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Commercial Banks' Performance In Malaysia Based On Non-Performing Loan (NPL) Using Two-Stage Data Envelopment Analysis (DEA) Model

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ABSTRACT

Although single-stage Data Envelopment Analysis (DEA) models with undesirable input-output have been extensively studied, there still lacks more systematic investigation of a two-stage DEA model with undesirable variables such as non-performing loan (NPL) in Malaysia. The NPL concept has been widely discussed by economists since the economic downturn in 1997, which had immense impacts on many countries, including Malaysia. This paper studies the performance of commercial banks in Malaysia from 2013 to 2017 using a two-stage Data Envelopment Analysis (DEA) model. The main objective of this paper is to measure the performance of commercial banks in Malaysia by considering NPL and next to determine the suggested value for the selected variables in order to improve the inefficient banks. The findings show that domestic banks were generally more efficient than foreign banks. The results for the whole process show that domestic banks also performed better than foreign banks in both stages. The two-stage model used in this analysis enables inefficient banks to look at where the problem occurs, either in stage 1 or stage 2, thus allowing them to determine the suggested values in that inefficient stage that can bring them towards becoming fully efficient banks.

Key words :DEA, efficiency, undesirable output

1. INTRODUCTION

A number of researches have been conducted in various perspective to study about bank performance [1] [2] [3]. Bank performance needs greater attention as it is central in achieving the financial stability of a country [4]. When the banking system fails, the whole country's economy, operation, and wealth will be in jeopardy.

The non-performing loan (NPL) concept has been widely discussed by economists since the economic downturn in the year 1997, which had tremendous impacts on many countries, including Malaysia. NPL happens when a debtor fails to pay the principal or interest amount for 90 days or more. It is impertinent to look at NPL as it reflects the credit quality of the loan portfolio of commercial banks. Statistics from the World Bank shows that NPL to total gross loans in Malaysia
decreased from 9.39% in the year 2005 to 1.55% in 2017. Although the NPL ratios have fallen recently, NPL has persisted in being the primary burden of Malaysian banks. An increase in the NPL will affect a bank's profitability and liquidity, which are the main components for measuring bank efficiency. Besides, it will be a serious threat to the bank's performance if there is no solution to recover their bad loans, rendering them unable to get the loan to be repaid in full. Some of the studies that include NPL in their investigation are Ramli et al. [5], Hamid et al. [6], Louhichi and Boujelbene [7], and Anwar et al. [8].

Although single-stage Data Envelopment Analysis (DEA) models with undesirable input-output have been extensively studied, there still lacks more systematic investigation of a two-stage DEA model with undesirable variables such as NPL in Malaysia. Measuring a bank's efficiency without incorporating the undesirable outputs can generate misleading results and bias as the undesirable outputs represent the adverse impacts resulting from operations. According to Nguyen [7], a two-stage DEA model is better than a single-stage DEA model in evaluating operating performance, as it informs the management which area in the inefficient company is facing problems either in the first stage of absorbing resource or in the second stage or spending resource. After computing the efficiency score, it is pertinent to measure the extent of the relative inefficiency of decision making units (DMUs) and to explore the areas that bring improvements to their efficiency [8]. Therefore, this paper aims to measure the performance of commercial banks in Malaysia by considering the NPL using a two-stage data envelopment analysis (DEA) model and then, provide the suggested values for the selected input and output variables in order to improve the inefficient DMUs towards becoming fully efficient banks.

2. EFFICIENCY MEASUREMENT USING DATA ENVELOPMENT ANALYSIS (DEA) MODEL

DEA, which was introduced by Charnes, Cooper, and Rhodes [11] is also known as mathematical programming for measuring the efficiency of decision making units (DMUs), assuming a constant return to scale (CRS). It was later extended by Banker [12] to incorporate variable returns to scale (VRS). In the banking sector, the results generated using VRS tend to be better than those using CRS. It is primarily because VRS shows which banks have increased their inputs and lowered their outputs. Moreover, the VRS assumption is more relevant than the CRS assumption in a real-world application which is characterised by imperfect competition [12]. This contention is supported by a previous study by Sufian and Kamarudin [14], which employed the VRS assumption in measuring the efficiency of banks since the CRS is valid only if all the banks in the sample are operating at the optimal level. However, technological advance and regulatory change may affect banks of different sizes differently. Similarly, Assaf et al. [15] have pointed out that VRS permits modelling the entire range of technology.

