"Efficiency Measurement in The Indonesian Commercial Banks By Using Data Envelopment Analysis"

By Umar Hamdan & Yulia Hamdaini Putri*)

Abstrak

Penelitian ini bertujuan untuk menganalisis tingkat efisiensi pada bank-bank umum di Indonesia dengan menggunakan sampel sebanyak 15 bank umum. Analisis efisiensi menggunakan Data Envelopment Analysis (DEA) berbasis Linear Programming (LP).Berdasarkan lima peringkat bank paling efisien, menunjukkan urutan bank paling efisien adalah Bank Central Asia (bank devisa), Citibank (bank asing), Bank Chinatrust Indonesia (bank usaha patungan), Bank Negara Indonesia (bank publik), dan UFJ (bank asing) selama periode 2004-2008.

Kata Kunci: *Efficiency, Commercial Banks, Data Envelopment Analysis*

I. INTRODUCTION

Act No. 7 of 1992 on Banking as revised by Act No. 10 of 1998, Bank is a legal entity that taking funds from community in the form of deposits, and making loans to the community in order to enhance community welfares.

The traditional role of the commercial bank as a financial intermediary taking deposits and making loans has considerably diminished, due primarily to the process of disintermediation: personal investors, who traditionally invested their money in bank deposits, have a much wider range of investment possibilities. As a result, banks have to pay more for a historically inexpensive source of funding. Correspondingly, with the expansion of non-traditional lending channels, business loans, which represent a substantial percentage of a bank's assets, have been facing increased competition from other institutions and products. Debtors looking to borrow can now bypass banks as the main credit providers, and dispose of a wide variety of credit instruments more conveniently and economically than traditional short-term and long-term bank credits.

Although it has been profoundly remolded, banking is still a high-volume, low-margin industry. In percentage terms, profit margins are very slim. For instance, for every Rp 100 of assets (including loans) in 2003, on average Indonesian banks earned only Rp2, which corresponds to an ROA (return on asset) of 2% (BI report, 2003). This implies that there are still rooms for improvement in their scale and operating efficiencies. Net interest margin and non performing loan of commercial bank period 2003 to 2007 can be described as follows:

Table 1
Performance Ratio of NIM and NPL of Commercial Banks in Indonesia

Category of Commercial banks	Dec. 2003		Dec. 2004		Dec. 2005		Dec. 2006		Dec. 2007	
	NIM %	NPL >5%	NIM %	NPL >5%	NIM %	NPL >5%	NIM %	NPL >5%	NIM %	NPL >5%
State Owned Banks	4.53	3	6.23	3	5.78	2	5.77	2	6.03	2
Foreign Exchange Commercial Banks	4.60	7	5.35	6	5.24	7	5.67	10	5.4	5
Non-Foreign Commercial banks	7.40	6	8.52	4	5.35	7	6.80	9	7.98	7
Regional Development Banks	8.42	1	10.45	5	9.56	2	8.20	1	7.24	1
Joint Venture Banks	3.54	12	3.46	12	3.81	9	4.59	7	4.03	2
Foreign Owned Banks	4.61	7	4.40	5	4.78	3	4.91	1	4.70	5
NIM Commercial Banks/ Total banks NPL >5%	4.64	36	5.88	35	5.63	30	5.80	30	5.70	22

Source: Indonesian Banking Statistics.
Note: NIM = Net Interest Margin (%); NPL = Non Performing Loans (Number of banks)
From 136 banks there are 36 banks have NPL>5% in December 2003. On the other hand, there are 22 banks from 130 banks have NPL >5% in December 2007.

Hempel at.al (1994); Allen and Ray (1996); Allen and Santomero (1997); Koch and Mac Donald (2004) mentioned that there are some factors that encourage us to analyze commercial banks efficiency. *First*, financial disintermediation enforces commercial banks to look for more innovation ways in finding more inexpensive source of funding, increasing LDR but still maintaining a lower NPL. *Second*, commercial banks must be more efficient in allocating resources and diversifying risks due to global competition. *Third*, increasing of customer expectations on banks services, such as a comfortable technology and electronic banking services; and performance-based fees activity. *Fourth*, technological developments that led commercial banks face the competition of non-financial firms, such as software and logistics companies, in the delivery of payment services and in fund management activities. *Fifth*, banks must have strategy shift by the increasing importance of non-interest income (NII) from fee-based businesses. *Sixth*, Central Bank has encouraged commercial banks to merge in order to achieve economies of scale, higher level of efficiency, and profitability. *Seventh*, commercial banks face efficiency dilemma as high-volume but low-margin industry. So, commercial banks still can improve in their economic scale and operating efficiencies.

According to Grady and Spencer (1990); Settlage (2003); Andersen and Petersen (1995) to measure, quantify, and improve inefficiency is an important exercise in economics. Classical economic theory rejects the idea of inefficiency, but producer inefficiency in empirical applications seems to be a common finding. A producer is economically efficient if: (1) maximum output is produced by given the input used, (2) this output is produced at minimum costs, and (3) the correct output mix is produced to maximize revenue. The cause of inefficiency comes from many roots, including: (1) poorly measured input data, (2) inadequate methods of measuring efficiency, (3) poor allocation of inputs and outputs (allocation inefficiency), and (4) producer failure to get maximum output from a given set of inputs (technical inefficiency).

The input activity of commercial banks can be traced on how efficient they raise funds from several sources, such as third party non banks, liabilities owned to Central Banks and/or other interbanks, issued debt securities, and other liabilities. Commercial banks have also to pay interest payment on collected funds and other operational expenses to support those funding activities. On the other hand, the output activity of commercial banks can be assessed how efficient they allocate all those funds have been raised to extend credits, place at central banks and/or other interbank deposits, and invest on income securities. From these lending activities, commercial banks receive interest income. Besides that, commercial banks can also generate other operational income, such as fee-based income.

