chu (1968) and extended by Aigner et al. (1977), and Meeusen and van den Broeck (1977) leading to stochastic frontier analysis (SFA). Another helpful aspect of SFA is that it is able to distinguish between a random disturbance and the inefficiency part. The trade-off is that researchers have to assume a functional form and the distributional assumption for both components. In recent years, SFA has been applied in a great number of banking-efficiency studies, such as De Vita et al. (2024), Galan and Tan (2024), and Cao et al. (2024).

DEA provides an alternative approach to the construction of the frontier. Under constant returns to scale (CRS), Charnes et al. (1978) developed the CCR model which does not require a parametric production function of the production system. Later on banker, et. al. (1984) developed the BCC formulation with the relaxation of CRS and introduction of variable returns to scale (VRS). Both versions can be estimated, allowing scale and pure technical efficiency to be distinguished. This distinction is crucial in the present study because, if the overall score

Advanced International Journal of Business, Entrepreneurship and SME's
AIJBES
EISSN: 2682-8545
Volume: 8 Issue: 29 (September 2026) PP. 2314-2328
seems to be low, it could be a reflection of how resources are being managed, or it could be a reflection of the size of the bank.

Review of Related Literature

A lot of the existing literature in banks efficiency has focused on the U.S. and other developed financial systems (Tregenna, 2009; Chortareas et al., 2016; Hughes et al., 2022; Bayeh et al., 2021; López-Penabad et al., 2023; Yildirim et al., 2023). There is less cross-country evidence of development and emerging banking systems, especially in ASEAN countries (Maudos et al., 2002). Most importantly, the findings from the ASEAN have been generated from samples at the country level. The efficiency scores reported do not always allow for direct comparison between countries due to the different definitions of studies, bank coverage and estimated frontiers. However, country studies can serve as a useful standard. In Thailand, scale inefficiency in specialized commercial and government banks is reported by Mahathanaseth and Tauer (2014) and efficiency differences between bank size and bank ownership are reported by Sufian and Habibullah (2010).

Furthermore, there was evidence that the role of scale was important from the Malaysian context as well: Katib and Mathews (2000) found that scale inefficiency was a significant cause of performance differences, while Sufian (2011) correlated productivity changes with technology and ownership. In the Philippines, Manlagñit (2011) reveals the presence of substantial cost inefficiency and demonstrates that risk and asset quality are significant factors in bank performance. The picture is mixed in Indonesia and Vietnam as well. According to Defung et al., (2016) the average efficiency of the banks in Indonesia is low, while state-owned banks and foreign-owned banks have the best performance. In general, the studies on Vietnamese banks' efficiency indicate that size, ownership, reform, non-performing loans, and scale-expansion strategies are related to bank efficiency (Vu and Turnell, 2010; Nguyen et al., 2014, 2016; Stewart et al., 2016; Le et al., 2022).

The results are country specific data, so they provide information on each country, but do not provide a common ranking or scale pattern for ASEAN. The difference is that we put the six banking sectors on the same DEA frontier and explore the changes in their RTS status over countries and over time. This enables a comparison of technical, pure technical and scale efficiency on a common basis and facilitates the scale inefficiency to be categorized as increasing or decreasing return to scale. This also means that the COVID-19 disruptions are not excluded from the spectrum of observation, but are included in the extended sample, which extends through 2021.

Data and Methodology

We use DEA because a bank combines several inputs to produce several outputs, a production process that is not well captured by a single financial ratio. Each bank is assessed against a frontier formed from the best observed input-output combinations in the sample, and no specific functional form is imposed on production technology. The model is input-oriented, and the efficiency score represents the proportional input reduction that would be feasible while holding the observed outputs constant. We estimate the frontier under both CRS and VRS so that overall technical efficiency can be separated into pure technical and scale efficiencies (Charnes et al., 1978; Banker et al., 1984; Emrouznejad and Yang, 2018; Ray, 2004).

