Research Journal of Finance and Accounting
ISSN 2222-1697 (Paper) ISSN 2222-2847 (Online)
Vol.4, No.3, 2013

X-efficiency in Tanzanian Commercial Banks: An empirical investigation.

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Abstract
This study empirically investigates the X-efficiency of Tanzanian commercial banks for the period of seven years 2005-2007. The X-efficiency is comprised of Technical efficiency and allocative component, there fore x-innefficiency may be due to technical inefficiency and allocative inefficiency. A non parametric method of Data Envelopment Analysis (DEA) is used to arrive to the estimated efficiency scores, followed by Tobit regression to investigate what dertermine x-efficiency of Tanzanian commercial banks.During the period of study, most commercial banks were found to have an overall low efficiency level of 53.2 percent, which is quite lower against world mean. Further analysis reveals the allocative efficiency scores are quite lower than technical efficiency scores, which implies that the X-efficiency of Tanzania commercial banks is more associated with choosing an incorrect input combination rather than inappropriate utilization of inputs. Moreover using Tobit Regression, Bank size, NII (Non Interest Income), non interest expenses as well as capital adequacy were found to have a positive influence on x-efficiency while NPLs were found to have a significant negative relationship.With respect to group categories, similar to previous studies, Large Domestic Banks (LDB) were found to be more efficient than Large Foreign banks (LFB) and Small banks(SB). The study has important implication to managers and regulators since it reveals the main sources of inefficiency.
Key words: Data Envelopment Analysis, X-efficiency, Tobit regression

1. Introduction

Commercial banks play a significant role in the economy of the country, since in most cases is the source of financial intermediation to various sectors of the economy. Therefore the study of efficiency is inevitable to an efficient and stable financial system, however the study of managerial efficiency (X-efficiency) is more important than scale and scope economies, Molyneux et al 1996. Some researchers recommends on more studies to be directed in X-efficiency this is because in recent time X-inefficiency account for some costs in banking sector, fore example the study in US X-inefficiency contributes 20% of banking sector costs or more, Berger et a (1993). Therefore X-inefficiency in developing countries could be more than this.

The concept of X-efficiency comprises of two important components, technical component which reflects the ability of the DMU to produce maximum outputs from a given set of inputs as well as allocative component which refers to the ability of the DMU to use right inputs combination with respect to prices.

Using the concept of Farrell (1957), the X-efficiency (cost efficiency) consists of technical efficiency and allocative efficiency. By using the idea of from firms that produces single output from two inputs by assuming a single unit isoquant, Farrell (1957) was able deriving technical efficiency and allocative efficiency of the unit isoquant of the fully efficient firm presented by MM`. The two inputs are presented by (x1 and x2) while the Output is presented by (y). Therefore our production function is represented as linear homogeneous functions such that $y=f(x_1, x_2)$ While at the same time the frontier is presented by the unit isoquant such that, $f(x_1/y, x_2/y) = 1$, this is to say two combinations of inputs are used to produce a single output. The following figure illustrates the above explanation and therefore allows the measurement of technical efficiency.

The figure 1 below illustrate technical and allocative efficiency, when a given firm uses unit sets of inputs defined by point P in order to produce a unit of output, the technical inefficiency of the given firm is therefore defined by all points above the unit isoquant MM`, this is to say technical inefficiency of the particular firm is represented as by the distance P, which is the amount of all inputs that could be reduced proportionally without affecting the output level in the production frontier. The percentage of inputs reduction can be presented as QP/0P, while on the other hand the technical efficiency of the firm can be calculated as, TEi=0Q/0P which is equivalent to 1-QP/0P, it takes the value between 0 to 1.