In the profit maximization case, allocation efficiency occurred if it was feasible for the firm to achieve higher profits given the prices of inputs and outputs. In this research, the DEA method can be used to measure both the allocation efficiency and technical efficiency of commercial banks based on the inputs and outputs empirical data.

The objective of this research is to apply DEA method to measure the efficiency of commercial banks in Indonesia. This will be done by collecting data, processing and analyzing data from commercial banks' financial reports from 2004 to 2008.

The DEA gains higher acceptance among practitioners and academicians, as a useful technique for evaluating efficiency. The application of DEA in measuring banking performance in developed country such as Indonesia still scare. Therefore, this study can also contribute as reference for decision makers and academicians in evaluating banking industry efficiency.

II. LITERATURE REVIEW

Efficiency analysis has always interested researchers because of the relative difficulty encountered in assessing the performance of a firm or an organization. Using an engineering-like approach, Farrell (1957) attempted to measure the efficiency of a unit of production in the single-input, single-output case.

Cook, Kress, and Seiford (1993) proved that in a relatively short period of time Data Envelopment Analysis (DEA) has grown into a powerful quantitative, analytical tool for measuring and evaluating performance. DEA has been successfully applied to a host of different types of entities engaged in a wide variety of activities in many contexts worldwide. Charnes A. et.al (1994) mentioned that Data envelopment analysis (DEA), occasionally called frontier analysis, was first put forward by Charnes, Cooper and Rhodes in 1978. It is a performance measurement technique which, can be used for evaluating the *relative efficiency* of *decision-making units* (*DMU's*) in organisations. Here a DMU is a distinct unit within an organization that has flexibility with respect to some of the decisions it makes, but not necessarily completes freedom with respect to these decisions.

The technical efficiency of a DMU is computed using the engineering like measure of efficiency, namely the ratio of virtual output produced of virtual input consumed:

$$\text{Technical efficiency} = \frac{\sum \text{weighted outputs}}{\sum \text{weighted inputs}}$$

As for the weights used the transformation of the vectors of inputs and outputs into two single virtual scalars, the DEA model allows each DMU to choose the set of multipliers (weights) μ_o and ν_o that permits it to appear in the best light. The efficiency score obtained is also relative to a sample of DMUs under analysis, since the set of weights has to be feasible for other units and none of these units hold has an efficiency score greater than unity.

Traditional approaches to assessing performance are based on the amount of "output" generated by a producer (bank). This statement is appropriate to economies that are based on undifferentiated goods and services delivered to uniform clientele segments. As such, a bank is viewed as a "factory" that transforms inputs into outputs.

The first standard DEA model as proposed by Charnes, Cooper, and Rhodes (1978), in ratio is expressed as follows:

Model of CCR Input-Oriented Ratio Form

$$(1) Max \quad \omega_o = \left\{ \frac{\sum_I \mu_i y_{io}}{\sum_i v_i X_i} \right\}$$

Subject to :

$$(2) \quad \frac{\sum_I \mu_i y_{jk}}{\sum_i v_i X_{jk}} \leq 1 \text{ for all DMUs k = 1,2,..n}$$

$\mu_i \geq 0$

(3) $v_i \geq 0$

The parameters used in model are :

ω_o = the efficiency score of the DMU 0 under analysis;

n = number of DMUs under analysis;

I = number of outputs

J = number of inputs

Yk = { *y1k,y2k,…,yik,….,yjk*} is the vector of outputs for DMU *k* with *yik* being the value of output *i* for DMU *k*.

Xk = {*X1k,X2k,…,Xik,….Xjk*} is the vector of inputs for DMU *k* with *Xik* being the value of input j for DMU k.

µ and v the vectors of multipliers respectively applied to *Yk* and *Xk*, where µ*i* ,v*j* = the respective weigths for output *i* and input *j*.

Given a set of *n* decision Making Units (branches), the model determines for each DMUo the optimal set of input weights $\{v_{jo}\}_{j=1}$ and output weights $\{\mu_{io}\}_{i=1}$ that maximizes its efficiency score ω_o. Charnes, Cooper, and Rhodes (1978) define efficiency by reference to the orientation chosen: (i) in an output oriented model, a DMU is not efficient if it is possible to augment any output without increasing any input or decreasing any other input; and (ii) in an input oriented model, a DMU is not efficient if it is possible to decrease any input without augmented any other input and without decreasing any output.

A DMU will be characterized as efficient if and only if neither (i) nor (ii) occurs. A score less than one means that a linear combination of other units from the sample could produce the vector of outputs using a smaller vector of inputs. Mathematically, a DMU is termed *efficient* if its efficiency rating ω_o obtained from the DEA model equal to one. Otherwise, the DMU is considered inefficient.

Traditional DEA models, as outlined by Charnes, Cooper, and Rhodes (1978), implicitly assumed that factor (inputs and outputs) are discretionary, which means that they are controllable and can be set up by the decision-maker. However, in many realistic situation, variables are exogenous and non-discretionary. In the case of bank branch efficiency, most outputs are non-discretionary; for instance, a branch does not have absolute control over the numbers of deposits processed, or of RRSPs sold. Banker and Morey (1986) proposed a methodology to include non-discretionary variables in DEA. This is done primarily by maximizing (minimizing) only discretionary outputs (inputs) in the linear programming (LP) model. DEA can also integrate categorical variables (non-continuous variables) in the LP model, such as discrete ordinal variables (dummy variables).

Other authors have analyzed the issue using categorical variables by proposing alternate formulations of the LP model (Cook, Kress and Seaford 1993 and 1996). Consequently, DEA embodies all different types of variables, whether they are discretionary or non-discretionary, categorical (ordinal) or continuous.

