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Technical and Scale Efficiency of Indonesian Domestic Commercial Banks

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Abstract

In this study, input-oriented Data Envelopment Analysis (DEA) model to evaluate the technical and scale efficiency of Indonesian domestic commercial banks from period of 2003 to 2008. Two approaches are used, intermediation approach and profit-oriented approach. We find that banks in our sample showing good performance in terms of efficiency in doing their intermediary role while there is fluctuation in perspective of the profitability.

Keywords: DEA, technical efficiency, scale efficiency, banking industry

Introduction and Development of Indonesian Banking Industry

The importance of Bank as the facilitator of economic development of a nation including Indonesia is getting more. Conservative economists believe that stable banking system is the pre-requisite for further development of a nation. In Indonesia, the asset of Bank relative to the total asset of finance company has reached 84.68% (Infobank Research Bureau, August 2007). This number has shown the trust given to the bank by Indonesian society. This reality must be enhanced by strong internal and external monitoring system. Internal means self evaluation or

internal audit performs by the bank to ensure the quality pursuance. External means evaluation from various parties starting from the government, customer and creditor. A reputable marketing research institution in collaboration with reputable banking periodical have been surveying the customer of banking industry since 2005 for Indonesian Banking Loyalty Index. The 2010 loyalty index shown that Bank Central Asia, Bank Mandiri and Bank BRI are in the top three spots. Learning from the history of Indonesia banking industry, customer's perception is a weak indicator in compare to the common financial ratio analysis namely CAMEL. CAMEL stands for Capital adequacy, Asset quality, Management, Earning and Liquidity. CAMEL rating system tends to be subjective, indecisive and inconsistent.

As most bank analysts and examiners will acknowledge, there are instances when an examination of the accounting records cannot decide whether to give an average or below average score. The 'good' and 'bad' indicators are easy to spot, but not so the 'in-betweens'. This is a problem of indeterminacy. But when bank inspectors are forced to make a judgment, then it leads to the second problem of subjectivity. Where human minds are at work, they come with differing levels of expectations and perspectives. This is confirmed by Berger et al. (1993), that financial ratios including CAMEL are regarded as misleading indicators of efficiency because they do not control for product mix or input prices. Berger later stated that using the cost to asset ratio assumes that all assets are equally costly to produce and all locations have equal costs of doing business.

Banking Industry in Indonesia has been under public scrutiny since the crash of financial sector in 1997. Learning from the financial disaster, the Bank of Indonesia (BI) has launched the grand design for banking industry namely Indonesian Banking Architecture (API). The policy direction for the future development of the banking industry set out in the API is based on the

vision of building a sound, strong, and efficient banking industry in order to create financial system stability for promotion of national economic growth. In order to achieve the vision stated by BI, API believes in six major pillars :1)healthy and banking industry, 2)effective regulation system, 3)effective and independent supervisory system, 4)strong banking industry, 5)adequate industry and 6)robust consumer protection. Per August 2009, there are 121 commercial banks in Indonesia (including four state-own) (BI, 2010). BI believes that Banks are special and therefore must run business based on prudential principles. The functions of banks in Indonesia are basically as financial intermediary that take deposits from surplus units and channel financing to deficit units. In 2009, credit channeled through the bank raised 15.4% to Rp. 1.179 Trillion and Capital Adequacy is more than 17.6%. The same year also mark that liquidity hits Rp 307 Trillion (Bisnis Indonesia, "Arah Bisnis dan Politik 2010, page 68).

The objective of this paper is to present a new method for estimating the overall technical efficiency and scale efficiency of Indonesian domestic commercial banks in order to study the degree of productive performance of the Indonesia banking sector using the intermediation and profit oriented approach. The paper is organized as follows, it starts with introductory and brief explanation about recent development of banking industry in Indonesia. Then it continues with literature review about DEA application in banking industry worldwide and in Indonesia. The next section will be discussing about DEA (methodology) and data also variables used in the research. Finally authors present the result along with the analysis and conclusion.

Literature Review

Over the last years, several papers have examined the efficiency of banks using Data Envelopment Analysis (DEA) combined with other methods such as Malmquist Index and Neural Networks. Barr et al. (2002) use a constrained multiplier, input-oriented, data

envelopment analysis (DEA) model to evaluate the productive efficiency and performance of U.S. commercial banks from 1984 to 1998. They found strong and consistent relationships between efficiency and inputs and outputs, as well as independent measures of bank performance.