However, according to Avkiran [16], using a single-stage DEA model will result in inaccurate efficiency measurement as it cannot find the source of inefficiency present in DMUs. This is due to the model itself as it only views DMUs as black boxes that consume inputs to produce outputs. Rho and An [17] shows that a two-stage DEA model allows us to investigate the structure inside the process further. In many real-life situations, DMUs can have a two-stage structure where the first stage produces the output by using the initial input, and that first-stage output becomes the input of the second stage to produce the final output (Kamarudin et al.,[18], Kamarudin et al.,[19]). The output of the first stage is the same as the input of the second stage and is called an intermediate product.

3.A TWO-STAGE DEA MODELDEVELOPMENT

Initially, Seiford and Zhu [20] presented the first two-stage DEA model to evaluate the marketability and profitability of US commercial banks. A decade later, Chen et al. [21] improved the two-stage DEA model by proposing an additive model in which the overall efficiency of the entire process is decomposed into the weighted averages of the two sub-stage efficiencies.

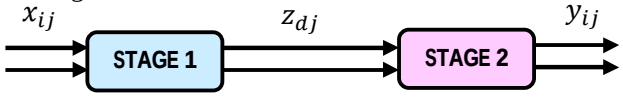


Figure 1: A two-stage DEA Model

Figure 1 shows a graphical representation of a two-stage process proposed by Chen et al. [21]. Consider there are*n* DMUs and each DMU_j ($j=1,2,\ldots,n$) utilizes m inputs x_{ij}($i=1,2,\ldots,m_1$). These inputs will produce p desirable intermediate products, z_{dj} ($d=1,2,\ldots,p_1$), which are then used as the inputs in the second stage to produce s outputs, y_{ij}($r=1,2,\ldots,s_1$).

However, as considered by Fukuyama and Weber [23], in the banking sector, some loans may become non-performing, which means they may become unable to be partially or fully repaid by borrowers. Therefore, these NPLs should be treated as bad outputs or undesirable outputs as a bank cannot produce NPLs until the deposits are utilized to produce loans.

3.1 A Two-Stage DEA Model with Undesirable Outputs

To improve bank performance, we need to increase the desirable outputs and simultaneously decrease the undesirable outputs. Ashrafi and Jaafar [23] and Wang et al. [24] have generalized a two-stage DEA model proposed by Chen et al. [21] by introducing undesirable factors into the model to improve the performance of the two-stage processes using the concept of increasing undesirable inputs and decreasing undesirable outputs.

Regarding the controversy on how to model undesirable outputs within a DEA framework, no agreement has been achieved in the literature concerning which of the approaches mentioned above is preferable as each model has its advantages and disadvantages. For this study, we chose the approach proposed by Ashrafi et al. [23] instead of Wang et al. [24], considering that they proposed the first two-stage DEA model with undesirable factors. Besides, the model proposed by Ashrafi et al. [23] involves optimal multipliers in measuring the efficiency score at each of the first and second stage, which are easier for us to understand and there is no need to build new linear programming with different objectives to find the efficiency score at each stage. In other words, the efficiency scores for the whole process consisting of stage 1 and stage 2 can be obtained by using the same linear programming. In addition, this model is more appropriate than the basic DEA model because it addresses NPLs in the second stage, thus rendering the evaluation process consistent with a bank's operations.