Depending on the orientation of the problem (input-oriented, output-oriented or base-oriented model), DEA presents three extremely useful features (Charnes et al 1994):

- It characterizes each DMU by a single efficiency score.
- By projecting inefficient units to the efficient envelope, it highlights areas of improvements for each single DMU.
- It facilitates making inferences on the DMUs' general profile.

Charner et al (1994) give a complementary list of other advantages of DEA :

- The possibility of handing multiple inputs and outputs stated in different measurement units
- The focus on a best-practice frontier, instead of on population central-tendencies. Every unit is compared to an efficient unit or a combination of efficient units. The comparison, therefore, leads to sources of inefficiency of units that do not belong to the frontier.
- No restrictions are imposed on the functional form relating inputs to outputs.

These characteristics have made DEA a popular method in efficiency assessment.
Traditional DEA analysis has other limitation (Thanassoulis, 1993):

- Limitations in aggregating different aspects of efficiency, especially in the case where DMUs perform multiple activities.
- Insensitivity to intangible and categorical components (for instance, the service quality in a bank branch setting).

Standard financial and operational ratios are the most usual measures for banks' performance. Performance can either refer to the operational or the financial performance of the bank. Among the most usual profitability measures used by regulators, financial institution managers, and consultants, are Return on Assets (ROA) and Return on Equity (ROE). Molyneux et al (1995) argues that these two indicators are the most appropriate for comparison of profitability between different activities and banking systems.

A commonly used measure for a bank's cost efficiency is the ratio of non-interest expenses to average assets. The other approach to efficiency relates to the operational efficiency of banks, as described by Molyneux et al (1995). Most banks depend heavily on internal productivity measures such as those relating outputs to staff time, while most international comparisons of cost efficiency usually use an aggregate ratio of cost to revenue or assets. Among the most commonly used operating ratios are: staff expenses as a percentage of total assets; operating expenses as a percentage of total assets; staff costs to non-bank deposits; non-staff operating costs to non-bank deposits; and cost over income (Molyneux et al 1995). The ratio of staff cost over non-bank deposits and the ratio of non-staff operating costs over non-bank deposits are among the most popular operating ratios (Berger and Humphrey 1997a).

Sherman and Ladino (1995) and Molyneux et.al (1996) point out that performance ratios also do not account for the quality of service. A central point to any efficiency analysis is that the inputs and outputs should be of equal quality among units under analysis.

Akhavein et al (1997) indicate that profitability and cost ratios provide little information on the managerial actions needed to improve efficiency; and in the case of event studies, such as mergers and acquisitions, these ratios fail to highlight the sources of changes in efficiency levels.

Non parametric approaches mainly include Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH). DEA is a linear programming technique that produces a best- practices frontier composed of efficient Decision-Making Units (DMUs). The efficiency condition is stated by Ali (1990:2): "A DMU b is efficient if there exists no other DMU k or linear combination of DMUs that produces the same vector of output with a smaller vector of inputs (in the input-oriented model) or produces a larger vector of outputs with the same vector of inputs." The FDH (Tulkens 1995) is a special case of a DEA model where DMUs are not projected onto a linear combination of efficient DMUs.

Many academics and practitioners believe that most financial institutions have quite homogenous networks, and particularly lend themselves to DEA methodology. Therefore, there are a growing number of DEA efficiency studies of bank branches since Sherman and Gold (1985) first applied the technique to a thirty-three branch system. Sherman and Gold found that the bank under study could save $6,000,000 in annual expenses and improve its branch productivity and profits while maintaining service quality. DEA helped management to locate the most efficient branches. And thus to uncover the best practices. Oral, Kettani, and Yolalan (1992) used DEA to measure the relative efficiency of a network of 44 commercial branches in Turkey.

Barr and Siems (1994) used DEA to produce a bank failure prediction model called CAMEL. They found that adding a DEA- derived measure of the relative X-efficiency of banks as a proxy for the quality of management (the M in CAMEL), enhances the predictive power of the traditional empirical models that have gained widespread acceptance in the industry. Interestingly, the DEA-derive measure is set as a proxy for the explanatory variable management quality. Zainal Abidin (2007) also approved that many researchers commonly used CAMELS stands for Capital (C), Asset Quality (A), Management (M), Earning(E), Liability (L), and Sensitivity Market to Risk (S) financial performance analysis and evaluation banking industry.

Early DEA banking studies usually rendered high efficiency scores, as in most cases, the number of observations was relatively small compared to the number of factors (inputs and outputs). For instance, Sherman and Gold (1995) found 8 out of 14 branches were efficient and the worst efficiency rating was just below 90%. Other studies have focused on the more complex issue of measuring the allocate efficiency of banks by evaluating how strategy, process, and people are efficiently aligned (Frei et al 1996a). Rather than assessing any one managerial action in detail, Frei et al (1996a) strove to identify drivers of effectiveness in the choice of human resources practices, technology management, and the design of the production process. Alirazee et al (1995) focused on identifying the type of returns to scale taking place for the purpose of identifying the appropriate resizing of branches. Other DEA extended models have been used to evaluate the efficiency of bank branches from more than one perspective. Oral et al (1992) evaluated both the financial and productive efficiencies of bank branches.