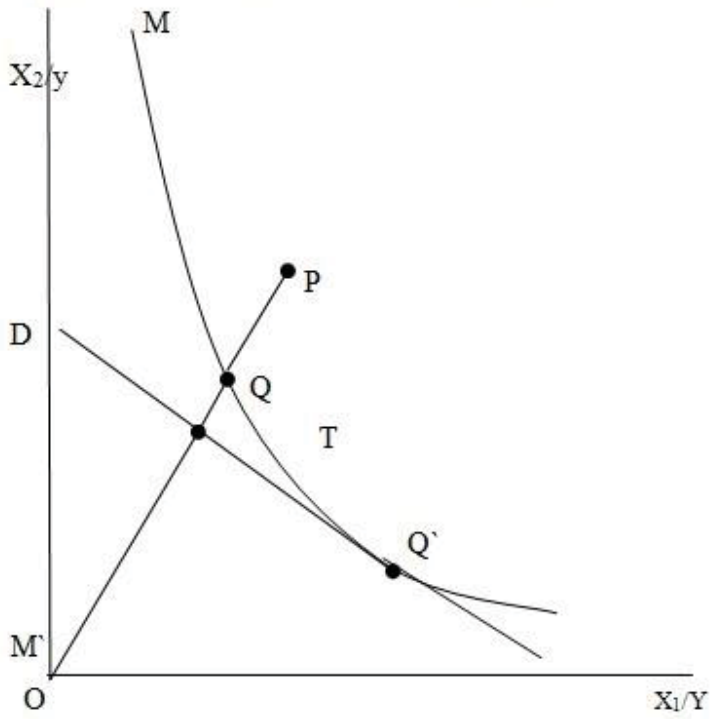
In case of cost efficiency usually the input prices are used, which is represented by DD` line in the above figure. One should be able to calculate the allocative efficiency; therefore the allocative efficiency of the firm operating at the point P of the above figure is given by AEi=0T/0Q.The distance TQ` represents cost reduction in production, given the assumption that the production will occur at point Q`. Therefore according to Farrell (1957) the total economic efficiency (EE) is defined by the ratio

EEi=0T/0P,

The distance TP is interpreted as cost reduction. The above illustration leads to the overall economic efficiency which if the product of technical efficiency and allocative efficiency; therefore it can be expressed as

TEi*AEi= (0Q/0P) * (0T/0Q) = (0T/0P) =EEi (input oriented approach)

Figure :1 Technical and allocative efficiency



Despite the significance of X- Efficiency only handful of studies has been done in developing countries using Non parametric Data envelopment analysis.

Therefore given the significance, of X-efficiency, this study intends to unfold three important issues, first assessing, economic efficiency (overall efficiency) of Tanzanian commercial banks using current unstudied period, with more important changes and competition in the banking industry. Secondly to investigate x-efficiency between and across major group categories of commercial banks operating in Tanzania and lastly to investigate what determines the X - efficiency in commercial banks.

2. Literature review

The other concept of efficiency is called operational efficiency, in which sometimes it is referred to as X-efficiency, managerial ability to control costs. A number of studies have found the existence of X- inefficiency and various factors influences bank performance. X- Inefficiency is the measure of loss of allocative and technical efficiencies. Numerous studies have reported the level of X-inefficiency worldwide. More specifically in U.S, (Berger and Mester, 1997) have reported that X-inefficiency ranges from 20 percent to 30 percent of total banking sector costs. Estimates of X-inefficiency are considerably larger than estimates of scale and scope economies and appear to be comprised of mainly technical inefficiency. There are some reasons for X-inefficiency, some are related to bank characteristic and some are related to macroeconomic factors. Some studies indicated the degree of X-Inefficiency is related to

managerial performance. De young (1994) found that X-inefficiency is higher with banks where the CEO chairs the board of directors, moreover it was also found that the level of X-inefficiency was found to be higher in small banks than in Larger banks, this is because the larger banks experience more pressure from the owner than small banks.

X-efficiency can be differentiated from Scope and scale economies. Berger (1993) differentiates X-efficiency of scale and scope economies as; X-efficiency takes the output bundle as is given while scale and scope economies try to determine the least cost scale and mix of the output bundle given the situation that firms are on the efficient frontier. According to Berger X-inefficiency is found primarily technical in nature, meaning that inputs are simply overused, rather than elective which means the choice of input was upon the reaction to the press in which it is faced.

Therefore the concept of X-efficiency takes into account two important economic concept Technical efficiency and allocative efficiency. Many studies have opted to measure X-efficiency applying different methods; however there is no consensus in method of measuring X-inefficiency in the Banking industry. Some studies indicated X-inefficiency can be measured by number of ways, for example (Berger And Mester, 1997) highlighted four different approaches each of which indicate different assumptions about the probability distribution of X-efficiency differences and random error. The four approaches are such as Econometric frontier approach (EFA), Thick Frontier approach (TFA), Data Envelopment Analysis (DEA) and Distribution Free Approach (DFA). The following are some of the empirical studies on X-efficiency.

