

# The profit efficiency analysis of malaysian commercial banks: A Data Envelopment Analysis (DEA)

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## Article History

Received on 6 July 2023

1<sup>st</sup> Revision on 31 July 2023

2<sup>nd</sup> Revision on 17 August 2023

3<sup>rd</sup> Revision on 24 August 2023

4<sup>th</sup> Revision on 28 August 2023

Accepted on 29 August 2023

## Abstract

**Purpose:** This study aims to measure and compare the profit efficiency of local and international commercial banks in Malaysia before and during the COVID-19 pandemic in accordance with the new Basel Committee III guidelines, which mandate banks to adopt a systematic approach to deal with uncertain economic conditions, including events such as the COVID-19 pandemic.

**Research methodology:** This study uses Data Envelopment Analysis (DEA), a non-parametric method based on linear mathematical programming, to measure the efficiency of local and international commercial banks in Malaysia.

**Results:** The analysis revealed that local international commercial banks were more efficient than local commercial banks before and during the COVID-19 crisis.

**Limitations:** Potential areas for future research involve extending the application of Data Envelopment Analysis (DEA) and examining various dimensions and metrics about different countries, as each country possesses distinct financial contexts.

**Contribution:** This study contributes to the existing body of literature on the profit efficiency of local and international banks. It provides insights that can assist the government in formulating appropriate regulations to enhance banks' profit efficiency, thereby improving their overall performance.

**Keywords:** *Data Envelopment Analysis (DEA), profit efficiency, liquidity risk, Commercial Banks, Malaysia*

**How to Cite:** Arif, N. M., Nasir, A., Rodrigo, R. S., Bujang, I., & Supar, S. J. (2023). The profit efficiency analysis of malaysian commercial banks: A Data Envelopment Analysis (DEA), *Annals of Management and Organization Research*, 4(3), 211-224.

## 1. Introduction

Banks are regarded as pillars of the financial system; they play a crucial role in economic development as intermediaries that shift funds from surplus units to deficit units (Alber, Elmoftý, Kishk, & Sami, 2019). The fundamental principle of banking is converting monetary resources through accepting deposits and extending loans to individuals, corporations, and governmental entities to facilitate a wide range of economic endeavors (Jemal, 2022). Therefore, bank efficiency is crucial and requires more consideration (Alber et al., 2019). Regarding the banking industry, Iršová and Havránek (2010) note that financial efficiency contributes to the success of adopted macroeconomic policies, which foster long-term development, economic growth, and societal welfare. In practice, financial efficiency encompasses three aspects: cost, revenue, and profit efficiency (Adongo, 2005). However, this study focuses only on profit efficiency. Profit efficiency refers to a bank's capacity to manage its resources and generate outputs with a higher economic value (Arbelo, Arbelo-Pérez, & Pérez-Gómez, 2021). Profit efficiency is a broader concept since it considers the consequences of selecting a particular production line on both costs and revenues (Maudos, Pastor, Perez, & Quesada, 2002).

Efficiency compares a company's output to its input. Efficiency is defined as usability that prioritizes sacrifice for results. According to Farrell (1957), efficiency has two components: technical efficiency (TE) and allocative efficiency (AE). Technical efficiency is a company's capacity to maximize output from its inputs. The company's technical efficiency indicates its ability to produce inside the isoquant frontier line. Allocative efficiency refers to a company's ability to employ inputs at a specific pricing and production technology. The company optimizes production through optimizing inputs, price structure, and technology. The sum of these two efficiencies is known as economic efficiency (EE) or overall efficiency. This implies that a company's products are technically and economically efficient.

A bank that is known as commercial bank is a bank that is recognized as providing services such as receiving deposits, making business loans, and selling essential investment products while also being operated as a business to make a profit. To differentiate itself from a retail bank and an investment bank, the term "corporate bank" can also refer to a bank or a subsidiary of a large bank that works with companies or large or middle-sized businesses. Unlike an investment bank, most consumers take care of their banking needs at a commercial bank. Commercial banks' primary responsibility is to meet the financial needs of consumers and businesses, contribute to maintaining economic and social order, and play a critical part in fostering the economy's long-term expansion (Tharu & Shrestha, 2019).

When trying to gain an edge over the competition, efficiency is essential. More efficient banks have significant cost and competitive advantages over less efficient ones (Berger & Humphrey, 1997). According to Saqib (2013), an efficient financial system facilitates progress in emerging countries. Only an efficient banking system will ensure that a country's financial sector will grow healthily and sustainably over time (Kumar et al., 2020).