Hasan, Lozano-Viras and Pastor (2000) analyzed the banking industries of Belgium, Denmark, France, Germany, Italy, Luxemburg, Netherlands, Portugal, Spain and the United Kingdom. First, the authors attempted to evaluate the efficiency scores of banking industries operating in their own respective countries. Later, they used a common frontier to control for the environmental conditions of each country. The result based on a cross-country efficiency scores suggested that the banks in Denmark, Spain, and Portugal were relatively the most technical efficient and successful. Fernandez, Gascon, and Gonzales (2002) studied the economic efficiency of 142 financial intermediaries from eighteen countries over the period 1989-1998 and the relationship between efficiency, productivity change and shareholders' wealth maximization. They applied DEA to estimate the relative efficiency of commercial banks of different geographical areas (North America, Japan, and Europe). The results showed that commercial bank productivity across the world had grown significantly (19,6%) from 1989 to 1998. This effect had been principally due to relative efficiency improvement, with technological progress having a vary moderate effect.

Maudos et.al (2002) analyzed the cost and profit efficiency of European bank in ten countries for the period 1993-1996. They used multiple regression analysis along with DEA and they split their sample in large, medium, and small banks. Their results indicated that only medium size banks were profit efficient. Case and Molyneux (2003) employed DEA to investigate whether the productivity efficiency of European banking systems has improved and converged towards a common European frontier between 1993 and 1997. Schure, Wagenvoort and O'Brein (2004) estimated the productivity of the European banking sector for period 1993-1997. They found that larger commercial banks were more productive on average that smaller bank.

Case, Girardone and Molyneux (2004) for the period 1994-2000, in an efficiency analysis of the European banking institutions found that Italian banks had an 8.89% productivity increase, Spain banks had a 9.5% increase, while German, French and English banks had 1.8%, 0.6%, and 0.1% productivity increase, respectively. The main reason for such improvement in efficiency was the cost reduction that these institutions managed to achieve.

Finally, Angelidis and Lyraudi (2006) examines the productivity of the 100 larger Italians banks for the period 2001-2002. Inputs and outputs are used as nominal values (millions of euros) and as the natural logarithms of these values. The mean error between the actually total factor productivity and the estimated one is calculated according to both approaches. Moreover, the weighted arithmetic mean of the Malmquist productivity index is calculated in addition to the geometric mean. Also, the correlation coefficient and the ranking correlation coefficient are computed to shed more lights to the relationship between bank' size and its performance. The empirical results revealed that the use of natural logarithms and neural networks regression reduces the errors in the estimates.

Cummins and Zi (1998) found that different econometric estimation methodologies are highly consistent in their ranking with a Spearman's rank coefficient of 96%. However, they observed low levels of correlation between FDH and econometric estimates, as well as between DEA and econometric efficiency scores. They also noticed that the efficiency ranking tended to be well preserved within the set of econometric methodologies, but tended to be less well preserved between econometric and linear programming approaches (rank correlation to 50%-60% range), and similarly between linear programming techniques (only 67% rank correlation between DEA and FDH).

However, Bauer et al found that the parametric and non-parametric techniques are not very consistent with one another. DEA tends to provide much lower average efficiency scores and ranks banks differently. Both DEA and parametric techniques tend to be consistent with what are generally believed to be the competitive market conditions and with usual ratio performance measures. A few recent attempts to make the two methodologies more comparable are, however, worth noticing. Stochastic DEA (Zhu and Seiford 1999) is an increasingly popular field in DEA studies. It has the advantages of accounting for noise (random errors) when assessing technical efficiency and can accommodate non-deterministic data.

There have been a few *cost*-based DEA studies (see Curnmins and Zi 1998), involving the evaluation of economic efficiency, and accounting for the prices of inputs and outputs being used. With regard to what is the best efficiency concept to use (cost minimization versus profit maximization), in the literature, most previous studies were cost-oriented.

Nevertheless, Akhavein et al (1997) argue that using a profit maximization approach lads to better informed efficiency estimates. They notice that profit efficiency is more inclusive than cost efficiency. In the specific case of evaluating the effects of a merger on efficiency levels, profit efficiency takes into account the cost and revenue vectors in the choice of the output vector, while this latter is taken as given in the measurement of cost efficiency. In fact, a merger could be profitable if it either implies a more-than-proportional increase in revenues when compared to costs, or a less-than-proportional decrease in revenues when compared to costs.

Similarly, Berger and Mester (1999) compared three alternative efficiency concepts to evaluate changes in the US banking productivity. Their striking result was that cost productivity has worsened, while profit productivity has improved substantially. They conclude that the cost-minimization specification fails to capture the unmeasured change in output quality, and that it does not reflect the profit maximization objective of the organization. Berger and Meaer (1999) point out that profit maximization embraces more adequately the organizational goal of maximizing the value of the firm for its shareholders.

As DEA gains higher acceptance among practitioners and academicians, as a useful technique for evaluating efficiency, several inconsistencies and pitfalls have appeared in the standard DEA models. Development in DEA was stimulated by problems that arose in the process of applying the technique. Moreover, many have felt the need to bridge the gap between DEA and other disciplines such as statistics and economics. This has motivated a whole stream of research on specific aspects of DEA among which we can list stochastic DEA, sensitivity analysis, and integrating DEA and regression models. Banker (1993) proved that the efficient frontier corresponds to the maximum-like hood estimate of the stochastic parametric frontier, thus giving more legitimacy to DEA efficiency rating.

Sensitivity Analysis is also a new rising field in DEA. It aims to test the extent to which results may vary with perturbations in the data. Charnes et al (1985) first evaluated the stability of DEA scores to changes introduced to a single output. O'Neill et al (1996), using an index based on Andersen and Petersen's (1995) super efficiency measure, evaluated the effect of dropping one DMU from the reference set. Seiford and Zhu (1999) studied the sensitivity DEA models to simultaneous changes in all the data.