Using Multiproduct-translog function adopted from Drake (1992) and Worthington (1998). Kirkpatrick; Murinde, V and Tefula, M (2008) Examined X-Inefficiency of 89 commercial banks in SSA, in their paper they model the determinants of X-Inefficiency in terms of bank specific characteristics and general macroeconomic condition. The main findings of the study Indicates X-inefficiency is slightly higher than Cost Inefficiency which suggest that revenue X-Inefficiency is rather small .The evidence also shows the degree of X-Inefficiency is exacerbated by bank loans , higher capital ratio and financial deregulation, more specifically it shows larger banks are more efficient and the level of foreign bank penetration reduces X-inefficiency.

Kwan S.H (2006) using Stochastic Frontier approach (SFA), developed from Aigner et al (1997), found that X-efficiency in Hong Kong commercial declined over time which implies that Hong Kong banks were operating closer to the cost frontier than before. Furthermore economies of scale were found to exist as larger banks were found to be less efficient compared to small banks and the size was found to be closely related to difference in portfolio characteristics among different size of banks. A similar approach was applied in the study of cost efficiency of commercial banks operating in China by Xiaoqing F & Heffernan, S (2007), which aimed at observing whether different ownership of the bank as well as bank deregulation influence X-Efficiency. The general findings revealed that banks are operating 40 percent to 60percent below the X-efficiency frontier. On Average the joint stock bank is found to be more X-more efficient than state Owned commercial banks.

Different from above studies is the study by Sathey, M (2001), using different approach namely Data Envelopment Analysis (DEA), the author arrived to the efficiency scores, which indicated the source of overall inefficiency was more contributed by the technical component rather than the allocative component, thus the inefficiency of Australian banks can be attributed to wasting of inputs resources(technical) rather than the choosing the incorrect input combination (allocative efficiency), with regard to ownership domestic banks were found to be more efficient than foreign owned banks. A similar approach was used by Akhtar, M.H (2010) in Pakistani commercial banks, whose major findings revealed low efficiency scores. Further analysis of ownership, foreign banks performed better than the counterpart domestic banks and therefore supports the Global Advantage hypothesis, where foreign banks appear to adapt to cross boarder advantages contrary to home field advantage hypothesis where local banks were expected to perform more efficiently than counterpart foreign banks. The results are quite different from the above study.

3. Data and Methods

3.1 Data and variables

We used intermediation approach to obtain efficiency estimates of Cost efficiency (CE), Allocative Efficiency (AE) as well as Technical Efficiency (TE). An intermediation approach (Sealy and Lindley (1997), treats banks as financial intermediaries that channels funds between depositors and creditors in the bank production process, the value of bank loans and investment is thought as output, while labor, deposits, and capital are treated as inputs.

When using this approach a bank is considered to use three traditional inputs namely Labor, capital and Banking funds to produce different output, which in this case are Loans and long term investment . The following are inputs and outputs used in this study, the inputs variables consists traditional inputs as well as respective prices, therefore

the inputs variables are as follows. Labor (X1) which is given by the total number of permanent employees, Physical capital (X2) which is given by book value of fixed asset, premises, furniture and fixtures, Operating cost (X3) which include officers salaries and benefits, employee salaries and benefits, rental expenses on premises and equipment, Depreciation in premises and equipment, as well as management and auditor's fees , and lastly Financial capital (X4) includes deposit and borrowing from other banks. As far as cost efficient as concern we also included prices, this is because cost efficiency calculations involves the use of input prices, the input prices are generated from the above inputs.

Therefore the input prices includes, prices of labor indicated by Z1, prices of Physical capital indicated by Z2, prices of operating costs as indicated Z3 and lastly the price of financial capital as indicated by Z4. To obtain the above prices we apply various ratios obtained from financial statements, therefore the following ratios are established. The price of Labor (Z1) is the ratio between total expenditures for employees as well as salary of directors and the number of permanent employees. The price of Physical capital (Z2) is the summation of depreciation in premises and equipment as well as repairs of bank property divided by the total book value of physical capital, Price of operating cost (Z3) is obtained by dividing the price of operating cost divide by Total deposits and lastly the interest rate on financial capital (Z4) is calculated by total interest paid on deposits and borrowing dividing by financial capital. On the other hand the output variables include Investment (Y1) which includes government securities and treasury bills as well as Loan and advances indicated by (Y2). The above classification of inputs and outputs in the calculation of cost efficiency is supported by Hunter, W.C, time, S.G and Yang, W.K (1990); Mitchel and Onivural (1996). See Appendix 1 and 2.

