European Journal of Business and Management
ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online)
Vol.9, No.34, 2017

Comparative Study of Domestic and Foreign Bank Efficiency in Tanzania: DEA Approach

Bora Gretha Haule
Alders gate College, Philippine

Abstract
Using data envelopment analysis (DEA), the objective of this paper is to analysis and compares the efficiency of domestic and foreign banks in Tanzania during the period of 2007 to 2016. The study is based on a panel data set of 5 domestic banks and 5 foreign banks; intermediation approach is employed to select the outputs and inputs in computing the efficiency scores. The findings of the study show that foreign banks *have a higher efficiency level than domestic banks, this imply that foreign banks are relatively more managerially efficient in controlling their costs*. The findings are consistent with most of the previous researches where foreign banks outperforming domestic banks in term of efficiency.
Keywords: Bank efficiency, Data envelopment analysis (DEA), Banking sector

1.1 Introduction

The stability and development of an economy is dependent upon the performance of financial sector. Banking sector is the vital part of country's financial system, and thus for sound economical development, banks efficiency is crucial (Sathye, 2001: Gishkori and Ullah, 2013). Measuring the efficiencies of banks can give a resourceful insight into banking system and potential of economic development of a country. In analyzing banking system efficiency, the most important question which should stick in mind of researchers that, why regulators, shareholders, managers and customers bother about banks' efficiency? The answers of this question would be different depending upon the perspectives of interested parties. From the regulators' perspective, inefficiency banks are riskier and have a higher likelihood of failure. Further, efficiency banking system is directly accelerating the productivity of the economy. Without a sound and efficiently functioning banking system, the economy cannot function smoothly and efficiently (Kumar and Gulati, 2008). From the view of shareholders need to be ensured that, bank value is maximized and rewarded reasonable returns, is that only efficient banks ensure reasonable returns. From the standing point of customers, only efficient banks can offer better quality services at reasonable costs. The standing point of bank management is that in a dynamic and competitive market environment, only efficient banks will survive and maintain their market share, and products positioning, and inefficient ones will eventually not compete and survive in the market. The efficient banks are able to compete because of their lower operational costs and can steal business away from less efficient banks. Thus to improve the banks performance, evaluating its efficiency and identifying the sources of inefficiency is always a matter of serious interest (Yang, 2011)

Tanzania has introduced regulatory reforms to its financial-services sector since 1991, the expected result of these changes in financial reforms were to increase competition in banking sector, which was also expected to lead to an improvement in efficiency of banking system and contribute the progress of economic development. Despite the literature on bank efficiency and benchmarking are widely used methods to identify the best practices, as a means to improve the performance and increase productivity (Barros, 2004) studies on efficiency of the Tanzanian banks is virtually non-existent. The main reason for this deficit is the lack of data on the Tanzanian banking system to carry out meaningful analysis, thus little is known about banks efficiency in Tanzania. Measuring Tanzanian banks efficiency is an important issue for regulators, shareholders and managers alike, in addition, efficiency bank is offered professional services at reasonable costs to customers (Anderson et al., 1998). DEA approach is widely used to evaluate bank efficiency in US and Europe (Rickards, 2003). However, DEA approach is less known within the banking sector in developing countries, and Tanzania is no exception. In this study, we fill this research gap in the literature by analyzing the efficiency of banks with respect to developing countries and transition economies using data of the Tanzanian banks where there has been virtually no previous research. This paper analyses and compares the efficiency of domestic and foreign banks in Tanzania. DEA model was employed to calculate efficiency scores.

The present study is an endeavour in this direction, and particularly aims to

- Analyse a measure of overall technical, pure technical, and scale efficiencies for individual peer banks group
- Analysis and compare the efficiency of domestic and foreign banks in Tanzania during the period of 2007 to 2016.
- Analyse and Identification of Reference set for individual peer banks group

The remainder of this study structured as follows. Section, 2 reviews of relevant literature on banks efficiency,

section 3 summarizes the methodology used to conduct the analysis; the subsequent section presents empirical results of the study and finally presenting the conclusions, managerial implications, limitations and Future research.