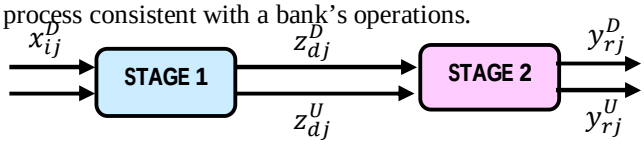


Figure 2: A Two-Stage DEA Model with Undesirable Factors

Figure 2 shows a graphical representation of a two-stage process of a DEA model, incorporating undesirable factors. Let there be n DMUs, and each DMU_j ($j=1,2,\ldots,n$) utilizes $m_1$desirable inputs, x^D_{ij} ($i=1,2,\ldots,m_1$) and m_2 undesirable inputs, x^U_{ij} ($i=1,2,\ldots,m_2$) with $m_1 + m_2 = m$. These two types of inputs will produce p_1 desirable intermediate products, z^D_{dj} ($d=1,2,\ldots,p_1$) and p_2 undesirable intermediate products, z^U_{dj} ($d=1,2,\ldots,p_2$) with $p_1 + p_2 = p$. These intermediate products are then used as the inputs in the second stage to produce s_1 desirable outputs, y^D_{rj} ($r=1,2,\ldots,s_1$) and s_2

undesirable outputs, y^U_{rj} ($r=1,2,\ldots,s_2$) with $s_1 + s_2 = s$. Equation 1 shows the overall efficiency measure for the two-stage DEA model with undesirable factors based on the VRS assumption.

$$E_0^* = \max \sum_{r=1}^{s_1} u_r^D y_{ro}^D - \sum_{r=1}^{s_2} u_r^U y_{ro}^U + u^2 + \sum_{d=1}^{p_1} \omega_d^D z_{do}^D - \sum_{d=1}^{p_2} \omega_d^U z_{do}^U + u^1$$

$$s.t \quad \sum_{i=1}^{m_1} v_i^D x_{io}^D - \sum_{i=1}^{m_2} v_i^U x_{io}^U + \sum_{d=1}^{p_1} \omega_d^D z_{do}^D - \sum_{d=1}^{p_2} \omega_d^U z_{do}^U = 1,$$

$$\left[\sum_{d=1}^{p_1} \omega_d^D z_{do}^D - \sum_{d=1}^{p_2} \omega_d^U z_{do}^U\right] - \left[\sum_{i=1}^{m_1} v_i^D x_{io}^D - \sum_{i=1}^{m_2} v_i^U x_{io}^U\right] + u^1 \le 0 \; ; j = 1, \ldots, n,$$

$$\left[\sum_{r=1}^{s_1} u_r^D y_{ro}^D - \sum_{r=1}^{s_2} u_r^U y_{ro}^U\right] - \left[\sum_{d=1}^{p_1} \omega_d^D z_{do}^D - \sum_{d=1}^{p_2} \omega_d^U z_{do}^U\right] + u^2 \le 0 \; ; j = 1, \ldots, n,$$

$$v_i^D, v_i^U, u_r^D, u_r^U, \omega_d^D, \omega_d^U \ge 0$$

u^1 *and* u^2 free in sign

where,

v_i^D ($i=1,2,\ldots,m_1$) = the multipliers associated with the desirable inputs

v_i^U ($i=1,2,\ldots,m_2$) = the multipliers associated with the undesirable inputs

ω_d^D ($d=1,\ldots, p_1$) = the multipliers associated with the desirable intermediate products

ω_d^U ($d=1,2,\ldots,p_2$) = the multipliers associated with the undesirable intermediateproducts

u_r^D ($r=1,2,\ldots,s_1$) = the multipliers associated with the desirable outputs

u_r^U ($r=1,2,\ldots,s_2$) = the multipliers associated with the undesirable outputs

Equation 1 will be solved *n* times, once for each DMU, in order to evaluate the overall efficiency score of the entire two-stage process.Optimally, the efficiency scores of the two stages of each DMU_o ($o=1,2,\ldots,n$) can be calculated as follows:

Efficiency of DMU_j at First Stage Process

$$E_o^{1*} = \frac{\sum_{d=1}^{p_1} \omega_d^{D*} z_{do}^D - \sum_{d=1}^{p_2} \omega_d^{U*} z_{do}^U + u^1}{\sum_{i=1}^{m_1} v_i^{D*} x_{io}^D - \sum_{i=1}^{m_2} v_i^{U*} x_{io}^U} \qquad (2)$$

where,

ω_d^{D*} ($d=1,\ldots, p_1$) = the optimal multipliers associated with the desirable intermediate products

ω_d^{U*}($d=1,2,\ldots,p_2$) = the optimal multipliers associated with the undesirable intermediate products

v_i^{D*}($i=1,2,\ldots,m_1$) = the optimal multipliers associated with the desirable inputs

v_i^{U*} ($i=1,2,\ldots,m_2$) = the optimal multipliers associated with the undesirable inputs

Efficiency of DMU_j at Second Stage Process

$$E_o^{2*} = \frac{\sum_{r=1}^{s_1} u_r^{D*} y_{ro}^D - \sum_{r=1}^{s_2} u_r^{U*} y_{ro}^U + u^2}{\sum_{d=1}^{p_1} \omega_d^{D*} z_{do}^D - \sum_{d=1}^{p_2} \omega_d^{U*} z_{do}^U} \qquad (3)$$

where, (1)

u_r^{D*} ($r=1,2,\ldots,s_1$) = the optimal multipliers associated with the desirable outputs

u_r^{U*} ($r=1,2,\ldots,s_2$) = the optimal multipliers associated with the undesirable outputs

ω_d^{D*} ($d=1,\ldots, p_1$) = the optimal multipliers associated with the desirable intermediate products

ω_d^{U*} ($d=1,2,\ldots,p_2$) = the optimal multipliers associated with the undesirable intermediate products

All the optimal multipliers can be obtained using Equation 1. Equation 1 allows us to evaluate the overall efficiency of the DMU in such a way that the operations of its two stages are taken into account. Also, recognizing the inefficient sub-processes and making later improvements can be done using these models.

Table 1: List of Banks in Malaysia used in this study

DMU	Name of the Bank	Ownership
1	Affin Bank Berhad	Domestic
2	Alliance Bank Malaysia Berhad	Domestic
3	AmBank (M) Berhad	Domestic
4	CIMB Bank Berhad	Domestic
5	Hong Leong Bank Berhad	Domestic
6	Maybank Berhad	Domestic
7	Public Bank Berhad	Domestic
8	RHB Bank Berhad	Domestic
9	Bangkok Bank Berhad	Foreign
10	Citibank Berhad	Foreign
11	HSBC Bank Malaysia Berhad	Foreign
12	OCBC Bank (Malaysia) Berhad	Foreign
13	Standard Chartered Bank Malaysia Berhad	Foreign
14	United Overseas Bank (Malaysia) Bhd.	Foreign
15	The Bank of Nova Scotia Berhad	Foreign

Source: Bank Negara Malaysia (2019). List of Licensed Financial Institutions.

Table 1 shows the list of commercial banks used as the decision making units (DMUs) in this study, while Table 2 provides the list of the input and output variables used for the analysis.