Al-Tamimi (2006) used DEA to identify the relatively best-performing banks and relatively- worst-performing banks in the United Arab Emirates during the period 1997-2001. It also seeks to identify banks' efficiency scores and ranks.

Casu and Molyneux (2003) employed DEA to investigate whether the productivity efficiency of European banking systems had improved and converged towards a common European frontier between 1993 and 1997. It covered France, Germany, Italy, Spain and the United Kingdom. Their results indicated relatively low average efficiency levels. Nevertheless, it was possible to detect a slight improvement in the average efficiency scores over the period of analysis for almost all banking systems in the sample, with the exception of Italy.

Galagedera and Edirisuriya (2004) investigate efficiency using DEA and productivity growth using Malmquist index in a sample of Indian commercial banks over the period 1995-2002. The rate of increase in technical efficiency though small is likely to be due to scale efficiency compared to managerial efficiency. In general, smaller banks are less efficient and highly DEA-efficient banks have a high equity to assets and high return to average equity ratios. There has been no growth in productivity in private sector banks where as the public sector banks appears to demonstrate a modest positive change through 1995-2002. Angelidis and Lyroudi (2006) examines the productivity of the 100 larger Italians banks for the period 2001-2002 using DEA and Neural Networks. There is rather an inverse relationship between size and

productivity growth, in contrast to the literature. However, this relationship is not statistically significant for the sample firms.

Saad and Moussawi (2009) uses two approaches to assess the cost efficiency of Lebanese commercial banks: a nonparametric method, Data Envelopment Analysis, and a parametric method, Stochastic Frontier Analysis. There are 43 commercial banks over a period from 1992 to 2005. The findings show that the average cost efficiency is quite high in both methods, and it is increasing over time. A test of convergence of the efficiency scores was done and indicates that there is convergence of efficiency levels of Lebanese banks between 1992 and 2005. Later on, an econometric model was used to investigate the determinants of the efficiency scores of Lebanese banks using financial and economic explanatory variables.

To date there has been relatively little research conducted in the efficiency of Indonesian banking system. The research were done by Permono dan Darmawan (2000), Hadad et al (2003), Putri dan Lukviarman (2008), Suseno (2008). Hadad et al (2003) is using non- parametric approach, DEA, to measure the efficiency of Indonesian banks from period of 1996-2003 and the merger affect on the bank performance. Input/ouput measurement was using asset approach in Altunbas, Yener, et. al. (2001). The conclusion is the non foreign-exchange private banks are the most efficient during year of 2001-2003 compare to other banks and merger does not always increase the efficiency of the bank.

Suseno (2008) measures the efficiency of Indonesian Islamic banking in the period 1999-2004 and uses DEA to analyze 10 banks as sample. It analyzes the relationship between efficiency score and the scale of banking industry using regression based on intermediation function. It found that first, Islamic banking in Indonesia is efficient enough during the period and reached an average of inefficiency about 7%. Second, there is no significant difference

between Islamic bank and general bank that has Islamic banking unit. Last, there is an increasing efficiency about 2.3 percent per year in Islamic banking during the year of study.

Methodology

To examine the efficiency of the banks, there are some approaches that can be used from a methodological perspective, include the parametric and non-parametric approaches such as Stochastic Frontier Analysis (SFA), Thick Frontier Approach (TFA), Distribution Free Approach (DFA), Free Disposal Hull and Data Envelopment Analysis (DEA). These efficiency measurements differ primarily in how much shape is imposed on the frontier and the distributional assumptions imposed on the random error and inefficiency (Berger and Humphrey, 1997). In the research literature, both parametric and non-parametric approaches have been widely used but there is no consensus which of these approaches is superior (Berger and Humphrey, 1997).

The main non-parametric approach is Data Envelopment Analysis. DEA is a mathematical programming approach for the development of production frontiers and the measurement of efficiency relative to the development frontiers (Charnes et al., 1978). It is also able in handling multiple inputs as well as multiple outputs. DEA is considered as a deterministic function of the observed variables, and no specific functional form is required. Other main advantages of using DEA are that it performs well with only small number of observations and it does not require any assumption to be made about the distribution of inefficiency. On the other hand, the shortcomings of DEA are that it assumes data to be free of measurement error and is sensitive to outliers.