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AIJBES
EISSN: 2682-8545
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Measures of Bank Production

Inputs and outputs are defined using the intermediation approach of Sealey and Lindley (1977). In this view, the bank's production process begins with funds and operating resources and ends with earning assets and related income. Accordingly, deposits, labour, and physical capital enter the model as inputs, while loans and investments are treated as outputs. Non-interest income is also included as an output because it is available in the source dataset and captures revenue generated outside the traditional interest margin. This specification is consistent with the asset-based intermediation approach used in earlier bank-efficiency studies (Sufian and Habibullah, 2010; Gržeta et al., 2023; Mateev et al., 2024).

This approach fits the purpose of the study for several reasons: it captures a substantial part of banks' operating and funding costs (Elyasiani and Mehdian, 1990; Berger and Humphrey, 1991; Avkiran, 1999), and the unit of analysis here is the bank rather than an individual branch. It also reflects the basic intermediation function, which is especially important in economies where capital markets are less developed: banks mobilize deposits and redirect those funds toward productive financing (Jaffry et al., 2007; Askari, 1991).

Sources of Data, Inputs and Outputs Specifications

The dataset covers 2013-2021 and is drawn from Fitch Connect. We began with 316 financial institutions: 121 from Indonesia, 53 from Malaysia, 43 from the Philippines, 18 from Singapore, 30 from Thailand, and 51 from Vietnam. Because DEA requires reasonably comparable decision-making units, the sample was restricted to commercial banks. Central banks, Islamic banks, and development financial institutions were removed. We also excluded observations with missing or negative values for the required inputs or outputs and eliminated redundant consolidated or aggregated statements, including bank-holding-company observations. After these screening steps, the sample contained 189 commercial banks: 78 in Indonesia, 27 in Malaysia, 19 in the Philippines, 20 in Thailand, 5 in Singapore, and 40 in Vietnam. Descriptive statistics for the variables used to build the frontier are presented in Table 1.

Table 1: Descriptive Statistics for DEA Inputs and Outputs (USD Millions)

Variables	Mean	Minimum	Maximum	Standard Deviation
Inputs				
Fixed Assets	1,095,677.29	0.40	49,144,800.00	4,322,909.57
Total Deposits	59,859,292.89	0.33	1,542,504,439.00	168,287,085.66
Labor	970,158.89	0.60	38,047,100.00	2,854,058.71
Outputs				
Loans	52,357,594.47	41.45	1,316,473,316.00	146,219,259.25
Investment	12,959,613.33	10.18	417,356,600.00	35,638,148.37
Non–Interest Income	935,161.26	100.00	33,253,300.00	3,096,688.34

Source: Calculated by the authors from the study dataset.

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AIJBES
EISSN: 2682-8545
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Results and Discussion

The empirical discussion follows the structure of the research questions. We begin with TE, PTE, and SE for each banking sector and then compare the country-income groups used in the study. The final part examines returns to scale to determine whether departures from efficient scale are associated mainly with IRS or DRS.

Efficiency of the Six ASEAN Banking Sectors

Panel A of Table 2 shows a clear spread in technical efficiency across countries. Thailand has the highest mean TE (0.599), while the Philippines has the lowest (0.348). Because the model is input-oriented, the distance from one can be read as the proportional scope for input saving at the observed output level. Based on this, the implied reduction is approximately 40.1% for Thailand and 65.2% for the Philippines. Thailand's relatively stronger result is broadly consistent with earlier evidence on the intermediation efficiency of Thai banks (Sufian and Habibullah, 2010).

The yearly estimates also weaken around the onset of COVID-19, although the DEA results do not identify the pandemic as a causal factor. One plausible interpretation is that the disruption to consumption, investment, and financing activity, together with greater uncertainty in credit markets, reduced the intensity of intermediation and fee-generating businesses during that period (Jiang et al., 2021; Mirzaei et al., 2022). Therefore, we treat the movement in the scores as descriptive evidence of what occurred over the sample period rather than as an estimate of a COVID-19 treatment effect.

The PTE results in Panel B show a somewhat different story. Vietnam has the highest mean PTE, at 0.795. Once the influence of scale is separated, Vietnamese banks appear relatively effective in converting their chosen inputs into outputs. This result is consistent with a period in which Vietnamese banks expanded digital channels and technology-based service delivery, developments that may have supported operating efficiency and a broader range of services. Scale efficiency, reported in Panel C, varies even more sharply. Malaysia's average scale inefficiency is about 8.7%, compared with roughly 40.3% for Vietnam. This gap indicates that an important part of the overall technical inefficiency is connected to operating size rather than resource use alone. Entry rules, branch restrictions, regulatory conditions, and the large, fixed cost of banking technology can all affect the scale at which a bank is able to operate (Chortareas et al., 2012; Wheelock and Wilson, 2012).