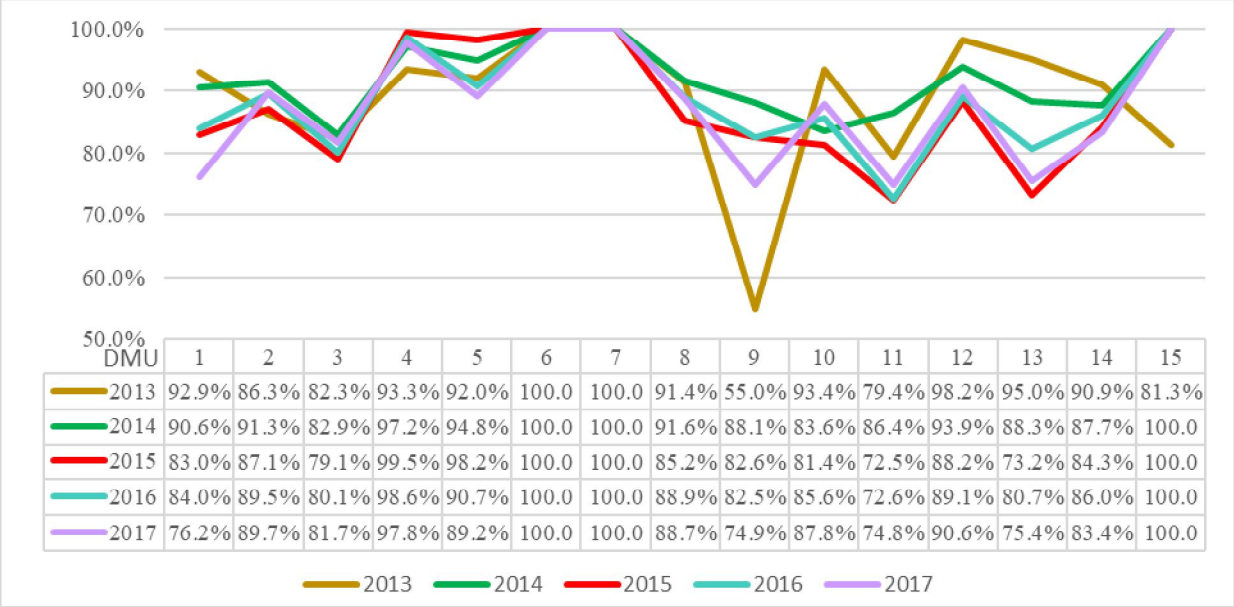
Table 2: List of Variables

Variable	Name of Variable	Type
x_{1j}^D	Personnel Expenses (RM'000)	Desirable Input
x_{2j}^D	Fixed Assets (RM'000)	Desirable Input
x_{3j}^D	Total Deposits (RM'000)	Desirable Input
z_j^D	Total Resources (RM'000)	Intermediate Product
y_{1j}^D	Total Earning Assets (RM'000)	Desirable Output
y_{2j}^D	Interest Income (RM'000)	Desirable Output
y_j^U	Non-Performing Loan (RM'000)	Undesirable Output

This study used LINGO software to find the efficiency score for each commercial bank in Malaysia using a two-stage model as well as proposing some improvements for the inefficient DMUs.

4. RESULTS AND DISCUSSION

Figure 3 shows the trends of efficiency scores for each commercial bank from the year 2013 to 2017. The trends clearly show that the domestic banks, DMU1–8, achieved better performance as compared to the foreign banks, DMU9–15, where their efficiency scores were fluctuating slightly throughout theperiod. Two domesticbanks, DMU6 and



DMU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2013	92.9%	86.3%	82.3%	93.3%	92.0%	100.0	100.0	91.4%	55.0%	93.4%	79.4%	98.2%	95.0%	90.9%	81.3%
2014	90.6%	91.3%	82.9%	97.2%	94.8%	100.0	100.0	91.6%	88.1%	83.6%	86.4%	93.9%	88.3%	87.7%	100.0
2015	83.0%	87.1%	79.1%	99.5%	98.2%	100.0	100.0	85.2%	82.6%	81.4%	72.5%	88.2%	73.2%	84.3%	100.0
2016	84.0%	89.5%	80.1%	98.6%	90.7%	100.0	100.0	88.9%	82.5%	85.6%	72.6%	89.1%	80.7%	86.0%	100.0
2017	76.2%	89.7%	81.7%	97.8%	89.2%	100.0	100.0	88.7%	74.9%	87.8%	74.8%	90.6%	75.4%	83.4%	100.0

Figure 3: Trends of technical efficiency scores from 2013 to 2017

DMU7, achieved full efficiency throughout the five-year observation. On the other hand, DMU9 had a poor performance in the year 2013. However, the efficiency score of DMU9 increased by almost 30% in the following year, indicating that improvements might have been made by this bank. Then, the banks gradually became less efficient until the year 2017. Meanwhile, DMU13 obtained an almost fully efficient score in the year 2013. However, the bank's efficiency score decreased to 75.4% in 2017, indicating the bank's failure to maintain its performance throughout the period. In contrast, DMU15 sustained its perfect efficiency score throughout the period after encountering difficulties in 2013. This trend indicates that the bank had improved on the problem areas and successfully maintained their performance.