The emergence of the COVID-19 pandemic has failed in several industries and has worsened the world economy (Ikhwan & Riani, 2022). COVID-19 disrupts the financial sector, including the banking industry (Ikhwan & Riani, 2022). This pandemic has impacted the operations of banks (Hidayat, Masyita, Nidar, Febrian, & Ahmad, 2021). The crisis caused by the COVID-19 outbreak has severely affected all business pillars, resulting in decreased revenue and cash flow (Ikhwan & Riani, 2022). In general, COVID-19 has altered banking behavior preferences to reduce the demand for bank loans because banks will be more wary of defaults or poor loans, which might worsen unstable situations (Ikhwan & Riani, 2022). Because of the pandemic, banks can no longer quickly raise funds from the general public and companies (Ikhwan & Riani, 2022). COVID-19 impacts borrowers' ability to repay loans (Ikhwan & Riani, 2022).

The Law of One Price (LoOP) implies that in a competitive market equilibrium, all firms face the same prices for their inputs and outputs (Kuosmanen, Cherchye, & Sipiläinen, 2006). This law has significant implications for productive efficiency analysis that have not yet been explored (Kuosmanen et al., 2006). According to the study, several price inputs must be analyzed to determine the efficiency level rather than focusing on a single price input. The input variables are the resources required to conduct a company's production activities (Pilar, Marta, & Antonio, 2018). Three price inputs were incorporated into the study: the price of labor ( $w_1$ ), the cost of physical capital ( $w_2$ ), and the price of borrowed funds ( $w_3$ ).

Therefore, this study measures and compares the efficiency of local and international commercial banks in Malaysia before and during the COVID-19 pandemic using the Data Envelopment Analysis (DEA) approach. First, it provides more empirical evidence on profit efficiency in emerging countries by focusing on local Malaysian and international banks. Second, it extends international local banking studies by comparing the findings of local and international banks in Malaysia. Third, specific inputs regarding whether they directly impact profit efficiency must be discussed.

The significance of this study will assist the body of knowledge, the banking industry, investors, and regulators, among others. This body of knowledge will gain a deeper comprehension of the previously studied issue, enabling researchers to structure and describe it confidently. In addition, banks require research-driven personnel to apply recent innovations and identify their potential usefulness. Therefore,

the banking sector needs to increase its strategic management by examining its profit efficiency. Moreover, this finding will aid investors in making prudent and profitable decisions, assuming all relevant aspects have been considered. This research provides insight into setting appropriate regulatory and supervisory requirements to prevent banks from excessive risk-taking without limiting the expansion of the banking industry.

This study is divided into several sections. Section 1 describes the research topic and outlines its profit efficiency. Section 2 presents the primary input and output data sources and examines these variables in dialogue with one another. Section 3 covers and clarifies the data gathering, analytical methods, and model specifications. Section 4 presents our results and findings. Finally, Section 5 concludes the study and summarizes the research.

## **2. Literature review**

Fundamentally, production theory governs the input required to generate output for a specific firm. The production function is where a firm can see all inputs converted into outputs (Koutsoyiannis, 1979). A firm must use production theory to determine how to maximize its output. If a company can manage its inputs and outputs, it can achieve profit efficiency. In a banking firm, several inputs can affect output.

The factors influencing bank efficiency can be categorized into two distinct groups: internal and external factors (Bahraini et al., 2021). Internal factors refer to bank-specific elements under management's control and can be utilized to enhance the company's performance. These factors encompass the efficient administration of capital, liquidity, and costs. Bank efficiency is influenced by various external factors, notably macroeconomic variables such as interest rates and inflation. The reduction in the performance of the banking sector can be attributed to the volatility of macroeconomic variables (Endri et al., 2022).

The COVID-19 pandemic reflects the most unexpectedly massive and broad external economic shock to the extent that such shocks are likely external, affecting the real economy or financial system (Berger & Demirgüç-Kunt, 2021). Borrowers were put into risky situations because their ability to repay loans deteriorated when cash reserves began to run low. As a direct consequence, it is anticipated that credit losses would rise in the form of non-performing loans, and the exposure to credit risk would rise (Mateev, Sahyouni, & Al Masaeid, 2022). On the consumer side, the unpredictability of the pandemic's progression has led to decreased demand for consumer products and services, financing investments, and current capital (Kozak, 2021). This was because people were unsure of how severe the pandemic would become.

Similarly, the COVID-19 pandemic had a negative impact on the profit efficiency of banking institutions, primarily because of their lending activities. Kozak (2021) witnessed the drop in the number of possible borrowers, and the chance for banks to issue new loans resulted in a considerable fall in the interest income that banks received and any other fees and commissions associated with granting loans. As a result, banks were less able to raise equity capital by retaining net profits and paying dividends to shareholders, making it more difficult to attract fresh capital from the market (Kozak, 2021). Shareholders have the right to receive dividends in the form of cash, assets, or any other state in which the company chooses to distribute some of its profits. The amount of money that is distributed in the form of dividends to shareholders is determined by the firm's ability to turn a profit and by the dividend policy set forth by the particular company (Shabrina & Hadian, 2021).