1.2 Literature review

Data Envelopment Analysis (DEA) method has been used extensively to analyze banking institutions. Well established efficiency literature has been mainly carried out in developed nations like the US and Europe. Berger and Humphrey (1997) provide a valuable summary on 130 studies of financial sector efficiency in 21 countries during different times using different estimation techniques, in their studies, they find that results from various efficiency methods are inconsistent. Sathye (2001) employed DEA approach to investigate the technical and allocative efficiency of Australian banks, the Australian banks found to have low levels of overall efficiency compared with the banks in the European countries and in the US. Domestic banks found to be more efficient than foreign owned banks and the source of overall inefficiency contributed by technical inefficiency. Grabowski et al (1994) examined the US multi-bank holding companies and branching banks by using Data Envelopment Analysis (DEA) approach, the study found that, on average input inefficiency of the US multi-bank holding companies and branching banks was about 68%. Pastor et el (1997) employed non- parametric approach, DEA by using three outputs (loans, other productive assets, and deposits) and two inputs (non-interest expenses and personal expenses), comparing the productivity, efficiency, and differences in the technology of different in European and U.S. banking sector for the year 1992. The results of the study found that, there was a difference in the efficiency level of the banking systems among the countries. The most efficient banks were in France, Spain, and Belgium, while the less efficient banks were in the U.K. Austria, and Germany. Wu (2007) employing DEA approach and Malmquist productivity index examined the efficiency and productivity performance of Australian banking sector during the post-deregulation period of 1983 to 2001. The results of the study showed that, major banks and existing regional banks found to be the least and the second least efficient groups, respectively while foreign banks and newly licensed regional banks showed superior performance. Miller and Noulas (1996) analyzed the efficiency of large banks in US and found the overall technical efficiency of banks is around 97 percent. Seiford and Zhu (1999) evaluated the efficiency of the top 55 US banks using a two-stage DEA approach. They found that, large banks exhibit better performance on profitability, whereas smaller banks tend to perform better with respect to marketability. Berg et al. (1993) employed DEA expanded the Norwegian study to an international comparison by including Finish and Swedish banking industries, the results indicated that, Swedish banks were more efficient than other two countries. Ramanathan (2007) examined performances of 55 banks operating in countries of the Gulf Cooperation Council (GCC) employed DEA and Malmquist productivity index using two outputs and four inputs, the results show that only 15 of the 55 banks are rated as efficient under constant returns to scale (CRS) assumption, and all the GCC countries have at least one efficient bank. Latter Mostafa (2007) employing DEA approach to investigate the relative efficiency of the top 50 GCC banks, the results indicated that, the performance of several banks in the regional is sub-optimal and suggested the potential for significant improvements was by possible reductions in resources used. Bhattacharya et al. (1997) using a two-stage DEA method to evaluate the effect of liberalization on the efficiency of the banking sector in India found that, in India publicly owned banks are the most efficiency banks followed by foreign owned banks and then Indian privately owned banks. Sathye (2003) using DEA measured the productive efficiency of three groups of banks in India, the results found that, the mean efficiency score of Indian banks compared well with the world mean efficiency score and the efficiency of private owned Indian commercial banks as a group was lower than that of public sector banks and foreign banks.

From this brief review, the evidences have shown that, an extensive and sprawling literature on the banking efficiency using non-parametric frontier exists for developed economies. However, DEA approach is less known within the banking sector in developing countries, and Tanzania is no exception. In this study, we aim to fill this research gap by empirically evaluating banks' efficiency in Tanzania by comparing domestic and foreign banks.

.