Window analysis is another growing field. It studies the temporal evolution of efficiency ratings for evaluating how consistent these ratings are. One can refer to

Charnes et al (1985) on measuring the temporal efficiency of maintenance unit in the US Air Force. Other authors have focused on statistical properties of DEA scores, and have compared them against performance measures derived with empirical techniques. On this regard, Thanassoulis (1993) proved that DEA yields better efficiency estimates than traditional regression models in an application to hospital units.

Emrouznejad, Parker, and Tavares (2007) agreed that DEA and its applications will continue to be a primary arena of research going forward. They see at least three reasons for this trend continuing in strong fashion: 1) Measuring efficiency and productivity of large organizations is a nontrivial exercise, involving a complex multi input/ output structure. DEA technology, by design, naturally accounts for such issues efficiently and effectively. 2) There is an inexhaustible number of real world applications involving efficiency measurement available to stimulate academics' and practitioners' interests in conducting research.

III. RESEARCH METHOD

1. Population, Sample, and Variables

The data will be collected from banks' data base. The pertinent information is obtained from the samples of commercial banks' balance sheets for the year 2004 to 2008.

Table 2

Number of Commercial Bank Population and Samples

No.	Category of Commercial Banks	Number of Population	Number of Samples
1	State Owned-banks	5	2
2	Foreign Exchange Commercial Banks	34	3
3	Non- Foreign Exchange Commercial Banks	36	3
4	Joint Venture Banks	18	2
5	Foreign Owned Banks	11	2
6	Regional Development Banks	26	3
	Total	130	15

The name of commercial bank samples, status, abbreviation, and code as shown in the following Table:

Table 3

Name of Commercial Bank Samples, Status, Abreviation, and Bank Code

No.	COMMERCIAL BANK	Status	Abbrv	BANK CODE
I.1	PT. BANK RAKYAT INDONESIA, TBK	Public Bank	BRI	10016
I.2	PT, BANK NEGARA INDONESIA, TBK	Public Bank	BNI	90010
II.1	PT. BANK CENTRAL ASIA, TBK	FOREX BANK	BCA	140012
II.2	PT. BANK DANAMON INDONESIA, TBK	FOREX BANK	BDI	111274
II.3	PT. BANK PERMATA, TBK	FOREX BANK	PMT	130307
III.1	PT.BANK EKSEKUTIF INTERNATIONAL TBK	NONFOREX BANK	BEI	5580017
III.2	PT. BANK TABUNGAN NASIONAL INDONESIA, TBK	NONFOREX BANK	BTPN	2130101
III.3	PT. BANK VICTORY INTERNASIONAL, TBK	NONFOREX BANK	BVI	5660018
IV.1	PT. BANK UOB BUANA TBK	JOINT VENTURE	UOB	0230016
IV.2	PT. BANK CHINATRUST INDONESIA	JOINT VENTURE	BCI	9490307
V.1	CITIBANK NA	FOREIGN BANK	CITI	310305
V.2	BANK OF TOKYO-MITSUBISHI UFJ	FOREIGN BANK	UFJ	0420305

VI.1	**PT. BANK PEMBANGUNAN DAERAH KALIMANTAN TIMUR**	**REGIONAL BANK**	**BPDKT**	**1230015**
VI.2	**PT. BANK PEMBANGUNAN DAERAH BALI**	**REGIONAL BANK**	**BPDBL**	**1290013**
VI.3	**PT. BANK PEMBANGUNAN LAMPUNG**	**REGIONAL BANK**	**BPDLP**	**1210051**

Source: Bank Indonesia

2. Variables

In the previous study, some authors used different Variables as output variables and inputs variables. For examples, study Hababau (2000) used four variables of outputs: 1) Number of account deposits, 2) Number of account transfers, 3) Number of RRSPs sold, and 4) Number of mortgages sold. On the other hand, variables as inputs are: 1) Number of Full Time Equivalent employees solely dedicated to Service, 2) Number of Full Time Equivalent employee solely dedicated to Sales, 3) Number of support staff, and 4) Number of Other staff.

In their study Altunbas, Yener et.al. (2001) employed *assets approach* by using input variables and output variables as follows:

Table 4
Variables Input and Output used in DEA Analysis

Variables Price of Input	**Definition**
P1 (Price of labor) (USD millions)	Total personnel expenses divided by total assets
P2 (Price of funds) (%)	Total interest expenses divided by total funds
P3 (Price of physical capital (%)	Total depreciation and other capital expenses divided by total fixed assets
Variables of Output Quantity:	Definition
Q1 (Mortgage loan) (USD millions)	Total dollar value of total aggregate mortgage loans
Q2 (Public loan)	Total dollar value of total aggregate public loans
Q3 (Securities)	The dollar value of total aggregate securities

Study Angelidis and Lyroudi (2006) used variables that are defined as outputs: 1) total other earning assets, 2) total customer loans, and 3) total deposits. On the other hand, as input variables are characterized the following: 1) personnel expenses, 2) other operating expenses, and 3) total fixed assets. Based on the those variables used in previous study, sources of data came from banks' financial reports, mainly balance sheets and income statements.

Zainal Abidin (2007) evaluated the performance of 93 commercial banks in Indonesia during period 2002 to 2005 by using Data Envelopment Analysis (DEA). He found that foreign banks and state-owned banks more efficient compared to another banks group. In selecting variables, he used *intermediate variable approach* since banks play roles as financial intermediary institution that taking deposit and making loans. The three variable inputs are *Dana Pihak ketiga* (third party funds*), Biaya Bunga* (interest expenses)*, Biaya Operasional Lainnya* (other operating expenses). On the other hand, as three variable outputs *are Kredit* (credits), *Pendapatan Bunga* (interest income), *dan Pendapatan Operasional Lainnya* (other operating income). These variables are similar with previous study has been done by Barr et al. (2002) and Yudistira (2003).