There is a lot of research using the Data Envelopment Analysis (DEA) approach, one of which is a study conducted on a dataset of 37 Brazilian banks provided by the Brazilian Central Bank. Henriques et al. (2018) found that Brazilian banks had yet to reach their maximum efficiency level over the average five years covered by the study. Besides, using the Window DEA (Data Envelopment Analysis) approach, Kumar et al. (2020) analyzed the performance of private sector banks in India from 2005 to 2017. Each window covered three years, resulting in a total of eleven windows. According to the study results, 60.1% of all private sector banks in India operate at an efficiency level of 0.9 or higher, with only three instances where efficiency was between 0.6 and 0.7. Besides banks, Abidin, Prabantarikso,

Wardhani, and Endri (2021) analyzed 23 insurance businesses using the two-stage DEA approach and found that large insurance companies are more efficient than small insurance companies. Hence, the DEA approach is used for more than just evaluating efficiency in the banking industry.

### ***2.1. Profit Efficiency***

Profit efficiency can determine whether a bank is performing well or poorly based on its profit compared to other banks during the same period when producing the same output (Bader, Mohamad, Ariff, & Shah, 2008). Therefore, this study focuses on profit efficiency, as mentioned in the Introduction. Researchers use DEA to measure profit efficiency scores by calculating input and output. Hence, with the profit efficiency score, researchers can determine which bank is performing well.

### ***2.2. Total Loans and Profit Efficiency***

The banking sector's primary income source is providing a loan (money or debt financing) to a borrower (Sarker & Bhowmik, 2021). This activity allows the borrower to use it as their capital for personal purposes, such as business (Sarker & Bhowmik, 2021). Therefore, it will benefit not only the borrower but also the bank because the total loans borrowed have turned into profit. Some individuals depend on loans to survive in the economy; hence, this activity is essential (Sarker & Bhowmik, 2021). The 'tax shield advantage' of debt financing is one of the advantages offered by this form of financing. This is because, in many countries, interest accrued on debt financing is deductible from a company's profits before calculating that company's tax liability (Oranefo & Egbunike, 2022). However, if the total loan increases, the growth of the loan will also increase, so the borrower will think twice about whether to take the loan (Sarker & Bhowmik, 2021). Therefore, total loans have a significant impact on bank profitability.

### ***2.3. Price of Labour and Profit Efficiency***

The price of labor plays a vital role in banking as one of the inputs because without a reasonable wage, no protection as an employee, and no regulations on hiring and firing, there will be a severe impact on a bank's firm (Bertola et al., 2010). Therefore, the main activity of a bank—lending loans—will not operate effectively. However, the right amount of labor can positively impact the bank. Laborers are more productive in what they do. The price of labor affects banks' profit efficiency.

### ***2.4. Price of Physical Capital and Profit Efficiency***

Throughout this modern era, our technology has been continuously changing for better development. In banking, most financial services use technology (Resende & Silva, 2007). Physical capital, tangible assets like computers, is essential for a bank's profitability. The quality of physical capital depends on this. For example, if someone purchases a more powerful and efficient computer, the financial service will run smoothly, attracting more customers to the bank. Based on the explanation above, the price of physical capital is one of the inputs for profit efficiency.

### ***2.5. Price of Borrowed Funds and Profit Efficiency***

Borrowed funds (deposits and borrowing), advances, and investments, together with associated pricing, such as the cost of funds, return on advances and return on investments, are often used to gauge the efficiency of a bank (Färe, Grosskopf, & Weber\*, 2004; Ray & Das, 2010; Resende & Silva, 2007). The increased cost of borrowing encourages prospective borrowers to invest in borrowed funds for projects with higher returns. Projects with greater returns are more likely to default (Stiglitz & Weiss, 1981). Thus, the price of borrowed funds is one of the variables contributing to profit efficiency.

### ***2.6. Price of Interest and Profit Efficiency***

A bank's income comes from the interest on the loan; hence, the interest price can affect the bank's profitability. The interest rate is the amount that a bank charges a borrower according to the period that they have chosen. Companies that are short on cash may have to turn to more expensive forms of borrowing, such as loans from banks or other lenders, which can have a negative impact on their bottom line. Defaulters who are unable to repay their debts and the associated interest regularly cause a shortage of funds for financial institutions. This makes these financial institutions precarious, as they cannot match the demand for loans from other borrowers without access to additional funding (Waitherero,

Muchina, & Macharia, 2021). However, interest rates are uncertain because of the rise and drop in commodity prices (Wicksell, 1936).