1.3 Methodology

The study adopted two-stage procedures to benchmark the banks. In the first stage, DEA model used to evaluate relative efficiency scores and in the second regression analysis used to examine the efficient drivers. The study used the input-oriented CCR model named after Charnes et al. (1978), to get a scalar measure of OTE. It also applied the input-oriented BCC model named after Banker et al. (1984), to obtain the PTE (also known as managerial efficiency). Formal notations of used input-oriented CCR and BCC DEA models for measuring efficiency scores for DMU o, under the different scale assumptions are as follows:

$$\max ho(u,v) = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{n} v_i x_{io}} \quad (1)$$

Subject to:

$$\frac{\sum_{i=1}^{n} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \qquad j=1, 2\ldots n \quad (2)$$

$$u_r \geq 0 \qquad r=1, 2\ldots s \quad (3)$$

$$v_i \geq 0 \qquad i=1, 2\ldots m. \quad (4)$$

Where x_{ij} is the observed amount of input ith of the jth DMU ($x_{ij} > 0$, I = 1, 2 …n, i= 1, 2…n) and y_{ij} = observed amount of output of the rth type for the jth DMU ($y_{ij} > 0$, r = 1, 2…3, j = 1, 2…n)

The above ratio form yields an infinite number of solutions; if (u^*, v^*) is optimal, then (αu^*, αv^*) is also optimal for $\alpha > 0$. However, the transformation developed by Charnes and Cooper (1962) for linear fractional programming selects a representative solution [i.e., the solution (u, v) for which = 1] and yields the equivalent linear programming problem in which the change of variables from (u, v) is a result of the Charnes-Cooper transformation one can select a representative solution (u, v) for which:

$$\sum_{i}^{m} v_i x_{io} = 1 \quad (5)$$

To obtain linear programming problem that is equivalent to linear fractional programme problem (equations 1- 4). Thus, denominator in the above efficiency measure h_o is set to equal to 1 and transformed linear problem for DMU_O can be written as:

$$\max z_o = \sum_{r=1}^{s} u_r y_{ro} \quad (6)$$

Subject to:

$$\sum_{r=i}^{s} u_r y_{rj} - \sum_{i=1}^{n} v_i x_{ij} \leq 0 \qquad j= 1, 2\ldots n \quad (7)$$

$$\sum_{i=1}^{m} v_i x_{io} = 1 \quad (8)$$

$$u_r \geq 0, r = 1,2...s$$

$$v_i \geq 0, i = 1,2...m$$

For which the Linear Programming dual problem is

$$Min\ z_o = \theta$$

Subject to:

$$\sum_{j=1}^{n} \lambda_i y_{rj} \geq y_{ro} \qquad r=1, 2,...s \quad (9)$$

$$\theta_o x_{io} - \sum_{j=i}^{n} \lambda_i x_{ij} \geq 0 \qquad j = 1, 2...n \quad (10)$$

Both the above linear problem yield the optimal solution θ which is the efficiency score (so-called technical efficiency) for the particular DMU_o and repeating them for each DMU_j, j= 1, 2…n, efficiency scores for of them are obtained. The above θ is always less than or equal to unity (since when tested, each particular DMU_o is constrained by its own virtual input-output combination too). DMU_s for which θ is less than unity are relatively inefficient and for which θ is equal to unity are relatively efficiency, having their virtual input-output combination points laying on the frontier. The frontier itself consists of linear facets spanned by efficient units of the data and the resulting frontier production function (obtained with the implicitly constant return to scale assumption) has unknown parameters.

The CRS assumption is only appropriate when all DMUs are operating at an optimal scale, meaning that, one corresponding to the flat of the long run average cost (LRAC). However, imperfect competitions, constraints on finance and other factors may result a DMU to be not operating at optimal scale. Banker, Charnes and Cooper (1984) suggest an extension of the CRS DEA model to account for Variable Return to Scale (VRS) situations. The use of the CRS specification when not all DMUs are operating at the optimal scale will result of TE, which confounded by scale efficiencies (SE). Hence, the use of the VRS specification will permit the calculation of TE devoid of these SE effects. The CRS linear programming problem easily modified to account for VRS by adding the convexity constraint