Among all the years, most of the commercial banks were seen to achieve low performance in 2015, except for DMU4, DMU5, DMU6, DMU7, and DMU15. This result is in line with the GDP growth trend in Malaysia, which decreased from 6% to 5.1% from 2014 to 2015 (World Bank). According to Jiménez et al. [25], GDP growth affects banking performance positively through net interest income, loan losses improvements, and operating costs. Higher GDP growth will be accompanied by increasing firm loans and deposits and better bank net interest income and loan losses.

Overall, DMU6, DMU7, and DMU4, which are Maybank, Public Bank, and CIMB Bank were the top three commercial banks that achieved the highest performance among all the commercial banks. These findings are similar to the real-world situation where Corporate Finance Institute [26] has reported that Maybank, Public Bank, and CIMB Bank to be the top three in the ranking of Malaysian commercial banks' performance.

Figure 4 shows the geometric mean of technical efficiency score in stages 1 and 2 for both domestic and foreign banks. Domestic banks were found to be more efficient than foreign banks in both stages. This result indicates that domestic banks were more efficient than foreign banks in collecting and spending their resources. This result is characterized by imperfect competition, implying that several market environmentfactors might have caused foreign banks to be less efficient than domestic banks. According to Chin et al. [27], bank size, cost to income ratio, and gross domestic product (GDP) affected the performance of foreign banks in Malaysia. They found the size of foreign banks had an

inverse relationship with the profit earned by the banks. Besides, they noted that foreign banks were less-efficient when the banks achieved a lower return on asset (ROA). Lastly, their empirical study also showed that foreign banks had a better performance during cyclical upswings in the business cycle.

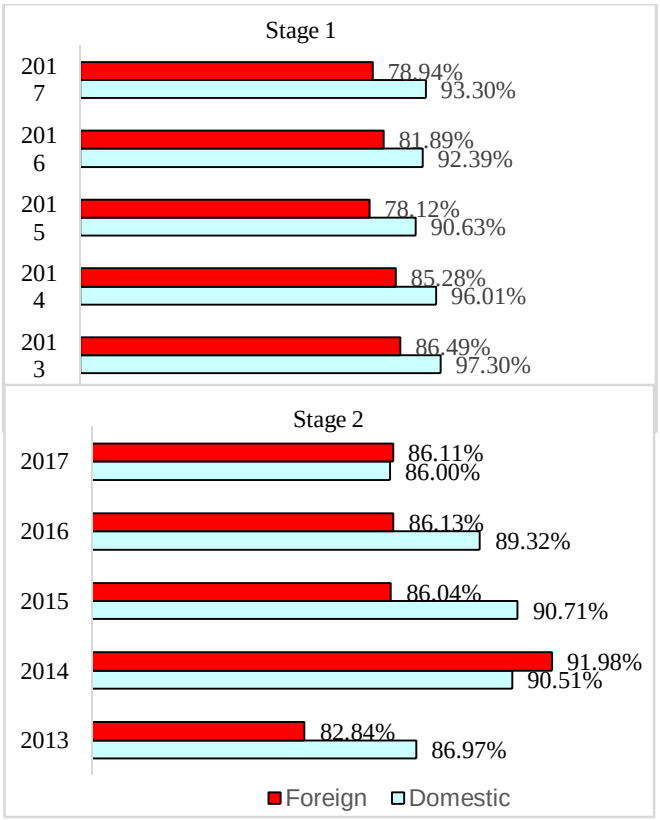


Figure 4: Geometric Mean of Technical Efficiency Score in Stage 1 and 2

The bar chart in Figure 5 shows that the actual and suggested values of personnel expenses improved in stage 1 from 2013 to 2017. Clearly, DMU4 and DMU6 invested vast amounts on personnel expenses throughout the years with DMU6 spending the largest amount on personnel expenses among all the banks. Nevertheless, both DMU still maintained better efficiency in their performance. It is not surprising that this bank incurred large personnel expenses as they operated many branches throughout the country. The graph also depicts that DMU4 and DMU8 needed to reduce relatively huge amounts of their personnel expenses as suggested by the model in order to achieve higher efficiency.