3.2 DEA methodology

The current study employs DEA developed by Charnes et al (1978) based on constant Return to scale (CRS), however later on it was extended by Banker et al 1984 to account for VRS. Using this approach the efficient unit cerebrate the score of the unit, while the inefficient DMU receives the DEA sore less than a unit. The ratio of weighted sum of output to input, determine the relative efficient DMU; therefore can be presented mathematically as

$$h_o = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}} \qquad (1)$$

s is the number of outputs, U_r is the weight of output, Y_{ro} is amount of r output by DMU; m is number of inputs; V_i is the weight of input i and X_{io} amount of input i in DMU. The above equation determines the CRS Scenario and assumes homogeneity within and between DMU, where inputs and outputs can be plugged into the equation without standardization. However DMU assess inputs and outputs differently, this situation was solved by Charnes et al 1978, by allowing DMU to adopt set of weight that will maximize its relative efficiency without the same ratio exceeding 1. The following programming problem was derived as

$$Max h_o = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}} \quad \text{Subject to} \qquad (2)$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \quad \text{Where j=…, n (number of DMUs)}$$

The equation 2 above is converted into linear programming components as shown below; the denominator of the equation is set as constant while the numerator (output) is maximized hence

$$Maxh_o = \sum_{r=1}^{s} u_r y_{ro} \quad \text{Subject to}$$

$$\sum_{i=1}^{m} v_i \; x_{io} = 1 \qquad (3)$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0$$

$u_{r,} v_i \ge \varepsilon$ Where *u* and *v* are not allowed to fall below *non -Archimedian* small positive numbers

4. Results

4.1 X-efficiency in Tanzanian Commercial banks

We used different inputs and outputs combination to obtain Technical, allocative efficiency and overall efficiency estimates, as described in section four of our study, different from previous analysis, in this analysis we use input prices for labor, capital and financial capital. The results estimates are obtained using the software package, DEAP Version 2.1 (Coelli, 1996). We present the average efficiency scores in the table below.

The concept of X-efficiency comprises of two important components, the technical component as well as the elective. The commercial bank is said to be X-inefficient if the two components estimates are below the frontier line. The technical efficiency is more concerned about the ability of the firm to achieve maximum outputs from possible minimum input combination, while the allocative efficiency is more concerned about how the management of the firm is capable of utilizing the right input combination with respect to the prices given. A good number of literatures have reported that X-inefficiency is much more concerned with the technical inefficiency although recently it has been reported on the allocative inefficiency more significantly influence the X-inefficiency. The table 5. Indicates the average cost efficiency varies from one period to another, with the lowest recorded overall efficiency score in 2011 (40.2 Percent) as well as highest recorded overall efficiency score in 2008 (66.4percent).

The results are not impressive in most commercial banks in terms of overall economic efficiency, this is because during the study period commercial bank could have to reduce its cost by 59.8 percent in 2011 to 33.6 percent (2008) to remain efficient in the production frontier (achieving best practice frontier). On the other hand the minimum cost efficiency ranges from 33.6 percent (2008) to 59.8 Percent (2011) with standard deviation 39.4 indicating more diversity within commercial banks. The table 5.11 and figure 5.8 below shows annual average cost efficiency scores indicating most commercial banks were cost efficient in 2008 and 2010 similarly the graph indicates most banks were cost inefficient in the year 2007 and 2011.

The overall mean efficiency for the entire years of study is 53.2 percent; this average is quite lower against the world mean average of 86.2, Berger and Humphrey, 1997. Our results are relatively similar to Sathye, M. (2001) in Australia where the average overall economic efficiency of commercial banks was 0.58.