$\sum\lambda = 1$

Since there are no constraints for the weight λ_j, other than the positivity conditions in the problem (9 – 10), it implies constant return to scale, it is necessary to add the convexity condition for the weight λ_j i.e. to include in the model (9 – 10) the constraint.

$$\sum_{j=1}^{n} \lambda_i = 1 \qquad (11)$$

The resulting DEA model that exhibits the Variable Return to Scale (VRS) called BCC model (Banker, Charnes and Cooper 1984). The input-oriented BCC model for the DMU_o written formally as:

$$Min\ z_o = \theta$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \qquad r = 1, 2\ldots s \qquad (12)$$

$$\theta_o x_{io} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0 \qquad i = 1, 2\ldots m \qquad (13)$$

$$\sum_{j-1}^{n} \lambda_j = 1 \qquad (14)$$

$$\lambda_j \geq 0 \qquad j = 1, 2\ldots n \qquad (15)$$

Running the above model for each DMU, the BCC efficiency scores obtained (with similar interpretations of its values as in CCR model). These scores are also called 'Pure technical efficiency scores' since they are obtained from model that allows variable returns to scale (VRC) and hence eliminate 'the scale part' of the efficiency from analysis. Generally, for each DMU the CCR-efficiency score will not exceed the BCC efficiency score, what is intrusively clear since in the BCC-model each DMU is analysed ' locally' i.e. compared to subset of DMUs, that operate in the same region of return to scale rather than globally.

1.3.1 Selection of inputs and outputs

Substantial studies conducted around the issues of banks efficiency. Besides, inputs and outputs used by these studies published in the literature vary widely. In evaluating banks efficiency, the most difficult task that researchers always face is to select the relevant inputs and outputs for modeling bank behaviour. It well known that, no general agreement exists about either the definition or the choice of relevant outputs and inputs in the banking industry (Casu and Girardone, 2002; Sathye, 2003: Ray and Mukherjee 1998). In Table I, presents a summary of inputs and outputs applied in the various studies published on banks efficiency using DEA. In the literature, the inputs and outputs applied in evaluating of banks efficiency can be defined by using different five approaches: intermediation approach, production approach, asset approach, user cost approach and value added approach. However, production approach and intermediation approach used more frequently for measuring of banks efficiency in banking sectors. The production approach addresses physical inputs, such as capital and labour and treats a bank as firms producing different deposits and loan accounts. Banks deal with transactions and document for its customers who own these accounts. The number of accounts and transactions regarded as the best measures of the bank output; to some extent, this is not practical. In practice, the number of deposit and loan account usually used as the measure of bank output rather than the detailed in transaction and documents (Ferrier and Lovell, 1990). The intermediation approach (Sealey 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 are thought as output, while labor, deposits, total expenses and capital are treated as inputs. Neither of these two approaches is perfect for measuring of banks efficiency because they cannot fully capture the dual role of banks as providers of transactions/document processing services and being financial intermediaries. However, it suggested that the intermediation approach is best suited for analyzing bank level efficiency and the production approach well suited for measuring branch level efficiency. This is because, at the

bank level, managers aim to reduce total costs and not only non-interest expenses, while at the branch level a large number of customer service processing take place and bank funding and investment decisions are mostly not under the control of branches. In practice, the availability of flow data required by the production approach is usually exceptional rather than in common. Thus, majority of the empirical literature adopted the intermediation approach as opposed to the production approach for selecting input and output variables for computing the various banks efficiency scores.

Depending upon, the literature reviewed and the dominant role of intermediation function of banking system in Tanzania lead this study to employ intermediation approach for analysis which, was originally developed by Sealey and Lindley (1977). The selected variables for measuring banks efficiency scores shown in Table 2, inputs variables are i) total deposits ii) number of employees iii) total expenses The outputs used for computing the efficiency scores are i) total loans ii) total interest income

1.4 DEA Empirical Results

In this section, the input-oriented efficiency scores obtained from CCR and BCC models discussed. It is significant to note that, an input orientation provides information as how much proportional reduction of inputs is necessary while maintaining the current levels of outputs for an inefficient bank to become DEA-efficient (Mostafa, 2007). We applied CCR model for a comparative purpose, because the model is completely ignores the scale of operations and may results to unrealistic benchmarks.