DEA uses the term Decision Making Unit (DMU) to refer to any entity that is to be evaluated in terms of its abilities to convert inputs into outputs. If there are n DMUs to be evaluated then each DMU

consumes varying amounts of m different inputs to produce s different outputs. Specifically, DMU_j consumes amount x_{ij} of input i and produces amount y_{rj} of output r. We assume that $x_{ij} \geq 0$ and $y_{rj} \geq 0$ and further assume that each DMU has at least one positive input and one positive output value.

The original formulation of the DEA model introduced by Charnes, Cooper and Rhodes (1978), denoted CCR. The ratio of outputs to inputs is used to measure the relative efficiency of the $DMU_j = DMU_0$ to be evaluated relative to the rations of all of the $j = 1,2,…,n$ DMU. This basic DEA model implied the assumption of Constant Returns to Scale (CRS). Using Charnes-Cooper transformation and dual formulation under CRS, then :

$$\theta^* = \text{Minimum } \theta$$

$$\text{Subject to } \sum_{j=1}^{n} \lambda_j x_{ij} - \theta x_{i0} \leq 0 \quad i = 1, …, m \tag{1}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - y_{j0} \geq 0 \quad r = 1, …, s$$

$$\lambda j \geq 0 \quad \forall j$$

The optimal solution, θ^*, yields an efficiency score for a certain DMU. The process is repeated for each DMU_j. DMUs for which $\theta^* < 1$ are inefficient, while DMUs for which $\theta^*=1$ are boundary points or efficient. This model is sometimes referred to as the "Farrell model" (Cooper et al., 2004).

CRS in only appropriate when all firms are operating at an optimal scale. A bank exhibits constant return to scale if a proportionate increase or decrease in inputs or outputs move the bank along or above the frontier. The efficiency measure derived from the model reflects the overall technical efficiency (OTE).

DEA has proven to be a valuable tool for strategic, policy and operational problems, particularly in the service sector and nonprofit sectors. Its feature is adopted to provide an analytical, quantitative comparison tool for measuring relative efficiency (Barr, 2002). Overall

technical efficiency (OTE) refers to ability to produce the maximum outputs at a given level of inputs (output-oriented), or ability to use the minimum level of inputs at a given level of outputs (input-oriented).

Due to imperfect competition or constraint in finance then not all banks are able to operate at the optimal scale. In that condition, Banker et al. (1984) suggested the use of Variable Return to Scale (VRS) that allows the calculation of efficiency leads to decomposition of overall technical efficiency into scale (SE) and pure technical efficiency (PTE) components. SE can be defined as the proportional reduction of input use to be obtained under CRS. PTE is showing how well bank's managerial and marketing skills in using its inputs in order to maximize outputs. A measure of scale efficiency (SE) is simply the ratio of OTE and PTE. OTE is determined by economies of scale due to the size of the bank (SE) and managerial efficiency (PTE) (Hermes and Vu, 2008; Tahir et al., 2009). According to Yin (1999), the type of efficiency measured depends on the data availability and appropriate behavioural assumptions (in Galagedera et al., 2004).

Data and Variables

The data used for this research were collected from various of sources: Annual Reports from the website of banks, Bank Indonesia database, Indonesian Stock Exchange database. Our sample is consisting of 21 domestic commercial banks (4 state-owned banks and 17 private banks) during the period from 2003 to 2008, totaling 126 observations. Berger and Mester (1997) concur with De Young (1997) that a six-year period reasonably adequate of not considered as too short or too long period (in Barry et al., 2008)

Berger and Humphrey (1997) commented on the difficulty of variable selection in performance of banks using DEA since there is no perfect approach on the explicit definition and

measurement of banks' input and outputs. The primary approaches in measuring banks' input and outputs are the production approach and intermediation approach (Barr, 2002; Paradi, 2003; Galagedera and Edirisuriya, 2004; Angelidis and Lyroudi, 2006; Hermes and Vu, 2008; Saad and Mousawi, 2009). As in Paradi (2003), the first approach assumes banks act as institutions providing fee based products and services to customers using various resources. This approach used for studying cost efficiency, since it considers the operating costs of banking. While the second approach looks at the bank as financial intermediaries who collect funds in the form of deposits and lend them out as loans or other assets earning an income. This approach is used for studying the organizational efficiency and economic viability of banks.

Recently, Drake et al. (2006) proposed the use of a profit-oriented approach in DEA context that is in line with the approach of Berger and Mester (2003). Their results are supporting the argument of Berger and Mester (2003) that a profit-based approach is better in capturing the diversity of strategy responses by financial firms in the face of dynamic changes in competitive and environmental conditions. In the current study, last two approaches mentioned are adopted to know the comparison of efficiency under each different perspective or function of a bank.