Analyzing efficiency gains from mergers and acquisition activity in the Australian banking sector Avkiran (1999) uses two DEA models, one with interest expenses and non interest expense as inputs and net interest income and non interest income as outputs. The second model applies deposits and staff numbers as inputs and net loans and non interest income as outputs. Recent study on mergers and acquisitions performance in the European banking sector by Figuera and Nellis (2007) use personnel costs, non personnel costs, interest costs and non interest costs as inputs and loans and other earning assets as outputs. To conclude, the selection of input and output variables depends on the approach to measure efficiency. The production approach measures outputs by the number of accounts and considers only operating costs. Conversely, the intermediation approach assumes that banks collect deposits and purchased funds with the assistance of labor and capital and intermediate these sources of funds into loans and other assets. It seems that the choice of variables mainly depends on the approach to be taken.

In our study, we will used the combination of asset approach and intermediation approach by using variables inputs and outputs as follows:

Table 5
Variables Input and Output used in DEA analysis

Variables Price of Input	**Definition**	**Sources of Data**
P1 (Third party funds)	Non bank third party deposits consisting of demand deposit, saving deposit, and time deposit	Commercial banks' balance sheets.
P2 (Liabilities owned to Interbank	Total liabilities owned to other banks	Commercial banks' balance sheets
P3 (Securities)	Total securities issued to get funds	Commercial banks' balance sheets
P4 (Interest expenses)	Total interest expenses	Commercial banks' income statements
Variables of Output Quantity:	**Definition**	**Sources of Data**
Q1 (Credits)	The provision of funds or related claims based on an agreement or contract to borrow/loan funds between banks and another party that obliged the borrower to pay off his/her debt according to a designated schedule and interest charges, including: 1. The purchase of money instruments by clients, complete with a Note Purchase Agreement (NPA). 2. The transfer of claims involved in factoring activities.	Commercial banks' balance sheets
Q2 (Placement at BI/ Interbank Deposits)	Deposit at other banks	Commercial banks' balance sheets
Q3 (Securities)	The value of total aggregate securities	Commercial banks' balance sheets
Q4 (Interest income)	Total interest income	Commercial banks' income statements

3. Conceptual Framework

As mention before in this research we use commercial banks financial reports: balance sheets and income statements. From balance sheets and income statements, we draw variables inputs P1, P2, P3, and P4 and variable outputs Q1, Q2, Q3, and Q4. These inputs and outputs variables compile in tables and ready to compute technical efficiency by apllying the above Linera Programming using Excel. From output of computation, we can rank commercial bank samples' efficiency and then we compare and analyze among individually bank.

Based on the previous explanation, the conceptual framework of this study can be described briefly as follows:

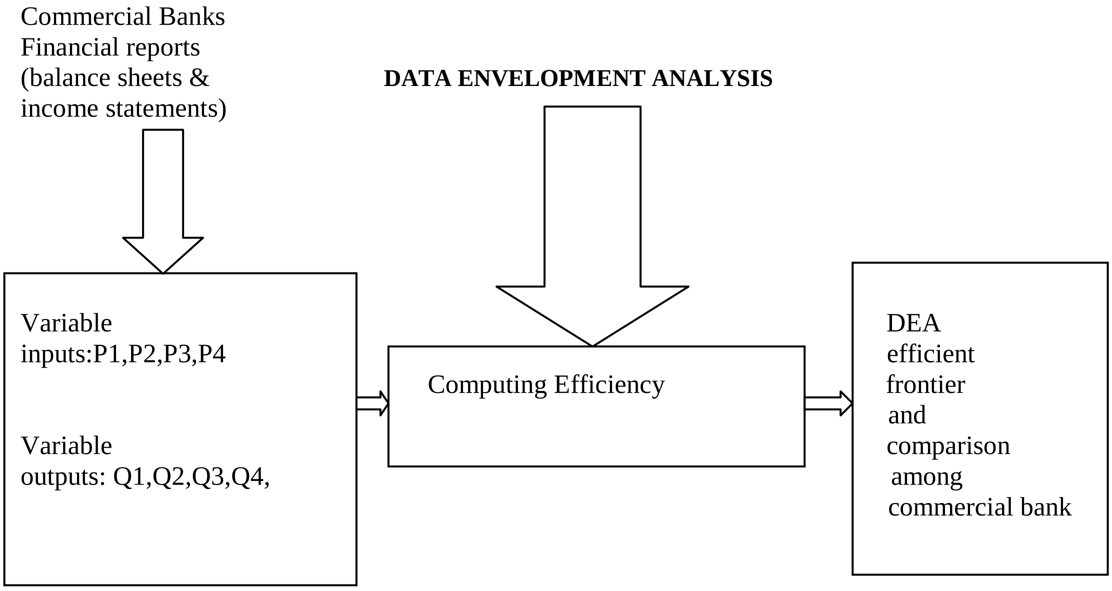

Figure 1. Conceptual Framework of DEA Research

4. Technical Efficiency Analysis

Based on the input variables and output variables for DEA analysis, the Linear Programming Formulation in this research as follows:
Minimize E
Subject to W1+W2+W3+W4=1
Input constraint for unit 1 for example:
W1P11+W2P12+W3P13+W4P14>P11
W1P21+W2P22+W3P23+W4P24>P21
W1P31+W2P32+W3P33+W4P34>P31
W1P41+W2P42+W3P43+W4P44> P41
Output constraint for unit 1 for example:
W1Q11+W2Q12+W3Q13+W4Q14>EQ11
W1Q21+W2Q22+W3Q23+W4Q24>EQ21
W1Q31+W2Q32+W3Q33+W4Q34>EQ31
W1Q41+W2Q42+W3Q43+W4Q44>EQ41
Note that E is an Efficiency Index.
W is weight, P is input variable, and Q is output variable.
When E<1, the unit 1 uses more resource that the composite (meaning unit 1 is less efficient). When E=1, both composite and the unit 1 use the same amount of resources (meaning there is no evidence to say that the unit 1 is inefficient). When E>1, the unit 1 uses lesser resource than the composite (meaning that the unit 1 is more efficient). The optimal E is an efficiecy score for unit 1. For other units, repeat these steps.