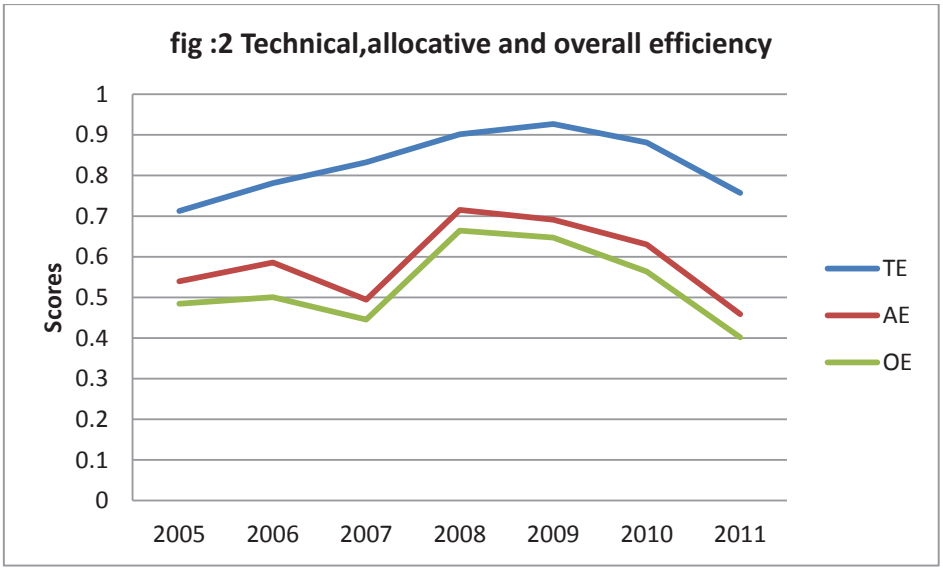
Contrary to previous studies, the technical efficiency scores of Tanzanian commercial banks were found to be relatively higher compared to allocative efficiency scores, the overall mean annual technical efficiency scores were found to be 82.4 percent, relatively similar to Ferrier and Lovell (1990) where technical inefficiency was found to be 21 percent. Our result implies commercial banks in Tanzania are using more than 17.6 of more inputs than necessary. Our results indicate allocative efficiency scores are quite lower which is different to other previous studies where allocative efficiency was reported to be higher, Akhtar, M.H (2010) reported allocative efficiency to be higher than technical efficiency in Pakistani Commercial banks.

Our results implies that the X-inefficiency of Tanzania commercial banks are more associated with choosing incorrect input combination (allocative component) rather than inappropriate utilization of inputs (Technical component), this implies the managerial inefficiency in choosing the right combination of inputs and outputs, the inputs are such as financial capital, labor, capital and operating costs and the outputs such as portfolio investments loans and advances were not utilized in optimum manner, as the allocative efficiency was found to be low.

Table: 1 Descriptive Statistics of TE, AE and CE of Tanzanian commercial banks

Year	Technical efficiency (TE)				Allocative efficiency (AE)				Cost Efficiency (OE)			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
2005	0.712	0.37	0.044	1	0.54	0.405	0.009	1	0.485	0.436	0.002	1
2006	0.781	0.316	0.215	1	0.586	0.373	0.012	1	0.501	0.4	0.004	1
2007	0.832	0.243	0.248	1	0.494	0.378	0.032	1	0.445	0.397	0.023	1
2008	0.902	0.195	0.268	1	0.715	0.28	0.106	1	0.664	0.315	0.07	1
2009	0.927	0.121	0.641	1	0.691	0.121	0.085	1	0.647	0.311	0.081	1
2010	0.881	0.162	0.514	1	0.63	0.342	0.074	1	0.564	0.338	0.057	1
2011	0.757	0.28	0.292	1	0.459	0.378	0.018	1	0.402	0.394	0.018	1
Mean	**0.824**		**0.532**		**0.591**							

Note: TE*AE= OE



4.2 Determinates of X-efficiency of Tanzanian commercial banks

Using Tobit regression model, the following explanatory variables were used in our study, LOTA which indicates loan and advances to total asset; LODE which measures loan to deposit; SIZE measured by natural logarithm to Total Asset, HHI measures concentration, NIE measures noninterest expenses to total asset; Ownership; Capital Adequacy and NPLs which measures loan loss provision to total loan, Gwahula, R (2013). Overall economic efficiency(X-efficiency) was used as Dependent variable, and the following results were generated as shown in Table 2 below.

Table 2: Tobit regression results

xeff	Coef.	Std. Err.	t	P>t	95% con	Interval]
nii	-1.753	0.809	-2.170	0.032	-3.354	-0.152
lota	-0.109	0.202	-0.540	0.590	-0.508	0.290
lode	0.051	0.050	1.020	0.307	-0.047	0.149
size	0.171	0.038	4.500	0.000	0.096	0.246
conc	-0.088	2.135	-0.040	0.967	-4.311	4.135
nie	4.073	1.720	2.370	0.019	0.670	7.475
own	-0.100	0.089	-1.130	0.260	-0.275	0.075
ca	0.018	0.011	1.650	0.102	-0.004	0.041
npl	-0.015	0.007	-2.300	0.023	-0.028	-0.002
_cons	-4.098	1.184	-3.460	0.001	-6.441	-1.755
/sigma	0.446	0.034		0.378	0.514	

The results reveal bank size, non interest income, noninterest expenses as well capital adequacy to have positive significant impact on X-efficiency on the other hand NPLs were found to have significant negative relationship on X efficiency.