In the intermediation approach, we use three inputs: customer deposits, fixed assets, and number of employees and three outputs: loans, other earning assets (consist of securities, deposits with other banks, others) and non-interest income (Paradi, 2003; Pasiouras, 2007; Tahir and Haron, 2008; Saad and Mousawi, 2009).

In the profit-oriented one, Drake et al. (2006) used revenue components as outputs and cost components as inputs. The three inputs are employee expenses, non-interest expenses and loan loss provision. The three outputs are net interest income, net commission income and other

income. In this study, earning assets loss provision is used for reflecting the credit risk better in the banks instead only loan loss provision since Indonesian commercial banks, most of the funds are transferred in loans and other earning assets such as securities, deposits with other banks, investments, and others. In addition, according to Bank Indonesia (BI) regulation (No.31/148/Kep/Dir) every bank must have loss provision on earning assets to anticipate the loss that is related with the risk of investment activities.

The data processing is performed using DEAFrontier program developed by Joe Zhu. Table 1 below presents the descriptive statistics of banks' inputs and outputs used in this study.

Table 1. Commercial Bank's input and output variables 2003-2008 (in Rp Million)

Variable	Model	Mean	Minimum	Maximum	St.Dev
Customer Deposits(X1)	I	42,554,376	10,032	289,112,052	61,859,103
Fixed Assets(X2)	I	1,009,425	3,300	5,483,628	1,357,977
Number of Employees(X3)	I	8,168	245	41,617	10,642
Loans(Y1)	I	26,157,715	118,477	174,499,434	35,514,329
Total Other Earning Assets(Y2)	I	23,616,096	29,300	159,589,227	39,088,315
Non Interest Income(Y3)	I,P	680,751	67	4,653,007	998,930
Employee Expenses(X1)	P	24,468,824	10,032	209,528,921	38,420,970
Non Interest Expense(X2)	P	1,014,363	7,457	4,815,993	1,286,507
Earning Assets Loss Provisions(X3)	P	469,017	62	4,445,226	891,175
Net Interest Income(Y1)	P				

		2,696,001	13,435	18,564,048	3,916,945
Net Commission Income(Y2)	P	158,680	371	1,078,006	218,331

<div align="center">X : Inputs, Y : Outputs, I:Intermediation Approach, P:Profit-Oriented Approach

Source : Authors' own estimates</div>

Results and Analysis

The discussion of the results on the efficiency of commercial banks in Indonesia is structured in 2 parts. First, the efficiency of commercial banks in Indonesia are examined by applying DEA and using intermediation (I) approach to calculate the overall efficiency (OE) of the sample of banks obtained through under CRS (input-oriented version of DEA). Continued by discussion of pure technical efficiency (PTE) resulted through under VRS (input-oriented version of DEA) and the scale of efficiency (SE). Second, we apply the profit-oriented (P) approach to have the same efficiency measurement as previously done.

Table 2 presents the results from the model that correspond to input/outputs selected on the basis of intermediation (I) approach. The average OTE obtained by intermediation approach ranges between 0.7776 (2003) and 0.9470 (2008), with an overall mean over the entire period equal to 0.8725, while corresponding figures for PTE are 0.9028 (2004), 0.9744 (2006) and 0.9489 (overall mean) respectively. The average of OTE during the period for both yearly and overall is higher than the average of PTE. These results are in line with Banker et al. (1984) stated that technical efficiency scores obtained under VRS (PTE) are higher than or equal to those obtained under CRS (OTE). In addition the average SE by intermediation approach is ranging from 0.8501 (2003) to 0.9779 (2008) with the overall mean of 0.9187.