Table 3 shows the input-oriented efficiency scores obtained from CCR and BCC Models of domestic banks for period 2007 to 2016. The results indicate that the sector characterized with small asymmetry between banks as regards to their efficiency scores that ranges between 75.5% - 88.2% and 81.9% - 98.7% for CCR and BCC models respectively. The average efficiency scores turned out to be 0.821 and 0.904 for both models respectively. This suggests that average, domestic banks, if producing its outputs on the efficient frontier instead of its current (virtual) location, would need only 82.1% and 90.4% respectively of the inputs currently used. The connotation of this finding is that the magnitude of inefficiency scores in domestic banks in Tanzania is to the tune of 17.9% and 9.6% respectively. This suggests that, by adopting best practice technology the sector can, on an average, reduce their inputs of labour and operation expenses by at least 17.9% and 9.6% respectively and still produce the same level of outputs. . In general, the results show that domestic banks are using more resources than what they are producing, in other words, domestic banks have wasted 17.9% and 9.6% respectively of resources in producing its levels of output. Still, domestic banks found to be inefficient under whole period of study for both CCR and BCC models. However, the efficiency scores and overall average are higher in BCC model than in CCR model. The results obtained are not surprising because the scores generated through CRS are less than or equal to the corresponding VRS scores (Banker et al, 1984)

Table 4 shows the input-oriented efficiency scores obtained from the CCR and BCC Models of foreign banks groups. For foreign banks, the results indicate that the sector characterized with small asymmetry between banks as regards to their efficiency scores that ranges between 95.6% and 97.4% and 100% for CCR and BCC models respectively. The mean efficiency scores turned out to be 0.988 and 0.994 for both models respectively. This suggests that average foreign banks, if producing its outputs on the efficient frontier instead of its current (virtual) location, would need only 98.8% and 99.4% respectively of the inputs currently being used. The connotation of this finding is that the magnitude of inefficiency scores in foreign banks in Tanzania is to the tune of 1.2% and 0.6% respectively. This suggests that, by adopting best practice technology the banks group can, on an average, reduce their inputs of labour and operation expenses by at least 1.2% and 0.6% respectively and still produce the same level of outputs.

Table 5 shows the input-oriented efficiency scores obtained from the CCR and BCC Models of banks peer groups. Table 6 shows the input-oriented efficiency scores obtained from the CCR and BCC Models of banks peer groups. Recall that the banks groups with OTE score equal to 100% considered most efficient between the banks peer groups included in the analysis. The banks group with OTE score less than 100% claimed to be relatively inefficient. Foreign banks found to be fully efficient for CCR and BCC models in four years and five years respectively since they had efficiency scores of 100%. Domestic banks found to be efficient in three years in CCR model and four years in BCC model.

The above results implying that foreign banks could perform the role of financial intermediaries, using labors and total expenses to transfer deposits into loans and interest income, more efficiently than domestic banks. This is not a surprising result, because revenues of commercial banks come from two major sources, which are interest incomes and non-interest incomes. However, foreign banks are normally superior to domestic banks in several aspects such as amount of capital, number of labors and reputation, generating non-interest incomes from other sources such as investment banking services, money transfer services or foreign exchange services. Consequently,. In addition, the liberalization has a significant impact on foreign banks in Tanzania, which encourage them to starting to use high technology such as establishing ATM networks, associating to the SWIFT system, using on-line computer systems and mobile banking. Because these transfers are mostly to foreign banks, they appear to

have benefited more from this diffusion than domestic banks. That is why foreign banks are more efficient than domestic banks. The findings are consistent with other previous studies.