4.3 X-efficiency by types of banks.

We grouped commercial banks into groups as before, so as to determine which peer group among commercial banks is more X-efficient. Our findings reflect the X- inefficiency is more attributed by bank size in Tanzanian commercial banks. The large banks were found to be more X-efficient compared to the smaller banks. Our findings reveal that the LDB (Large Domestic Bank) were more efficient compared to the constituent groups followed by LFB (Large Foreign Bank) and the last group was found to be SB (Small banks). However in both groups under analysis the X-inefficiency was more attributed by inappropriate input combination (Allocative) rather than the wastage of input resources.

Our findings are similar to Berger and Humphrey, 1991 where inefficiency was found to be less severe in larger banks than small banks in US, in Australia by Avkiran (1997) and Sathye, M (2001) where Large Domestic banks were found to be more efficient than the foreign owned banks. The reason for the efficiency of LDB comparison to the counterpart, could be extensive branch network as well as a stable retail market, on the other hand the inefficiency of LFB could be caused by poor branch networks across the country like LDB also in most cases the LFB depend on purchased funds, which are more expensive than core deposits.

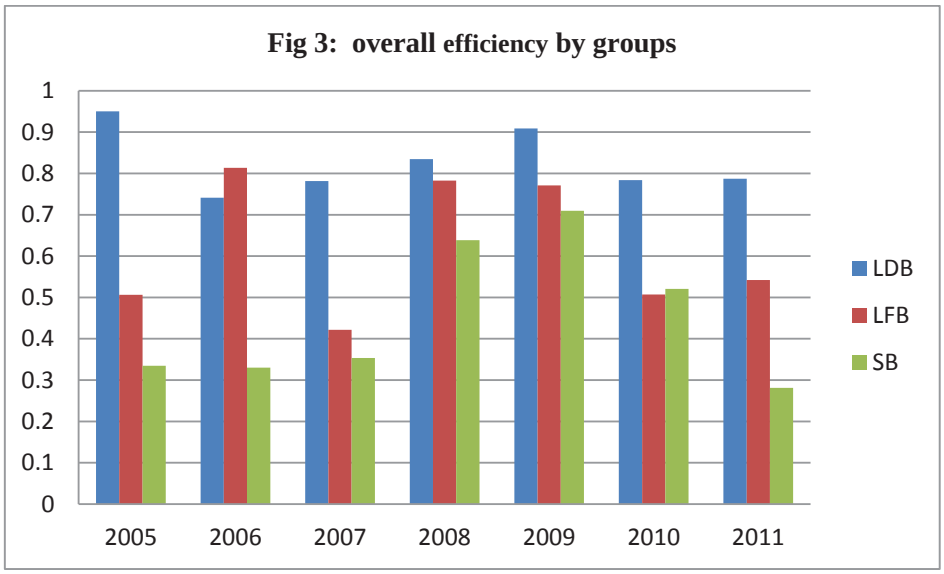
The average estimated overall efficiency revealed most Domestic banks were efficiency by 82.7 percent, allocative efficiency 77.7 percent and technical efficiency 98.5 Percent followed by Large Domestic banks with an overall efficiency estimates of 62.1 percent and the last group constitute of Small banks with an overall efficiency estimate of 45.3 Percent. Largest Domestic Banks could have to reduce only 1.5 percent of costs without affecting the output levels. On other hand Large Foreign banks and Small Banks were found to have much lower cost efficient compared to the counterpart Large Domestic banks, these banks were supposed to reduce the costs by 37.9 percent and 54.7 percent respectively to achieve the best practice frontier.

However the average overall efficiency of all commercial banks is 0.532, which signify that commercial banks were supposed to reduce the cost of production by 46.8 percent without affecting the output level. In other words, the commercial banks could have saved 43 percent of the cost to produce the same level of output had they been operating in efficient frontier. General the inefficiency of commercial banks was more associated with cost inefficiency rather than how inputs are allocated efficiently in different productive units (allocative inefficiency). The mean cost efficient estimates, allocative efficiency estimates and technical efficiency estimates are shown in the table 3 below, on the other hand figure 3 indicate overall efficiency by group.