Table 2: DEA Efficiency Estimates across Six ASEAN Banking Markets

Year	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Panel A: Overall Technical Efficiency (TE)						
2013	0.389	0.512	0.341	0.523	0.517	0.434
2014	0.381	0.498	0.337	0.512	0.486	0.435
2015	0.344	0.515	0.265	0.423	0.551	0.346
2016	0.332	0.545	0.271	0.409	0.582	0.404
2017	0.454	0.669	0.414	0.607	0.674	0.476

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Year	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
2018	0.407	0.657	0.374	0.615	0.688	0.426
2019	0.459	0.621	0.391	0.455	0.666	0.537
2020	0.413	0.609	0.378	0.578	0.629	0.501
2021	0.380	0.655	0.352	0.603	0.625	0.544
Mean	0.395	0.587	0.348	0.525	0.599	0.452
Panel B: Pure Technical Efficiency (PTE)						
2013	0.520	0.579	0.203	0.603	0.603	0.737
2014	0.495	0.531	0.397	0.563	0.535	0.782
2015	0.515	0.598	0.435	0.513	0.676	0.765
2016	0.513	0.599	0.396	0.485	0.682	0.819
2017	0.584	0.693	0.468	0.631	0.706	0.764
2018	0.557	0.688	0.438	0.649	0.734	0.772
2019	0.567	0.705	0.413	0.581	0.694	0.828
2020	0.666	0.692	0.473	0.664	0.724	0.875
2021	0.642	0.711	0.445	0.692	0.680	0.874
Mean	0.562	0.644	0.408	0.598	0.682	0.795
Panel C: Scale Efficiency (SE)						
2013	0.799	0.888	0.217	0.865	0.841	0.630
2014	0.844	0.932	0.859	0.895	0.908	0.595
2015	0.722	0.868	0.642	0.815	0.785	0.489
2016	0.702	0.904	0.732	0.822	0.818	0.509
2017	0.825	0.968	0.918	0.958	0.946	0.674
2018	0.762	0.959	0.909	0.933	0.927	0.598
2019	0.853	0.892	0.961	0.869	0.958	0.678
2020	0.631	0.888	0.829	0.845	0.837	0.570
2021	0.599	0.919	0.829	0.848	0.899	0.613
Mean	0.749	0.913	0.766	0.872	0.867	0.597

Source: Authors' calculations using the study sample.

Efficiency by Country Income Level

Table 3 re-arranges the same efficiency estimates by the income groups used in the study. Malaysia and Thailand, falling in the middle-income group, are the highest with the mean TE of 0.595. The low-income group in the study had 0.399 while Singapore the high-income group in the study had 0.525. This lower mean does not necessarily contradict Singapore's higher technological capacity as compared to the middle-income group. Sometimes capacity may remain underused for a while, and measured costs may even increase in the case of large investments or restructuring of technology before the benefits can be fully realised (Isik and

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Hassan, 2002).The value of PTE is relatively stable across the middle- and low-income groups, while Singapore shows weaker values in a number of years. The DEA scores will not show the root cause but there are potential avenues such as differences in internal processes and managerial practice, differences in compliance costs, or consolidation activity. For instance, Sufian and Habibullah (2014) report efficiency effects of mergers in banks.

The comparison points for the SE are in the same general direction: Efficient scale for the high- and middle-income groups is closer to them than for the low-income group in this study. The lower SE values reflect the fact that more banks are located away from the most productive operating size for the latter. This mismatch goes either way, depending on the bank. For some institutions, it is possible that the scale economies are not yet being realised and for others, the diseconomies may already be coming into play.