1.4.1 Identification of Reference set

DEA being a widely known tool for benchmarking enables identification of efficient DMU for the inefficient ones. This group of efficient DMUs when identified used for defining the operating procedures and goals for the inefficient DMUs. The frequency, which an efficient bank shows up in the reference sets of inefficient banks, represents the extent of robustness of that bank relative to other efficient banks. The higher the frequency, the more robust it is. In other words, a bank which appears frequently in the reference set of inefficient banks is likely to be a bank which is efficient with respect to a large number of factors, and is probably a good example of a 'well-rounded performer' or 'global leader' or 'bank with high robustness' (Kumar and Gulati, 2008). The banks with less number of frequency in the reference set are the 'marginally efficient banks' and would likely to drop from efficient frontier if there is even a small drop in the value of an output variable (or a small increase in the value of an input variable). When the efficient banks have zero frequency in the reference set, may also observed in the analysis. In DEA terminology, the bank with zero frequency count is termed as 'efficient by default' because it does not possess the characteristics, which must be followed by other inefficient banks.

Table 7 provides the reference sets for domestic banks along with the frequency (or peer count) of each efficient bank in that, reference sets. On the basis of frequency in the reference sets NMB and CRDB have the highest peer counts of two each which, rank first, followed Exim Bank which have peer counts of one rank second.

Table 8 provide the reference sets foreign banks group with the frequency (or peer count) of each efficient bank in that, reference sets. Based on frequency in the reference sets, Standard Chartered Bank (T) Limited has the highest peer counts of two, which rank first, followed by Citibank Banks (T) limited and Barclays, which rank second with the peer counts of one for each bank. It should be noted that, the above-mentioned banks are benchmarked by other peers. These banks are the most efficient, which serve as the benchmark peers for inefficient banks in the sample. Thus, inefficient banks could improve their efficiency level by benchmarking efficient banks.

1.4.2. Areas for Efficiency Improvement: Slacks and Targets Setting Analysis.

Tables 9 and 10 provide the summary results of input and output slacks derived from DEA model for inefficient foreign and domestic banks for the year 2007 to 2016. For interpreting the contents of the tables, consider the case of each group in a single year of 2010. The OTE score of foreign and domestic banks are 0.974 and 0.873 respectively, , implying that the banks in that year could become technically efficient (under the Farrell's definition) provided if all of its inputs are proportionally reduced by 2.6% and 12.7% respectively (i.e., (1-OTE score). However, even with this required proportional reduction in all inputs, these banks in that year would not be Pareto-efficient, as it would be operating on the vertical section of the efficient frontier. In order to project these banks to a Pareto-efficient point, some further slack adjustments are necessary because non-zero input and output slacks appear for these banks in that year. Thus, the adjustments are required in order to operate at the efficient frontier. They have to reduce all inputs by 2.6% and 12.7% respectively.

Tables above also present the target values of inputs and outputs for inefficient for each group of banks in years of study along with potential reduction in inputs. The potential improvement shows those areas of improvement in input-output activity needed to put inefficient banks onto the efficient frontier. For getting what these figures of potential input reduction show, consider the year 2010 for each banks groups. To move onto the efficient frontier, banks need to reduce their deposits, number of employees and total expenses: foreign banks need to reduce by 12.6%, 17.04% and 25.7% respectively and domestic banks by 12.7%, 9.6% and 12.7% respectively. Similar conclusions can be drawn for other inefficient years for each group of banks.

1.5 Conclusions and Managerial Implications

The study analyses and compares the efficiency of domestic and foreign banks in Tanzania for the period of 10 years from 2007 to 2017.employing panel data for domestic and foreign banks.