<div align="center">Table 2. DEA Results with Intermediation Approach</div>

Overall Technical Efficiency(OTE)							
	2003	2004	2005	2006	2007	2008	All
Mean	0.7776	0.8233	0.8832	0.9114	0.8853	0.9470	0.8725

	2003	2004	2005	2006	2007	2008	All
Median	0.9130	0.85305	0.9499	1.0000	0.9947	1	0.9677
Minimum	0.3032	0.5102	0.4594	0.5452	0.5076	0.6784	0.3032
Maximum	1	1.0000	1	1	1	1	1
St. Dev.	0.2557	0.1764	0.1570	0.1337	0.1626	0.0867	0.1745
N	20	20	21	21	21	21	124
Pure Technical Efficiency (PTE)							
	2003	2004	2005	2006	2007	2008	All
Mean	0.9140	0.9028	0.9720	0.9744	0.9577	0.9686	0.9489
Median	1.0000	1.00000	1.0000	1.0000	1.0000	1	1.0000
Minimum	0.3264	0.5755	0.6728	0.7751	0.5275	0.8121	0.3264
Maximum	1	1.0000	1	1	1	1	1
St. Dev.	0.1889	0.1560	0.0723	0.0552	0.1177	0.0560	0.1192
N	20	20	21	21	21	21	124
Scale Efficiency (SE)							
	2003	2004	2005	2006	2007	2008	All
Mean	0.8501	0.9146	0.9089	0.9345	0.9229	0.9779	0.9187
Median	0.9716	0.98854	0.9962	1.0000	0.9947	1	0.9982
Minimum	0.4052	0.6370	0.4594	0.5932	0.6624	0.6784	0.4052
Maximum	1	1.0000	1	1	1	1	1
St. Dev.	0.1973	0.1229	0.1456	0.1207	0.1129	0.0697	0.1358
N	20	20	21	21	21	21	124

Source : Authors' own estimates

Table 3 presents the results from the model that corresponds to input/outputs selected on the basis of Profit-Oriented (P) approach. The average OTE obtained by profit-oriented approach ranges between 0.8806 (2004) and 0.9593 (2003), with an overall mean over the entire period equal to 0.9145, while corresponding figures for PTE are 0.9405 (2004), 0.9747 (2003) and 0.9608 (overall mean) respectively. The average SE by profit-oriented approach is ranging from 0.9039 (2006) to 0.9841 (2003) with the overall mean of 0.9509.

Table 3. DEA Results with Profit-Oriented Approach

Overall Technical Efficiency (OTE)							
	2003	2004	2005	2006	2007	2008	All
Mean	0.9593	0.8806	0.9275	0.8812	0.9199	0.9188	0.9145
Median	1	0.9314	0.9812	0.9050	1	0.9903	1

Minimum	0.6779	0.5557	0.6754	0.4873	0.5455	0.5226	0.4873
Maximum	1	1	1	1	1	1	1
St. Dev.	0.0792	0.1446	0.1035	0.1439	0.1383	0.1330	0.1266
N	20	20	21	21	21	21	124

Pure Technical Efficiency (PTE)							
	2003	2004	2005	2006	2007	2008	All
Mean	0.9747	0.9405	0.9645	0.9726	0.9568	0.9552	0.9608
Median	1	1	1	1	1	1	1.0000
Minimum	0.6936	0.5784	0.6915	0.8152	0.6791	0.5766	0.5766
Maximum	1	1	1	1	1	1	1
St. Dev.	0.0714	0.1168	0.0868	0.0564	0.0987	0.1061	0.0905
N	20	20	21	21	21	21	124

Scale Efficiency (SE)							
	2003	2004	2005	2006	2007	2008	All
Mean	0.9841	0.9360	0.9625	0.9039	0.9583	0.9616	0.9509
Median	1	0.99821	0.9990	0.9408	1	1	1
Minimum	0.8842	0.7092	0.7628	0.5288	0.7444	0.6320	0.5288
Maximum	1	1	1	1	1	1	1
St. Dev.	0.0344	0.0961	0.0719	0.1275	0.0804	0.0860	0.0894
N	20	20	21	21	21	21	124