Table 3: DEA Efficiency Scores by Country Income Group

Year	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency
Panel A: High–Income Countries			
2013	0.523	0.603	0.865
2014	0.512	0.563	0.895
2015	0.423	0.513	0.815
2016	0.409	0.485	0.822
2017	0.607	0.631	0.958
2018	0.615	0.649	0.933
2019	0.455	0.581	0.869
2020	0.578	0.664	0.845
2021	0.603	0.692	0.848
Mean	0.525	0.598	0.872
Panel B: Middle–Income Countries			
2013	0.515	0.591	0.865
2014	0.492	0.533	0.920
2015	0.533	0.637	0.827
2016	0.564	0.641	0.861
2017	0.672	0.700	0.957
2018	0.673	0.711	0.943
2019	0.644	0.700	0.925
2020	0.619	0.708	0.863
2021	0.640	0.696	0.909

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Year	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency
Mean	0.595	0.657	0.897
Panel C: Low–Income Countries			
2013	0.388	0.487	0.549
2014	0.384	0.558	0.766
2015	0.318	0.572	0.618
2016	0.336	0.576	0.648
2017	0.448	0.605	0.806
2018	0.402	0.589	0.756
2019	0.462	0.603	0.831
2020	0.431	0.671	0.677
2021	0.425	0.654	0.680
Mean	0.399	0.591	0.703

Note: The country-income categories are reproduced from the source manuscript: Singapore (high income); Malaysia and Thailand (middle income); and Vietnam, Indonesia, and the Philippines (low income).
Source: Calculated by the authors from the study dataset.

Developments in Returns to Scale

Returns to scale are classified in two steps. First, within each bank, the efficiency of their CRS and VRS scores are compared. If equality occurs, the product has constant returns to scale. If the scores are not equal, we re-estimate the model with the non-increasing returns to scale (NIRS) constraint. In the light of Coelli et al. (1998), the equality of the VRS and NIRS scores indicates the presence of DRS, and if they are not equal, the bank is regarded as an IRS. Overall, this pattern is clear from Table 4. There are 1,235 bank-year observations at DRS, 200 at CRS and 88 at IRS. The highest number of CRS observations is in 2014, and the lowest numbers are in 2015 and 2020. The shares of countries in observing CRS vary, with Thailand and Malaysia accounting for the highest levels of observations and Vietnam and Philippines for the lowest. This distribution has been observed by McAllister and McManus (1993) who noted that larger institutions were more likely to be associated with either the CRS or DRS, whereas smaller institutions were more likely to be associated with either the CRS or IRS. The meaning of the implications vary between the two inefficient regions. With DRS, inputs can be increased, but output will not increase by a proportionate amount, which can exacerbate the scale issue. IRS can decrease average costs, particularly when there are fixed costs for technology and infrastructure that are distributed over a greater number of customers. The management response will therefore be dependent on where a bank is with regard to efficient scale. An IRS institution might want to grow from within and/or consolidation if it would help the institution reach the frontier. The other worry for a bank already subject to DRS is a merger, or expansion of its footprint, which could increase complexity and capacity, but not production. The results therefore suggest that there are many reasons to believe that the mismatch in scale is not the only reason for the lack of efficiency in the sample.

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Table 4: Returns-to-Scale Classification by Year and Country

Panel A: Returns to Scale by Year

	CRS			DRS			IRS			
Year	**No of Bank Observations**	**Row share (%)**	**Column share (%)**	**No of Bank Observations**	**Row share (%)**	**Column share (%)**	**No of Bank Observations**	**Row share (%)**	**Column share (%)**	**Total observations**
2013	20	11.17	10	153	85.47	12.39	6	3.35	6.82	179
2014	34	19.88	17	128	74.85	10.36	9	5.26	10.23	171
2015	14	8.33	7	150	89.29	12.15	4	2.38	4.55	168
2016	19	11.31	9.5	145	86.31	11.74	4	2.38	4.55	168
2017	31	18.34	15.5	124	73.37	10.04	14	8.28	15.91	169
2018	22	13.33	11	135	81.82	10.93	8	4.85	9.09	165
2019	23	13.69	11.5	116	69.05	9.39	29	17.26	32.95	168
2020	14	8.33	7	146	86.90	11.82	8	4.76	9.09	168
2021	23	13.61	11.5	140	82.84	11.34	6	3.55	6.82	169
Total	200		100.0	1235		100.0	88			1523
Panel B: Returns-to-Scale Distribution across Banking Sectors										
	CRS			**DRS**			**IRS**			
Banking sector	**No of Bank Observations**	**Row share (%)**	**Column share (%)**	**No of Bank Observations**	**Row share (%)**	**Column share (%)**	**No of Bank Observations**	**Row share (%)**	**Column share (%)**	**Total observations**
Indonesia	88	13.37	44.0	569	86.47	46.07	1	0.15	1.14	658
Malaysia	43	20.57	21.5	119	56.94	9.64	47	22.49	53.41	209
Philippines	8	5.23	4.0	137	89.54	11.09	8	5.23	9.09	153
Singapore	5	12.82	2.5	30	76.92	2.43	4	10.26	4.55	39
Thailand	45	22.50	21.3	138	65.92	11.90	28	12.56	31.82	211
Vietnam	11	4.35	5.5	242	96.68	18.87	0	0.00	0.00	253
Total	200		100.0	1235		100.0	88	5.78	100.0	1523