To achieve the research objectives DEA framework has been applied in which the estimates of technical, pure technical and scale efficiencies for individual group banks have been obtained by CCR and BCC models. The study applied an intermediation approach to choose input and output variables. The output vector contains two outputs: i) total loans, and ii) total interest income, while input vector contains three inputs: i) total deposits ii) labour (number of employees and iii) total expenses. Several interesting and useful managerial insights and implications arising from the study are discussed

The remarkable comment from the findings of this study is that efficiency status of domestic and foreign banks in Tanzania is not disappointing to financial sector reforms because the scores for both groups under the period of study turned out to be high. The results indicate that the level of overall technical efficiency in Tanzanian banking sector is around 95.9%. Thus, the magnitude of inefficiency is to the tune of 4.1%. We can see from the results that, foreign banks group are, on average, more efficient than domestic banks group. Turning to the sources of inefficiency it has been noticed that, the observed technical inefficiency for both groups of banks is due to poor input utilization, (i.e., managerial inefficiency).

In view of the results, the managerial implications of this paper are as follows: firstly, in some banks human resources are not proportional to the range of activities they have to do. Either more people than required are employed or the employees do not work, as they should do. Such banks should accordingly implement policies aiming at enhancing efficiency and reactivation of the work morale. Banks should harness their underutilized resources, which can be used in the production of new variety of services. Secondly, banks management should consider these benchmark exercises, since they compare different units in the same market, allowing the less efficient banks to overcome their relative inefficiencies.

ACKNOWLEDGMENTS
I would like to convey heartfelt thanks and appreciation to all those, who in one way or another, contributed to the successful completion of this paper. Sincere appreciation is extended to the reviewers of this paper for their constructive comments. Special thanks should also be extended to Editor and Dr. Don for their continued support and encouragement. I would like also to put on record my sincere gratitude to those who have at different stages of this work been very encouraging and supportive

References

Anderson, R., F, R., Zumpano, L. and Elder, H. (1998), "The efficiency of franchising in the residential real estate brokerage market", Journal of Consumer Marketing, Vol. 15, pp. 386-96

Banker, R. D., Charnes, A. and Cooper, W. W., (1984) "Some models for estimating technical and scale inefficiencies in data envelopment analysis", *Management Science*, Vol.30, No.9, pp.1078-1092

Barros, C. (2004), "Measuring performance in defence-sector companies in a small NATO member country", Journal of Economic Studies, Vol. 31, pp. 112-28

Berger, A.N. and Humphrey, D.B., (1997), "Efficiency of financial institutions: international survey and directions for future research", *European Journal of Operational Research* Vol. 98(2): 175-212.

Berger, A.N., Hunter, W.C and Timme, S.G (1993) "Efficiency of financial institutions" .A review and preview of research, past present, and the future, *Journal of banking and finance*, Vol. 21,pp 895 947

Bhattacharyya, A., Lovell, C.A.K., and Pankaj, Sahay (1997) "The impact of liberalization on the productive efficiency of Indian commercial banks" *European Journal of Operational Research*. Vol. 98, pp. 332-345

Casu, B., & Molynuex, P. (2003) "A Comparative Study of Efficiency in European Banking" *Applied Economics*, 35 (17): 1865–187.

Casu, B. & Girardone, C. (2002) "A Comparative Study of the Cost Efficiency of Italian Bank Conglomerates." *Managerial Finance* Vol. 28(9): pp. 3-23.

Chan, V.L. and Liu, M. (2006) "Effects of deregulation on bank efficiency and productivity in Taiwan" Academia *Economic Papers,* Vol. 34, 251-300

Charnes, A., Cooper, W.W., Rhodes, E., (1978) "Measuring efficiency of decision making units" *European Journal of Operational Research*, Vol. 1 (2), 429- 444.

Coelli, T., (1996) A Guide to DEAP Version 2.1, A Data Envelopment Analysis (Computer) Program. CEPA Working paper 96/08.