The solution for Linear Programming Optimation can be done by using Microsoft Office Excel 2007 version.

IV. RESEARCH FINDIGNS AND DISCUSSION

The commercial bank sampels effciency from year 2004 to 2008 can be seen in Tabel 6 to Table 11 in the **Appendices** of this paper.

From Table 6 the five more efficient commercial banks are BCA, BNI, Citibank, UJF, and BCI. For the lowest rank efficiency bank among fifteen bank samples is BTPN. The low of technical efficiency in most banks are due to low output efficiency comparing to the input efficiency.

Table 7 describes summary of commercial bank samples efficiency in 2005. From this Table the five more efficient commercial banks are Citibank, BCI, BCA, UFJ, and BNI. For the lowest rank of efficiency bank sample is PMT. Furthermore, Table 8 the five more efficient commercial banks are BCA, Citibank, UFJ, BCI, and BNI. For the lowest rank of efficiency bank sample is UOB. Table 9 describes summary of commercial bank samples efficiency in 2007. From Table 9 the five more efficient commercial banks are BCA, Citibank, UFJ, BCI, and BPDBL. For the lowest rank of efficiency bank sample is UOB.

Table 10 describes summary of commercial bank samples efficiency in 2008. From Table 10 the five more efficient commercial banks are BRI, BCA, BCI, Citibank, and BDI. For the lowest rank of efficiency bank sample is BEI.

Furthermore, based on the above tables, we can summarize development of commercial bank samples during year 2004 to 2008, as follows:

It can be concluded based on ranking, the most five efficiency commercial banks during year 2004 to 2008 are BCA (foreign exchange bank), Citi (foreign bank), BCI (joint venture bank), BNI, (government banks), and UFJ (foreign bank), see Table 11.

Based on commercial bank ranking categories: BNI is the most efficient among the three samples government bank. For foreign exchange bank category, the most eficient is BCA. For non foreign bank category the most efficient is BEI among the three bank samples. For joint venture bank category the most efficent bank is BCI For foregin bank category the most eficient is Citibank. Finally, for regional bank catedory the most eficient is BPDBL among the three bank samples, also please see Table 11.

V. CONCLUSION AND SUGGESTION

5.1. Conclusion

This research utilises the non-parametric frontier approach, DEA, to analyze bank efficiency in commercial banks using 15 samples banks. Efficiency analysis is conducted across individual banks and bank types. For price of input variables, we use third party funds, liabilities owned to interbank, securities issued, and interest expenses as controlled variables and for output variables are credits, placement at Bank Indonesia and interbank Deposits, Securities bought, and interest income. The result we found that public government banks more efficient than other type of banks.

Based on development of commercial bank samples efficiency during year 2004 to 2008, it can be concluded, based on ranking, the most five efficiency commercial banks during year 2004 to 2008 are BCA (foreign exchange bank), Citi (foreign bank), BCI (joint venture bank), BNI, (government banks), and UFJ (foreign bank)

Meanwhile, based on commercial bank ranking categories, BNI is the most efficient among the three samples of government bank. For foreign exchange bank category, the most eficient is BCA. For non foreign bank category, the most efficient is BEI among the three bank samples. For joint venture bank category the most efficent bank is BCI. For foregin bank category, the most eficient is Citibank. Finally, for regional bank category the most eficient is BPDBL (regional bank) among the three bank samples.

5.2. Suggestion

The weakneses of this research are: 1) samples used in this research is too small, it is better to used all commercial banks. 2) in calculation of technical eficiency, we used total samples of commercial banks without grouping individual bank based on its category. Therefore, for next study researcher can first calculate based on banks category and then comparing the banks efficiency among banks categories.

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APPENDICES

Tabel 6. Summary of Commercial Bank Samples Efficiency, in Year 2004

No.	Abbrv	BANK CODE	INPUT EFFICIENCY	OUTPUT EFFICIENCY	TECHNICAL EFFICIENCY	RANKING
I.1	BRI	10016	121%	79%	65%	7
I.2	BNI	90010	107%	86%	80%	2
II.1	BCA	140012	165%	136%	82%	1
II.2	BDI	111274	101%	57%	56%	9
II.3	PMT	130307	181%	64%	35%	12
III.1	BEI	5580017	212%	129%	61%	8
III.2	BTPN	2130101	171%	52%	30%	15
III.3	BVI	5660018	174%	64%	37%	11
IV.1	UOB	0230016	79%	27%	34%	14
IV.2	BCI	9490307	102%	78%	76%	5
V.1	CITI	310305	185%	146%	79%	3
V.2	UFJ	0420305	184%	130%	71%	4
VI.1	BPDKT	1230015	153%	58%	38%	10
VI.2	BPDBL	1290013	129%	90%	70%	6
VI.3	BPDLP	1210051	150%	53%	35%	13
	Average		148%	83%	57%	