Notes: Row share (%) refers to the proportion within a given year or banking sector; column share (%) reports the corresponding proportion across years or sectors.
Source: Authors' calculations using the study sample.

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Conclusions and Policy Recommendations

Using a DEA frontier, this paper applies the DEA frontier to compare the positional efficiency and scale efficiency of banks in six key economies of ASEAN from 2013 to 2021. The results were not even across the country. The highest mean TE was 0.599 for Thailand while the lowest was for the Philippines at 0.348. Vietnam had the highest score for PTE (0.795), and the average SE for Malaysia was 0.913, closest to efficient scale. The countries were divided into income classes by the classification used in this study and the middle-income countries had the highest average TE.

Scale becomes an important piece of the ASEAN efficiency puzzle. There were 1,523 observations of the bank year of which 1,235 were classified as DRS (approximately 81%), 200 as CRS, and 88 as IRS. This is a high concentration of DRS which indicates there's a lot of excess operating scale in the sample. Meanwhile, the existence of IRS suggests some banks continue to operate at a scale that doesn't allow them to be efficient, and they might still benefit from growth. What this means is not that banks need to be all the same size or all the same size, but that the size of the bank will depend on where the bank is located.

The results indicate two key issues for bank managers. When inefficiency is primarily technical, emphasis needs to be placed on the organization and utilization of existing resources, such as process design, managerial capacity and technology deployment. If the problem is large in size, the suitable treatment will rely on the classification of RTS. For banks under IRS, there may be space to expand while for banks under DRS, they should be wary of building up capacity at a higher rate than the output. The same applies to regulators: They may be able to achieve the economies they seek by promoting consolidation while simultaneously creating diseconomies for a different type of bank. The decline in efficiency during the years of the pandemic also supports the importance of systems and regulations that provide flexibility in response to changing conditions for intermediation.

There are a number of limitations to this study. The analysis is limited to technical measures based on the DEA and does not measure cost, revenue or profit efficiency. Results can also differ if a different definition of bank production is used, or if a parametric frontier is used which explicitly models statistical noise. It would be helpful if the efficiency and RTS indicators could be correlated with macroeconomic, industry and bank-specific variables to allow for a direct study of the factors driving the movement towards or away from the efficient scale.

Acknowledgements:	The authors gratefully acknowledge Universiti Teknologi MARA (UiTM) for the institutional support, academic resources and research environment that contributed to the completion of this study.
Funding Statement:	No Funding.
Conflict of Interest Statement:	The authors declare that there is no conflict of interest regarding the publication of this paper.
Ethics Statement:	This study did not involve human participants, animals, or sensitive data requiring ethical approval. The research used secondary institutional and macroeconomic data and was conducted in accordance with accepted academic integrity and ethical publishing standards.
Author Contribution Statement:	All authors were responsible for conceptualisation, methodology, data compilation, analysis, interpretation of results, drafting and critical revision of the manuscript, and approved the final version for submission.
Data Availability Statement:	Bank-level financial data are proprietary Fitch Connect data and cannot be redistributed. Macroeconomic variables are publicly available from the IMF Financial Access Survey and the World Development Indicators.

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