Figure 6 shows the actual and suggested values of NPLs improved in stage 2 from 2013 to 2017. Similar to the case in stage 1, DMU6 had a huge NPL amount but the bank had been effective in handling it because they remained efficient in stage 2. On the other hand, DMU4 needed to reduce a huge amount of NPL at the beginning of the observation period. Subsequently, DMU4 gradually became better at handling their bad loans because the bank had successfully achieved full efficiency in stage 2 at the end of the observation period.

The results for the whole process show that domestic banks also performed better than foreign banks in both stages. These results indicate that the domestic banks dealt with bad loans efficiently, even though Omar et al. [28] stated that NPLs

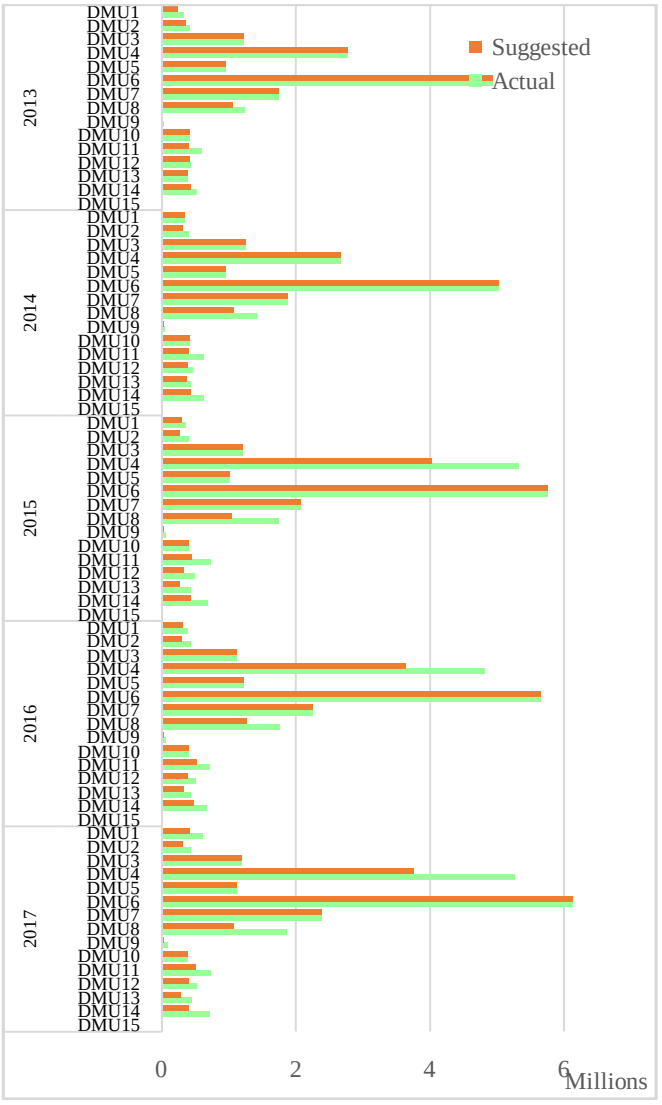


Figure 5: Improvement of Personnel Expenses in Stage 1 from 2013 to 2017

were higher in domestic banks than in foreign banks. In addition, the results show that only personnel expenses and NPL needed to be changed to improve the inefficient DMUs. It is therefore suggested that any banks that have problems in stage 1 need to review the level of compensation of their employees. Meanwhile, banks that achieve low performance in stage 2 need to create effective rules and regulation, develop awareness, and curb unproductive borrowings.