Source : Authors' own estimates

Under intermediation approach, there is increasing of efficiency scores from year 2003 to 2008 in terms of both OTE and SE (Figure 1). On the contrary, under profit-oriented approach, there is declining of both efficiency scores during the year of 2003 to 2008 (Figure 2). It can be stated that banks are performing better as the intermediary function while it does not happen the same in managing the profitability.
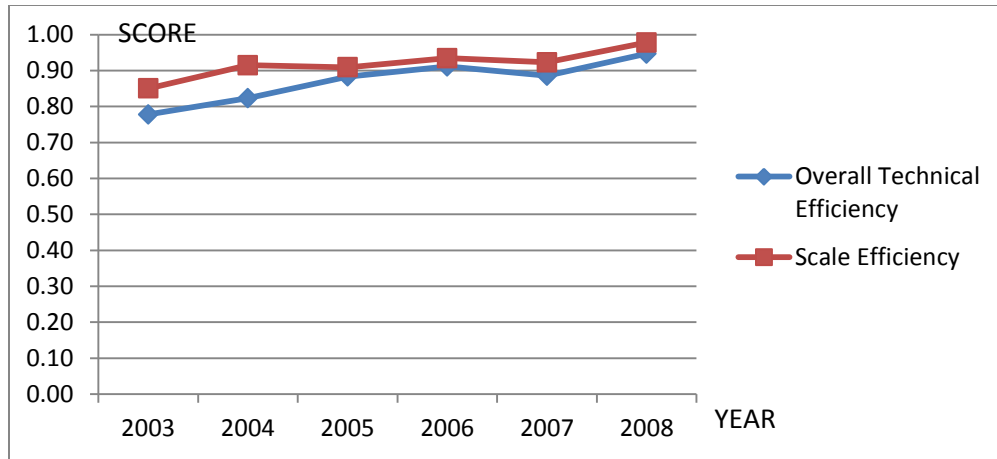
Figure 1. Mean of OTE and SE under Intermediation Approach during 2003-2008

From the figure above, the authors can state that the banking Industry has performed their intermediary role well. This tells us as well that the government has played a nice role to ensure commercial banks performed their essential role of intermediation. Historical facts has stated how the relax government regulation has caused banks to be more effective in performing their intermediary role. As October 2006, Bank Indonesia issued a Policy Package that consisted of 14 Bank Indonesia Regulations and 11 out of them are giving room for banks to optimize its intermediary role.
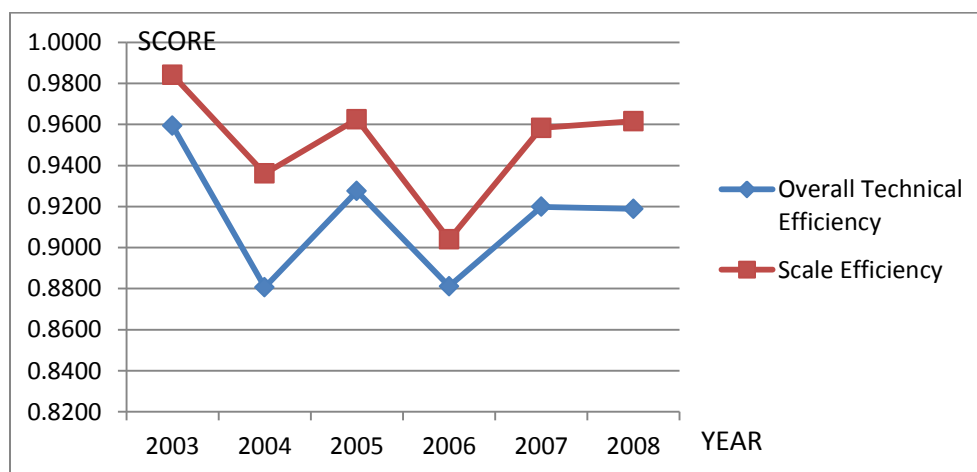
Figure 2. Mean of OTE and SE under Profit Oriented Approach during 2003-2008

The graph on figure 2 explains the fluctuation of bank's efficiency in relation with profit-orientation approach, it tells us how banks are not immune from various external conditions such as general election in 2004, energy and food crisis in 2006 that make the inflation and the interest rate soared. Those externalities have cause banks to be cautious with their spending despite the necessary investment such as internet banking etc.
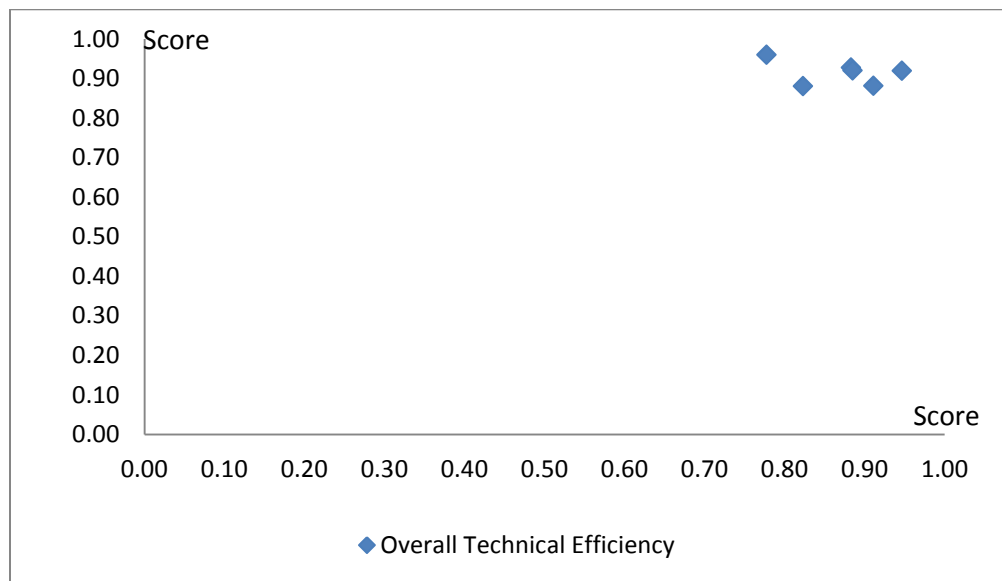