### 3. Methodology

There are two primary approaches for measuring efficiency: the Stochastic Frontier Analysis (SFA) approach and the Data Envelopment Analysis (DEA) approach (Krmac & Mansouri Kaleibar, 2022). The SFA approach estimates a parametric econometric frontier model (Krmac & Mansouri Kaleibar, 2022). In 1978, Charnes et al. explained that the DEA approach is a non-parametric comparative performance evaluation method that can be applied to any set of entities that change various inputs into outputs without specifying the nature of their relationship in advance (Coelli, 1995). The literature identifies the DEA approach as a potent tool better suited for performance measurement than traditional econometric techniques, such as regression analysis and simple ratio analysis (Zhu & Zhu, 2014). This method converts inputs to outputs using linear programming techniques to analyze the performance of comparable organizations or products (Krmac & Mansouri Kaleibar, 2022).

Additionally, an examination of the banks' efficiency scores has been conducted through the utilization of an efficiency mapping matrix. The focus of this analysis is on the consistency of these ratings. Furthermore, the mean efficiency score of each bank within each period is examined. The interpretation of the standard deviation score indicates that banks with the highest efficiency scores also have more significant variability in their efficiency scores. No financial institution was located inside the matrix that guarantees high-efficiency ratings while maintaining low variability. The study's findings suggest a positive relationship between a DMU's efficiency scores and the corresponding standard deviation of overall efficiency scores. The data support the idea that risk and return have a positive relationship, or between risk and efficiency.

This study used the DEA approach to measure the profit efficiency scores of local and international commercial banks in Malaysia from 2011 to 2021. The DEA approach is also a non-parametric method based on a linear mathematical programming technique for measuring the efficiency of organizations described as Decision Making Units (DMUs) by transforming inputs into outputs (Tipuric, Krajnovic, & Recker, 2022). This method was developed by Charnes, Cooper, and Rhodes (1978). However, its roots can be traced back to the work of Farrell (1957), who was interested in creating accurate models for evaluating productivity. Farrell's (1957) contribution provided new insights into defining productivity and efficiency and benchmarking technology and efficiency measurements. Researchers tend to use the DEA approach because the decomposition of technical, allocation, and scale efficiencies is more accessible than that of the SFA approach. Moreover, the DEA approach has no functional form specification for the production function.

A decision-making unit (DMU) is any entity that uses input to generate output (Curtis, Hania, Kourtis, & Kourtis, 2020). This study used a simple equation to measure banks' profit efficiency. The equation used is as follows:

$$PE = \frac{\text{Output (w)}}{\text{Input}}$$

It indicates the total output divided by the total input used for that purpose (Curtis et al., 2020). Each unit's efficiency score is compared to the optimal performance of DMUs that excel in the group of references currently under survey (Curtis et al., 2020). It is not an absolute measurement but rather a relative one compared to the ones of the peer units; this measurement cannot be improved any further (even for so-called efficient units). It simply refers to the group member whose performance is the best among those measured (Curtis et al., 2020).

Table 1 presents the input and output measurements used in this study. This study's input and output data were obtained from the bank's annual financial statement reports. The input-oriented analysis approach calculates the number of minimized inputs to produce the current DMU outputs (Selamzade & Baghirov, 2022). To determine the profit efficiency of the bank, we use the output (w) divided by the

input. (1) Loans were used as inputs in this study. The three input prices used in the estimation were the prices of labor, physical capital, and borrowed funds. Meanwhile, the output was (1) profit and the output price was of interest. The DEA-solver program was used to analyze all the data in the analysis.

Table 1. Input and Output Measurement

Variables	Symbol	Name	Description	Sources
Input	TA	Total loans	The sum of short-term and long-term loans	Bhowmik and Sarker and Bhowmik (2021)
Input Prices (w)	w1	Price of labor	Personnel expenses/total assets	Bertola et al. (2010) Resende and Silva (2007)
	w2	Price of physical capital	Other operating expenses/fixed assets	Färe et al. (2004); Ray and Das (2010); Resende and Silva (2007); Stiglitz and Weiss (1981)
	w3	Price of borrowed funds	Total interest expenses/total funding	
Outputs (y)	y1	Profit	Pre-tax Profit	
Output Prices	w1	Price of interest	Net interest margin	Wicksell (1936)

*Note:* \*Personnel expenses are divided by total assets because bank scope does not provide information on the number of employees.