4. CONCLUSION

The present study investigated the efficiency of Malaysian commercial banks from 2013 to 2017. The efficiency score of each bank was evaluated using a two-stage DEA model with the presence of non-performing loan (NPL) under VRS assumptions. The advantage of this type of study is that we can investigate in detail the stage at which inefficient banks encounter problems so that the management can focus on the identified problem areas and make the required efforts to improve in those areas.

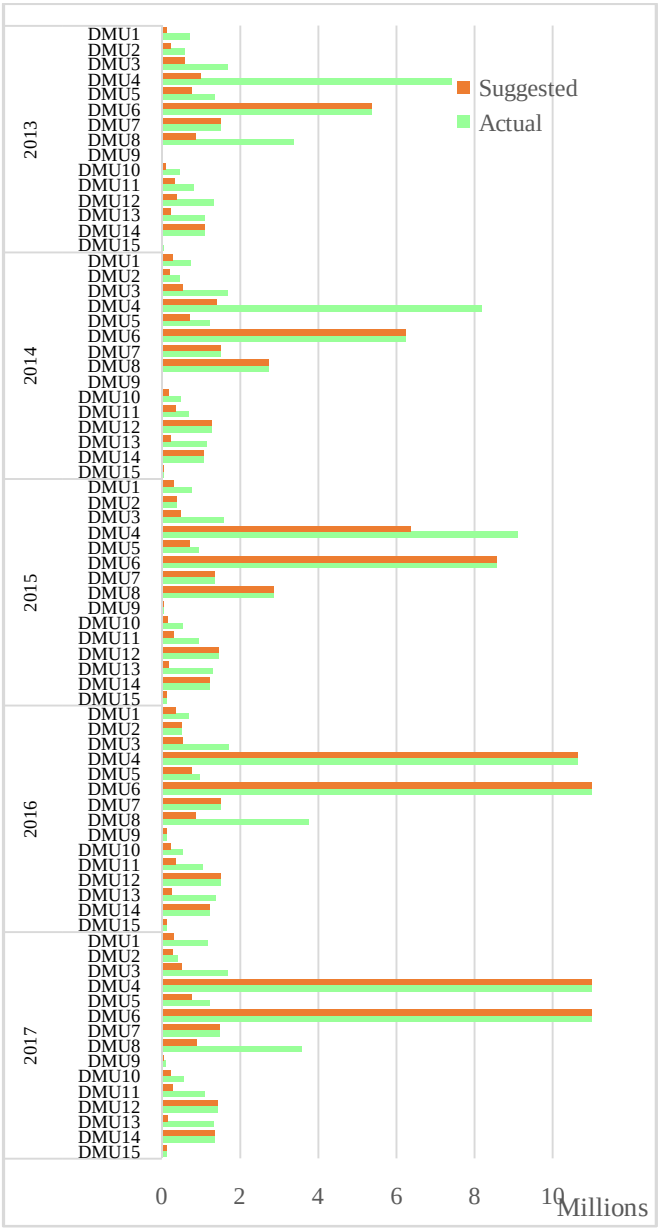


Figure 6: Improvement of Non-Performing Loans (NPLs) in Stage 2 from 2013 to 2017

We found that domestic banks performed better than foreign banks in both stages. This result means domestic banks were more efficient than foreign banks in absorbing their resource and spending their resource. Despite incurring high levels of NPL, the domestic banks remained more efficient than foreign banks in stage 2. This finding may indicate that the domestic banks had a good practice in place in ensuring that they had reserved a specific amount of their profits for loan loss provision to reduce the probability of achieving poor performance.

This study demonstrates the advantage of using a two-stage model, which encourages researchers to apply data envelopment analysis (DEA) in measuring the performance of various sectors such as academic, tourism, hospitality, and insurance, among others. This two-stage DEA model could estimate the technical efficiency score of 15 commercial banks in Malaysia effectively with the presence of desirable and undesirable outputs. In addition, this model is a suitable method for identifying the areas that inefficient banks are slacking in their performance and hence, can suggest improvements to the input-output variables that can bring the banks towards becoming fully efficient banks.

5. ACKNOWLEDGEMENT

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