Figure 3. Comparison Mean of OTE under Intermediation & Profit-Oriented Approach

The figure above clearly explains how commercial banks in Indonesia have done well for overall technical efficiency as they are able to perform their essential role and yet manage their profitability. This result is also being confirmed by the figure below that they are performing well in the area of scale efficiency as confirmed in Figure 4.
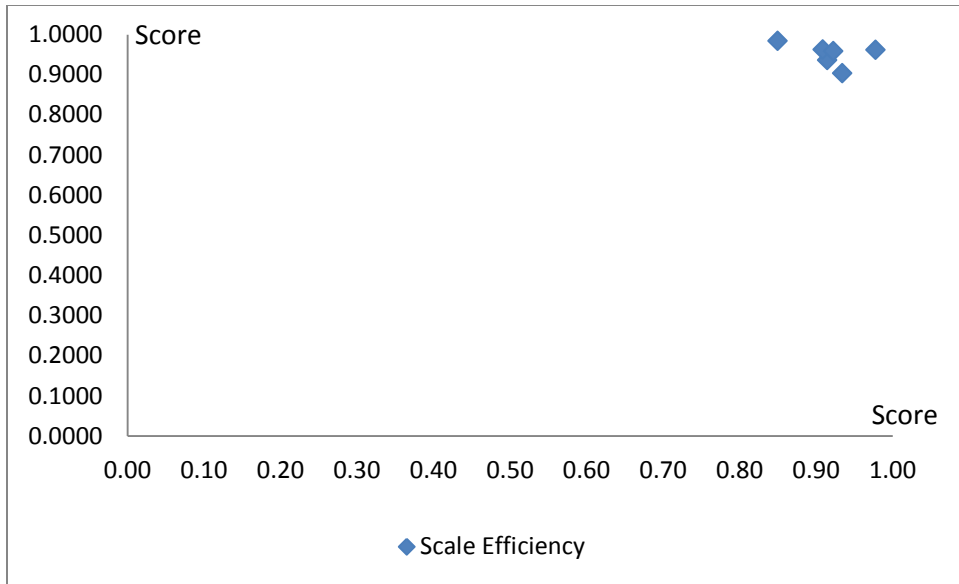
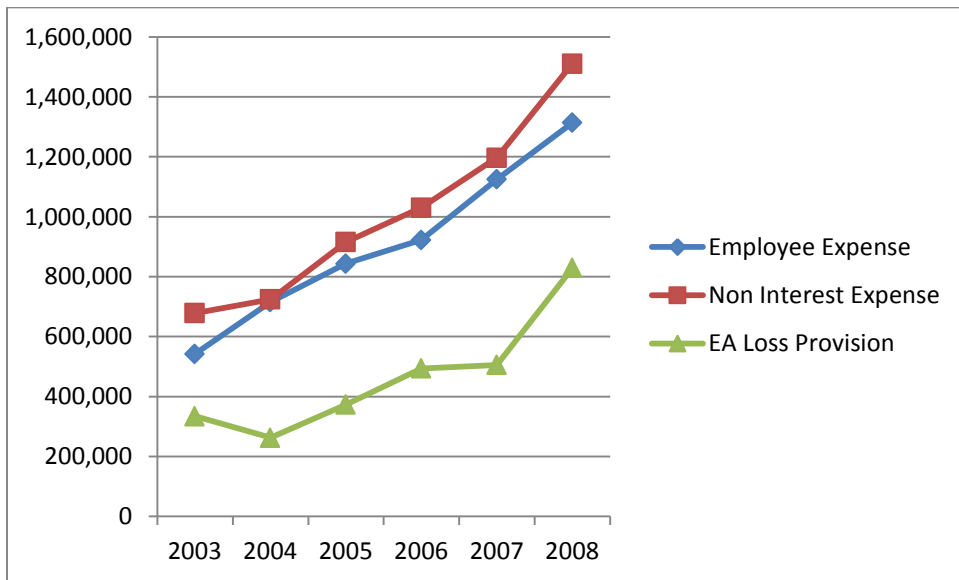Figure 4. Comparison of SE under Intermediation & Profit-Oriented Approach