Researchers collect specific data from the bank's annual report to find the profit efficiency score. The data were transferred to Microsoft Excel 2003. The data were then divided into years ranging from 2011 to 2021. For example, one Excel file is available annually. Subsequently, software called the DEA Excel Solver needs to be installed, and it will be used to determine the profit efficiency of each bank. The first step is to enable macros. Next, the DEA Excel Solver was launched, and the DEA symbol was clicked on the menu bar. Then, click on the profit-efficiency category. The constant return to scale (CRS) is chosen, and the software automatically provides the required results. Finally, the researchers obtained the profit efficiency score from the benchmark category.

#### 4. Result and discussion

The descriptive statistics in the table indicate that the mean of loans for local commercial banks is 197,248,955, with a mode and median of null and 141,146,202, respectively. Meanwhile, the mean of loans for international local commercial banks was 18,684,356,408, with a mode and median of null and 2,308,011, respectively. The mean score of loans, the average of the overall loans, indicates the amount of money customers borrow. It can be seen that international local commercial banks have higher average loans compared to local commercial banks. In addition, the mode is stated as null because no repeated values can be observed from the data.

The mean score of profits for local commercial banks is 3,650,828, with a mode and median of null and 2,534,147, respectively. Meanwhile, the mean profit for international local commercial banks is 439,960,332 with a mode and median of null and 93,251, respectively. The mean score of profits, the average of the overall profits, indicates the amount of positive income for banks. It can be seen that international local commercial banks have a higher average of profits than local commercial banks. In addition, the mode is also stated as null for the same reason.

Overall, the results indicate high loans, labor, physical capital, and profit scores for international local commercial banks. On the other hand, for local commercial banks, the results indicate high scores for borrowed funds and interest.

Table 2. Descriptive Analysis for Local and International Local Commercial Banks

INPUT	Local Commercial Banks			International Local Commercial Banks		
	MEAN	MODE	MEDIAN	MEAN	MODE	MEDIAN
Loans	197,248,955	-	141,146,202	18,684,356,408	-	2,308,011
Labour	0.008	-	0.0078	0.0235	-	0.0077
Physical Capital	3.8438	-	3.1546	6754.368	-	8.0503
Borrowed Funds	26.5012	-	1.5008	9.386	-	0.2499
<b>OUTPUT</b>						
Profit	3,650,828	-	2,534,147	439,960,332	-	93,251
Interest	1.8173	-	1,965	1.4969	-	1.2

Generally, two scale assumptions are used: constant returns to scale (CRS) and variable returns to scale (VRS). Charnes et al. (1978) first introduced the efficiency measurement of decision-making units (DMUs) for constant returns to scale (CRS), in which all DMUs operate at their optimal scale. Subsequently, Banker, Charnes, and Cooper (1984) proposed the variable returns to scale (VRS) efficiency measuring approach, permitting the separation of DEA efficiency into technical and scale efficiencies. The researchers use the CRS in the DEA analysis because the results of the CRS can show that changes in output also make changes to the input simultaneously. For example, the output (interest) used in this study is increasing, which makes the input (loans) used in this study either decreasing or unattractive, causing people to borrow and spend less.

The resulting efficiency scores were between 0 and 1 (Curtis et al., 2020). Their DEA scores divide DMUs into efficient and inefficient categories (Panayiotis et al., 2020). A score of 1 is assigned to cases on the frontier that are regarded as efficient and serve as the comparison base (Curtis et al., 2020). The inefficient DMUs have a rating greater than 0 but less than 1 (Curtis et al., 2020).

Table 3. Efficiency Score for Local Commercial Bank Pre-COVID19

Pre- COVID19											
Bank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean	%
A	1.000	1.167	1.000	1.000	0.001	0.001	0.001	1.000	1.000	<b>0.686</b>	<b>68.55%</b>
B	0.001	0.149	0.395	0.295	0.000	0.000	0.000	0.149	0.000	<b>0.110</b>	<b>11.00%</b>
C	0.001	0.622	0.354	1.000	0.001	0.000	0.000	0.319	0.000	<b>0.255</b>	<b>25.52%</b>
D	0.000	0.182	0.134	0.306	0.000	0.000	0.000	0.150	0.000	<b>0.086</b>	<b>8.60%</b>
E	1.000	1.000	1.000	1.000	0.001	1.000	1.000	1.000	1.000	<b>0.889</b>	<b>88.90%</b>
F	0.000	0.282	1.000	0.001	0.001	0.000	0.001	1.000	0.001	<b>0.254</b>	<b>25.39%</b>
G	0.668	0.412	1.000	0.018	0.002	0.002	0.002	1.000	0.116	<b>0.358</b>	<b>35.78%</b>
H	0.000	0.431	0.101	0.264	0.000	0.000	1.000	0.109	0.963	<b>0.319</b>	<b>31.88%</b>
Mean	<b>0.33375</b>	<b>0.53069</b>	<b>0.62310</b>	<b>0.48553</b>	<b>0.00075</b>	<b>0.12547</b>	<b>0.25056</b>	<b>0.59086</b>	<b>0.38506</b>		
%	<b>33.37%</b>	<b>53.07%</b>	<b>62.31%</b>	<b>48.55%</b>	<b>0.08%</b>	<b>12.55%</b>	<b>25.06%</b>	<b>59.09%</b>	<b>38.51%</b>		

*Note:* The efficiency score is derived after selecting the best producer for each year.