Table: 3 the mean CE, AE and OE by bank groups.

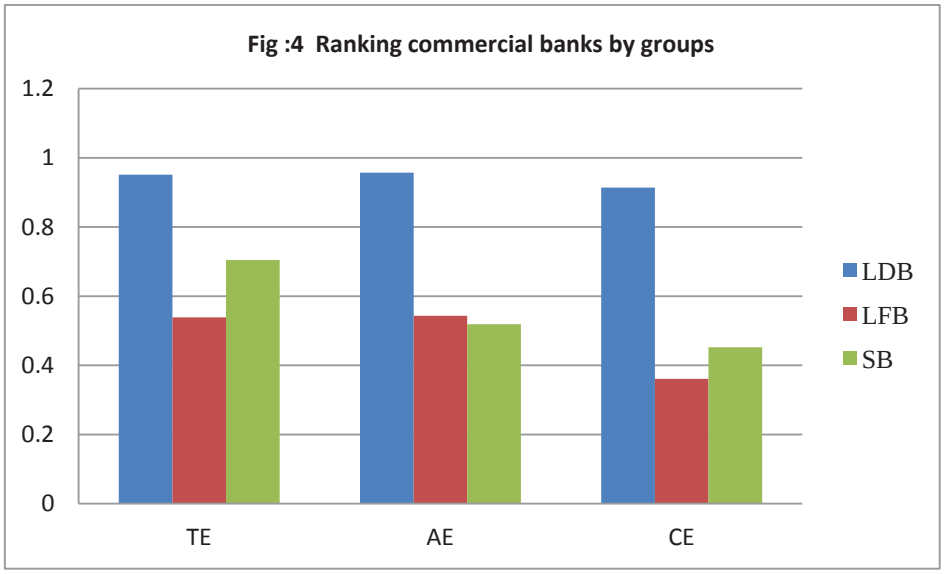
		2005	2006	2007	2008	2009	2010	2011
LFB	TE	1.000	0.992	0.981	0.954	1.000	0.966	1.000
	AE	0.950	0.745	0.850	0.817	0.476	0.816	0.787
	OE	0.950	0.741	0.781	0.835	0.909	0.784	0.787
LDB	TE	0.951	0.888	0.779	0.680	0.616	0.797	0.823
	AE	0.507	0.865	0.446	0.532	0.649	0.610	0.566
	OE	0.506	0.814	0.422	0.783	0.771	0.507	0.542
SB	TE	0.551	0.683	0.777	0.672	0.616	0.836	0.679
	AE	0.423	0.451	0.412	0.490	0.348	0.617	0.407
	OE	0.335	0.330	0.353	0.639	0.710	0.521	0.281

TE=Technical efficiency, AE=Allocative efficiency, OE =overall efficiency



The figure above shows technical, allocative and cost efficiency trend for the entire period of study with respect to the bank groups. The large domestic banks were found to be relatively overall efficient from 2006 to 2009 there after showing a decline trend to reach 0.787 in 2011. Large Foreign Banks were relatively cost efficient in the years 2006, 2008 and 2009 however showing a declining trend to reach 54.2 in 2011. With cost efficient estimates 72.7 percent and 70.1 percent respectively. The last constituent is smaller banks in which the entire period of the study was found to have poor efficient estimates in both technical, allocative efficiency as well as the overall efficiency

The average annual Technical, Allocative and cost efficiency can be presented in the following chart. The chart indicates large domestic banks were most efficient, followed by Large Domestic Banks and the last constituent is smaller banks.



Furthermore we wanted to get a clear understanding whether the three groups of commercial banks were derived from the same population. The single factor ANOVA was carried out. Our results failed to reject the null hypothesis, and the alternative hypothesis were accepted, indicating three groups of commercial banks were originating from the same population, therefore it was appropriate to construct the single production frontier than separate frontiers, see the table 4 below.

Table 4 ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.195927	6	0.032654	0.690838	0.660912	2.847726
Within Groups	0.661751	14	0.047268			
Total	0.857677	20				

5. Concluding remarks

This study empirically investigates the X-efficiency of which is comprised of Technical efficiency and allocative component of Tanzanian commercial banks, for the period of seven years 2005-2007. A non parametric method of Data Envelopment Analysis (DEA) is used to arrive to the estimated efficiency scores, followed by Tobit regression on X-efficiency determinants.