Figure 5. Comparison Mean of Inputs Variables under Profit-Oriented Approach

In relation with the fluctuation of efficiency under profit-oriented approach, figure 5 tells us that Bank's are required to stay competitive while being cautious with investment, the year of the cautious investment can be seen from the year 2004-2007 where many uncertainties including national politics and global crisis hit Indonesia.
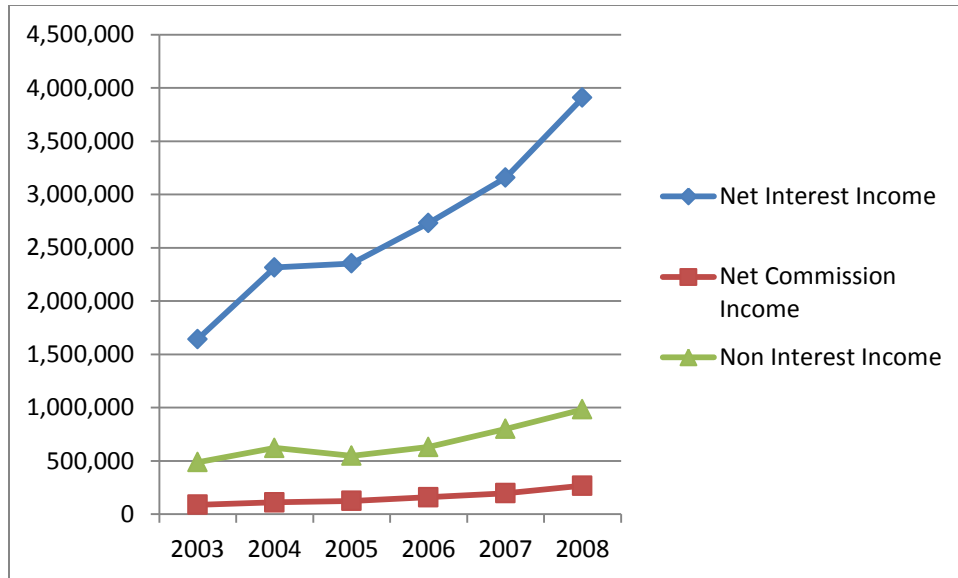
Figure 6. Comparison Mean of Outputs Variables under Profit-Oriented Approach

The profit oriented approach of DEA has convincingly explain the fluctuation of profit oriented efficiency that cause the banks of not performing very well in getting their income especially in the three years in between (2004-2007). The 2004 was the year of contemplation and wait and see for many Indonesian businessmen as the country experienced the first direct presidential election. This has cause the slowdown of net interest income growth for the banks. In a way, the government has placed necessary policy and regulations to ensure Banks performed outstandingly in terms of intermediary efficiency but Indonesian commercial banks must also go through the fluctuation of profit oriented efficiency given the certainties surrounding them.

Conclusion

This paper is trying to describe the importance of more comprehensive approach in measuring bank's performance. The weaknesses of the available measurement system namely IBLI index and CAMEL caused DEA to be very special. DEA will let us know to important things in Banking performance, the intermediation efficiency performance and profit oriented

efficiency performance. Using two approaches of intermediation and profit oriented, the authors have discovered that the commercial banks have performed very well for the intermediary role. The authors believe that the various government initiative and the lessons learnt from the previous crisis have cause people to be more prudent with banks in Indonesia. Profit Oriented Approach revealed that banks are still struggling in stabilizing the efficiency in relation with profit seeking activities. In one hand, banks have to always improve in serving the customers and perform their intermediary role "instructed by the government" but in the other hand they have to cope with many uncertainties happenings in Indonesia from 2003-2008. Those uncertainties are the political event, opportunities arise from the advancement of information technology, global crisis on energy and food and last but not least the massive global financial crisis.

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