The scores of the eight local commercial banks' overall efficiency during the pre-COVID-19 period are presented in Table 2, which covers the years 2011 to 2019. With an efficiency score of 88.90 percent, Bank E is the most effective rival among other banking firms. The performance of Bank E appears to be successful every year, where the efficiency score is 1, except for 2015, which has a score of 0.001. This demonstrates that banks can earn more income than other banks because their financial stability is more efficient. On the other hand, Bank D is the least efficient of the group because its efficiency score is lower than one, and it came in with the lowest result of all the banks at 8.60 percent. The performance of Bank D can be viewed as the worst circumstance for the years 2011, 2015, 2016, 2017, and 2019, which is equal to 0.

Additionally, 2013 had the best profit efficiency results, and the reason for this is that most banks had an outstanding performance in 2013. Banks A, E, F, and G scored 1 for their excellent efficiency in 2013. Banks B, C, D, and H's efficiency scale scores were 0.395, 0.354, 0.134, and 0.101, respectively. By contrast, 2015 is expected to have the lowest profit efficiency because most banks' performance will likely decline this year. This can be observed by examining banks B, D, and H, all of which have a score of 0 for their efficiency, which is considered very poor. Banks A, C, E, F, and G can score between 0.001 and 0.002.

The researchers concluded that the performance of the local commercial bank from 2011 to 2019 was unreliable because of the state of the economy, which caused factors such as an increase in the rate of loan defaults and a decline in the value of assets to determine efficiency scores. By looking at the banks' efficiency score at the end of 2019, researchers have formed the opinion that by the end of 2022, the performance of local commercial banks will slowly improve.

The results of the efficiency score for 10 Malaysian international local commercial banks are presented in Table 3, which covers the years 2011 to 2019. Banks L, N, O, P, Q, and R are six less efficient banks because their efficiency scores are lower than 100 percent. Nevertheless, Bank P has the lowest efficiency of the six banks, reaching 54.30 percent. This may be because these banks have excessive liabilities that are about to become due but not enough cash to satisfy those liabilities. Bank I, Bank J, Bank K, and Bank M are the four banks with a 100 percent efficiency score, which indicates that these banks are good at managing their cash inflows, leading to high-profit efficiency.

Table 3. Efficiency Score for International Local Commercial Bank Pre-COVID19

Bank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean	%
I	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
J	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
K	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
L	1.000	1.000	1.000	0.015	1.000	1.000	1.000	1.000	1.000	<b>0.891</b>	<b>89.05%</b>
M	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
N	1.000	0.168	1.000	0.073	0.688	1.000	1.000	1.000	0.480	<b>0.712</b>	<b>71.20%</b>
O	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	0.447	<b>0.827</b>	<b>82.74%</b>
P	0.000	0.169	0.213	0.505	0.000	1.000	1.000	1.000	1.000	<b>0.543</b>	<b>54.30%</b>
Q	1.000	1.000	1.000	1.000	0.128	1.000	1.000	1.000	0.023	<b>0.795</b>	<b>79.46%</b>
R	0.216	1.000	1.000	0.032	1.000	1.000	0.086	1.000	0.720	<b>0.673</b>	<b>67.26%</b>
<b>Mean</b>	<b>0.82162</b>	<b>0.73362</b>	<b>0.92132</b>	<b>0.66241</b>	<b>0.78168</b>	<b>1.00000</b>	<b>0.90863</b>	<b>1.00000</b>	<b>0.76694</b>		
<b>%</b>	<b>82%</b>	<b>73%</b>	<b>92%</b>	<b>66%</b>	<b>78%</b>	<b>100%</b>	<b>91%</b>	<b>100%</b>	<b>77%</b>		

*Note:* The efficiency score is derived after the best producer is selected for each year

From 2011 to 2019, 2016 and 2018 had the highest efficiency scores, earning 100 percent. This indicates that the two banks had outstanding performance in these years. Nevertheless, the effectiveness of the remaining years was reduced because the results were less than 100 percent. On the other hand, because of the likelihood that the bank's performance will worsen throughout this year, 2014 is anticipated to have the lowest profit efficiency. This can be seen by looking at banks L, N, P, and R, each with a poor score, ranging from 1.5 percent, 7.3 percent, 50.5 percent, and 3.25%, respectively. All of these scores were bad. Banks I, J, K, M, and Q have perfect 100 percent scores.