Tabel 7. Summary of Commercial Bank Samples Efficiency, in Year 2005

No.	Abbrv	BANK CODE	INPUT EFFICIENCY	OUTPUT EFFICIENCY	TECHNICAL EFFICIENCY	RANKING
I.1	BRI	10016	291%	116%	40%	9
I.2	BNI	90010	143%	90%	63%	5
II.1	BCA	140012	171%	124%	73%	3
II.2	BDI	111274	161%	42%	26%	13
II.3	PMT	130307	164%	28%	17%	15
III.1	BEI	5580017	97%	56%	58%	6
III.2	BTPN	2130101	232%	55%	24%	14
III.3	BVI	5660018	161%	73%	45%	8
IV.1	UOB	0230016	288%	146%	51%	7
IV.2	BCI	9490307	155%	122%	79%	2
V.1	CITI	310305	91%	74%	81%	1

V.2	UFJ	0420305	109%	78%	72%	4
VI.1	BPDKT	1230015	185%	61%	33%	12
VI.2	BPDBL	1290013	171%	67%	39%	10
VI.3	BPDLP	1210051	182%	69%	38%	11
	Average		173%	80%	49%	

Tabel 8. Summary of Commercial Bank Samples Efficiency, in Year 2006

No.	Abbrv	BANK CODE	INPUT EFFICIENCY	OUTPUT EFFICIENCY	TECHNICAL EFFICIENCY	RANKING
I.1	BRI	10016	209%	123%	59%	7
I.2	BNI	90010	127%	86%	68%	5
II.1	BCA	140012	85%	82%	96%	1
II.2	BDI	111274	137%	53%	39%	10
II.3	PMT	130307	101%	33%	33%	14
III.1	BEI	5580017	88%	52%	59%	6
III.2	BTPN	2130101	108%	61%	56%	8
III.3	BVI	5660018	145%	53%	37%	11
IV.1	UOB	0230016	179%	59%	33%	15
IV.2	BCI	9490307	107%	76%	71%	4
V.1	CITI	310305	91%	80%	88%	2
V.2	UFJ	0420305	109%	80%	73%	3
VI.1	BPDKT	1230015	185%	69%	37%	13
VI.2	BPDBL	1290013	177%	67%	38%	12
VI.3	BPDLP	1210051	182%	79%	43%	9
	Average		135%	70%	55%	

Tabel 9. Summary of Commercial Bank Samples Efficiency, in Year 2007

No.	Abbrv	BANK CODE	INPUT EFFICIENCY	OUTPUT EFFICIENCY	TECHNICAL EFFICIENCY	RANKING
I.1	BRI	10016	196%	122%	62%	6
I.2	BNI	90010	155%	81%	52%	9
II.1	BCA	140012	138%	118%	86%	1
II.2	BDI	111274	172%	88%	51%	10
II.3	PMT	130307	144%	98%	68%	4
III.1	BEI	5580017	132%	62%	47%	11
III.2	BTPN	2130101	107%	61%	57%	8
III.3	BVI	5660018	148%	66%	45%	12
IV.1	UOB	0230016	207%	49%	24%	15
IV.2	BCI	9490307	150%	114%	76%	3
V.1	CITI	310305	101%	84%	83%	2
V.2	UFJ	0420305	125%	76%	61%	7

VI.1	BPDKT	1230015	156%	61%	39%	13
VI.2	BPDBL	1290013	102%	67%	66%	4
VI.3	BPDLP	1210051	152%	59%	39%	14
	Average		146%	80%	57%	

Tabel 10. Summary of Commercial Bank Samples Efficiency, in Year 2008

No.	Abbrv	BANK CODE	INPUT EFFICIENCY	OUTPUT EFFICIENCY	TECHNICAL EFFICIENCY	RANKING
I.1	BRI	10016	89%	79%	89%	1
I.2	BNI	90010	109%	81%	74%	6
II.1	BCA	140012	105%	92%	88%	2
II.2	BDI	111274	111%	91%	82%	5
II.3	PMT	130307	119%	78%	66%	9
III.1	BEI	5580017	171%	73%	43%	15
III.2	BTPN	2130101	102%	56%	55%	13
III.3	BVI	5660018	164%	78%	48%	14
IV.1	UOB	0230016	119%	80%	67%	8
IV.2	BCI	9490307	102%	88%	86%	3
V.1	CITI	310305	109%	83%	76%	4
V.2	UFJ	0420305	121%	67%	55%	11
VI.1	BPDKT	1230015	108%	67%	62%	10
VI.2	BPDBL	1290013	109%	75%	69%	7
VI.3	BPDLP	1210051	119%	66%	55%	12
	Average		117%	77%	68%	

Tabel 11. Commercial Bank Samples Efficiency Trends, CB Ranking, and Ranking by Category of CB during Years 2004 – 2008

No.	Abbrv	2004	2005	2006	2007	2008	AVR	RANK	RKCT
I.1	BRI	65%	40%	59%	62%	89%	63%	6	2
I.2	BNI	80%	63%	68%	52%	74%	68%	4	1
II.1	BCA	82%	73%	96%	86%	88%	85%	1	1
II.2	BDI	56%	26%	39%	51%	82%	51%	9	2
II.3	PMT	35%	17%	33%	68%	66%	44%	11	3
III.1	BEI	61%	58%	59%	47%	43%	53%	8	1
III.2	BTPN	30%	24%	56%	57%	55%	45%	10	2
III.3	BVI	37%	45%	37%	45%	48%	42%	12	3
IV.1	UOB	34%	51%	33%	24%	67%	42%	12	2
IV.2	BCI	76%	79%	71%	76%	86%	78%	3	1
V.1	CITI	79%	81%	88%	83%	76%	81%	2	1
V.2	UFJ	71%	72%	73%	61%	55%	66%	5	2
VI.1	BPDKT	38%	33%	37%	39%	62%	42%	12	2
VI.2	BPDBL	70%	39%	38%	66%	69%	56%	7	1
VI.3	BPDLP	35%	38%	43%	39%	55%	42%	12	2
	Average	57%	49%	55%	57%	68%			

RKCT=ranking in category