During the period of study, most commercial banks were found to have an overall low efficiency level of 53.2 percent, which is quite lower against world mean. Further analysis reveals the allocative efficiency scores are quite lower than technical efficiency scores, which implies that the X-efficiency of Tanzania commercial banks is more associated with choosing an incorrect input combination rather than inappropriate utilization of inputs. Moreover using Tobit Regression, Bank size, NII (Non Interest Income), noninterest expenses as well as capital adequacy were found to have a positive impact on x-efficiency while NPLs were found to have a significant negative relationship.

With respect to group categories, similar to previous studies, Large Domestic Banks (LDB) were found to be more efficient than Large Foreign banks (LFB and Small banks. The study has important implication to managers and regulators since it reveals the main sources of inefficiency.

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Appendix 1: definitions of inputs and Outputs used in estimation of CE, AE and TE

Inputs/outputs	Variable name	Description
Inputs		
X1	Labor	Number of permanent employees
X2	Physical capital	Book value of physical capital
X3	Operating cost	Total operating cost
X4	Financial capital	Total deposits and borrowings
Input prices		
Z1	Price of labor	Total expenditures for employees as well as salary of Directors divide by the number of permanent employees
Z2	Price of Physical capital	Depreciation and repairs of bank property Divide by Total value of physical capital
Z3	Price of operating cost	Operating costs of the bank divide by Total deposits
Z4	Price of financial capital	Interest paid on deposits and borrowing Divide by financial capital
Outputs		
Y1	Loan and advances	The amount of Loans and Advances
Y2	Investments	The value of investments made by the banks

The data sources were obtained from financial statements with the exception of Total number of employees which were obtained from Ernst and Young Report (2011)

Appendix: 2 Descriptive statistics of inputs and outputs used in TE, AE and CE

VAR		2005	2006	2007	2008	2009	2010	2011
X1	Mean	268.5238	259.0455	327.3333	373.7619	409.3333	446.619	451.619
	std.dev	426.9639	420.1379	480.2338	531.3341	605.2161	642.8403	642.8403
X2	Mean	4.33E+10	3.36E+09	6.47E+10	7.93E+09	1.03E+10	1.33E+10	1.35E+10
	std.dev	7.43E+10	5.64E+09	1.37E+11	1.34E+10	1.76E+10	2.23E+10	2.23E+10
X3	Mean	9.15E+09	1.10E+10	1.60E+10	2.02E+10	2.28E+10	2.96E+10	4.81E+10
	std.dev	1.14E+10	1.48E+10	2.04E+10	2.57E+10	2.83E+10	3.66E+10	5.42E+10
X4	Mean	8.93E+10	1.30E+11	1.80E+11	2.92E+11	3.54E+11	4.37E+11	5.01E+11
	std.dev	1.44E+11	2.04E+11	2.64E+11	3.82E+11	4.60E+11	5.62E+11	6.32E+11
Y1	Mean	3.92E+10	8.62E+10	1.28E+11	1.78E+11	2.05E+11	2.41E+11	2.88E+11
	std.dev	4.37E+10	1.15E+11	1.68E+11	2.41E+11	2.55E+11	3.03E+11	3.80E+11
Y2	Mean	4.68E+10	5.36E+10	9.27E+10	7.05E+10	7.78E+10	1.05E+11	9.47E+10
	std.dev	1.08E+11	1.07E+11	1.14E+11	1.13E+11	1.22E+11	1.59E+11	1.25E+11
Z1	Mean	0.104836	0.111017	0.130753	0.029308	0.031056	3.10E+12	1.411733
	std.dev	0.190456	0.188113	0.37392	0.017714	0.018571	5.80E+12	1.050814
Z2	Mean	1.07E+07	9728840	1.09E+07	1.21E+07	1.56E+07	2.01E+07	2.93E+07
	std.dev	7876684	6910500	7561076	8800625	9961566	1.81E+07	1.80E+07
Z3	Mean	0.298608	0.296495	0.172134	0.227655	0.231017	0.221546	0.201158
	std.dev	0.162138	0.15854	0.144605	0.122993	0.119037	0.07949	0.061514
Z4	Mean	0.441054	11.73003	0.112132	0.074066	0.070247	14.78017	0.072857
	std.dev	1.339328	12.29037	0.099527	0.030597	0.027131	18.90265	0.037009

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