According to the data presented in the table, Bank P received a score of 0 for its profit efficiency on two separate occasions, in 2011 and 2015, signifying that the bank could not maximize its profit by optimizing the inputs. Bank L came very close to reaching profit efficiency in 2014 but could not do so. This may result from several factors, including credit, liquidity, and interest rate risks.



Table 4. Efficiency Score for Local Commercial Bank During COVID-19

<b>During COVID19</b>				
<b>Bank</b>	<b>2020</b>	<b>2021</b>	<b>Mean</b>	<b>%</b>
A	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
B	0.060	0.000	<b>0.030</b>	<b>3.02%</b>
C	0.330	0.000	<b>0.165</b>	<b>16.54%</b>
D	0.000	0.000	<b>0.000</b>	<b>0.01%</b>
E	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
F	0.000	1.000	<b>0.500</b>	<b>50.02%</b>
G	0.589	1.000	<b>0.794</b>	<b>79.44%</b>
H	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
<b>Mean</b>	<b>0.49747</b>	<b>0.62510</b>		
<b>%</b>	<b>49.75%</b>	<b>62.51%</b>		

*Note:* The efficiency score is derived after the best producer is selected for each year

The efficiency score for the local commercial bank during COVID-19, which runs from 2020 to 2021, is presented in Table 4. Banks A, E, and H have a score of 100.00% for their level of efficiency, making them the banks with the highest efficiency score. These banks were nevertheless able to perform well, as evidenced by their high efficiency score, even when the epidemic was in progress. During this time, banks were able to produce greater profits. Despite this, Bank D has the lowest efficiency score at 0.01%. During the outbreak, Bank D was unsuccessful at reducing costs and increasing profits to its maximum potential. Banks G, F, C, and B have poor efficiency scores of 79.44%, 50.02%, 16.54%, and 3.02%, respectively. These banks have not only been unable to maintain their performance throughout the pandemic but have also been unable to increase their profits by lowering their costs.

The profit efficiency score in 2020 is lower than in 2021 due to the six-month moratorium. In the moratorium, the borrower is not compelled to repay (Ramasamy, 2020). Bank Negara Malaysia (BNM) announced a six-month moratorium on loans in March 2020 for borrowers impacted by the COVID-19 outbreak to relieve cash flow. When comparing the efficiency scores before and during COVID-19, the efficiency scores during COVID-19 increased. This is because the crisis during COVID-19 affected the economy, and the interest rate decreased to increase the demand for borrowing money from banks. During the COVID-19 crisis, Bank Negara Malaysia (BNM) announced that 125 basis points reduced the overnight policy rate (OPR) to a historic low of 1.75%. When COVID-19 strikes, individuals cannot survive, so banks reduce the interest rate to allow borrowers to obtain loans. The loan amount increases when the interest rate is reduced. Therefore, the bank's profit from the interest rate will rise, and profit efficiency will increase.

Table 5. Efficiency Score for International Local Commercial Bank During COVID-19

During COVID19				
Bank	2020	2021	Mean	%
I	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
J	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
K	0.600	0.649	<b>0.625</b>	<b>62.46%</b>
L	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
M	0.122	1.000	<b>0.561</b>	<b>56.12%</b>
N	0.440	0.523	<b>0.481</b>	<b>48.11%</b>
O	1.000	0.923	<b>0.962</b>	<b>96.15%</b>
P	1.000	0.079	<b>0.540</b>	<b>53.96%</b>
Q	1.000	1.000	<b>1.000</b>	<b>100.00%</b>
R	0.277	0.070	<b>0.174</b>	<b>17.40%</b>
<b>Mean</b>	<b>0.74393</b>	<b>0.72447</b>		
<b>%</b>	<b>74.39%</b>	<b>72.45%</b>		

*Note:* The efficiency score is derived after the best producer is selected for each year

Table 5 shows the efficiency scores for international and local commercial banks during COVID-19 from 2020 to 2021. The highest-level efficiency scores are Bank I, Bank J, Bank L, and Bank Q, with a 100.00% score. These banks maintained a good performance during the outbreak. The lowest efficiency score is Bank R, with a 17.40% score, because it fails to maximize profit. Bank P shows a 96.15% level efficiency score, which almost reaches the level of profit efficiency. The other banks offer low-efficiency scores: Bank K, Bank M, Bank P, and Bank N, with 62.46%, 56.12%, 53.96%, and 48.11%, respectively. From the table above, the level of efficiency score in 2020 is higher than that in 2021, even though there was a moratorium in 2020. International local commercial banks show that they still managed to generate profits in 2020 with a 74.39% efficiency score. However, the efficiency score decreased to 72.45%.

In the post-COVID year of 2022, a monetary policy statement was released in which the Bank Negara Malaysia Monetary Policy Committee (MPC) decided to raise the Overnight Policy Rate (OPR) by 25 basis points to 2.75%. In line with this adjustment, the ceiling and floor rates for the OPR corridor are 3% and 2.50%, respectively. However, the researchers could not analyze banks' profit efficiency post-Covid because the banks' annual report has yet to be released.

## 5. Conclusion

The researchers investigated the profit efficiency of eight local commercial banks and ten international local commercial banks from 2011 to 2021. The findings propose an analysis of bank data from 2011 because of Basel Committee III, which invented new regulations in response to the financial crisis from 2007 to 2009. The findings also measured the data during pre-COVID-19 and during COVID-19 due to the global impact on the banking and financial sectors from 2019 to 2021. The researchers compared local and international commercial banks and found significant differences in the profit efficiency score. Banks' profit efficiency scores show good and bad performance. This study measured the profit efficiency score using the Data Envelopment Analysis (DEA) approach, which is more accessible than the Stochastic Frontier Analysis (SFA) approach of banks' output and input. The output is profit, with an output price of interest, and the inputs are loans, with input prices of labor, capital, and borrowed funds.

The profit efficiency of a bank needs to be measured to optimize the usage of the input to gain the maximum output. Hence, once banks see their profitability, they can better manage their banks. Lending a loan to borrowers is the main activity of a bank that can boost profitability. Some individuals need loans to cover their financial obligations, purchase a home, or open businesses. As a result, lending money is an excellent way to help people survive, especially in unpredictable situations such as the

COVID-19 pandemic. During COVID-19, it was a disaster for each individual that significantly impacted them. Hence, a loan is essential for overcoming an individual's financial issues. Next, the price of labor affects bank employees. Without reasonable employee payment, it would be difficult for the bank to conduct a loan. Banks must have sufficient physical capital to reduce costs to operate effectively and smoothly. Moreover, borrowed funds can boost a bank's profitability because, with a good investment, the bank can have a high return. The interest price can affect a bank's profitability because of the uncertain rate's ups and downs; hence, it can significantly impact banks.

The researchers compared the results of the mean efficiency score between local and international commercial banks. They found that international local commercial banks performed better than local commercial banks from 2011 to 2021. The results of the mean efficiency score of local commercial banks show that they need to achieve an efficiency score. In contrast, international local commercial banks offer only two banks that earn the efficiency score. In addition, researchers compared local and international local commercial banks during the pre-COVID-19 and COVID-19 periods. The results showed a decline in the mean efficiency score during the COVID-19 pandemic. Researchers confirmed that COVID-19 had an impact on the banking sector. The banking sector declined during the pandemic because fewer individuals took out loans. When the banking sector does not perform well, it can impact the economy. Therefore, Bank Negara Malaysia (BNM) decided to release a statement of moratorium on loans within six months to stabilize the economy. Moreover, during COVID-19, the interest rate on loans is declining, allowing the people affected by the outbreak to take loans to survive during the pandemic. This situation increases the bank's profitability. The researchers found that the mean efficiency score during COVID-19 was much better than pre-COVID-19.

The study confirms that measuring the profit efficiency of a bank is essential to managing the bank's performance well, thereby maximizing the profit in the future and being more prepared for uncertain situations.

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**APPENDICES**

<b>Local Commercial Banks</b>	<b>International Local Commercial Banks</b>
<ul style="list-style-type: none"><li>➤ CIMB</li><li>➤ RHB Bank</li><li>➤ Ambank Group</li><li>➤ Affin Bank Berhad</li><li>➤ Public Bank Berhad</li><li>➤ Hong Leong Bank Berhad</li><li>➤ Maybank Banking Berhad</li><li>➤ Alliance Financial Group Berhad</li></ul>	<ul style="list-style-type: none"><li>➤ Citibank Berhad</li><li>➤ Bangkok Bank Berhad</li><li>➤ BNP Paribas Malaysia Berhad</li><li>➤ J.P. Morgan Chase Bank Berhad</li><li>➤ Bank Of China (Malaysia) Berhad</li><li>➤ Bank Of America Malaysia Berhad</li><li>➤ Deutshce Bank (Malaysia) Berhad</li><li>➤ United Overseas Bank (Malaysia) Berhad</li><li>➤ India International Bank (Malaysia) Berhad</li><li>➤ Standard Chartered Bank Malaysia Berhad</li></ul>