Darrat, A.F., Topuz, C. and Youzef, T. (2002), "Assessing cost and technical efficiency of banks in Kuwait", paper presented at the ERF's 8th Annual Conference in Cairo, ERF, Cairo

Ferrier, G., Lovell, C., (1990) "Measuring cost efficiency in banking: Econometric and linear programming evidence". *Journal of econometrics* Vol. 46 pp, 229-245

Fukuyama, H. and Weber, W.L. (2002), "Estimating output allocative efficiency and productivity change: application to Japanese banks", *European Journal of Operational Research*, Vol. 137, pp. 177-90.

Gishkori, M, A and Ullah, N (2013) "Technical Efficiency of Islamic and Commercial Banks: Evidence from Pakistan Using DEA Model" *IOSR Journal of Business and Management,* Vol. 7 pp 68-76

Grabowski, R., Rangan, N., and Rezvanian, R. (1994), "The effect of deregulation on the efficiency of US banking firms", *Journal of Economics and Business* Vol. 46, 39-54

Kumar, S and Gulati, R (2008) "An Examination of Technical, Pure Technical, and Scale Efficiencies in Indian Public Sector Banks using Data Envelopment Analysis" *Eurasian Journal of Business and Economics*, Vol. 1, pp 33-69

Mester, L. J. (1996). "A study of bank efficiency taking into account risk preferences" *Journal of Banking and Finance,* Vol. 20, 1025-1045

Miller, S. M., & Noulas, A. G. (1996) "The Technical Efficiency of Large Bank Production" *Journal of Banking & Finance*, Vol. 20(3): 495-509

Mostafa, M. (2007), "Modeling the efficiency of GCC banks: a data envelopment approach", *International Journal of Productivity and Performance Management*, Vol. 56 No. 7, pp. 623-43.

Pastor J., Perez, F. and Quesada, J. (1997). "Efficiency analysis in banking firms: An international comparison". *European Journal of Operational Research*, Vol. 98, 395-407

Ramanathan, R. (2007), "Performance of banks in countries of the Gulf Cooperation Council" International Journal of Productivity and Performance Management, Vol. 56 (2), pp. 137-154

Ray, S. C. and Mukherjee, K., (1998) "A study of size efficiency in US banking: Identifying banks that are too large" *International Journal of Systems Science*, Vol.11, pp.1281-1294, 1998.

Rickards, R. (2003), "Setting benchmarks and evaluating balanced scorecards with data envelopment analysis": *Benchmarking an International Journal*, Vol. 10, pp. 226-45.

Sathye, M (2003) "Efficiency of banks in a developing economy: The case of India" *European Journal of Operational Research*, Vol. 148 (3) pp 662–671

Sathye, M (2001) "X-efficiency in Australian banking: An empirical investigation" *Journal of Banking & Finance*, Vol. 25 pp 613- 630

Sealey, C, W and Lindley, J, T (1977) "Inputs, Outputs, and a Theory of production and Cost of Depository financial Institutions*" The Journal of finance* Vol. 32pp 1251-1266

Seelanatha, International Journal of Applied Economics, March 2012, 9 (1), 41-58 52 Aspects of European Union Enlargement, Conference at EUI (Florence), on May 13th - 15th, 2004

Seiford, L. and Zhu, J. (1999), "Profitability and marketability of the top 55 US commercial banks", *Management Science*, Vol. 45, pp. 1270-88

Vu, H and Turnell, S (2011) **"**Cost and Profit Efficiencies of Australian Banks and the Impact of the Global Financial Crisis" Economic Record, Vol. 87 (279), pp. 525-536

Wu, S. (2007), "*Efficiency and productivity analysis of the Australian banking sector under deregulation*" PhD thesis, Department of Economics, The University of Melbourne

Yang, C.C (2011) "An enhanced DEA model for decomposition of Technical efficiency in banking" *Annals of Operations Research journal*, Vol. 214, Pp 169-185

Table 1: A summary of inputs and outputs considered in selected DEA studies on bank efficiency analysis

Author(s)	Inputs	Outputs
Bhattacharyya et al. (1997)	Interest Expense	Advances
	Operating Expense	Deposits
Darrat et al. (2002)	Labour	Loans
	Capital	Investments
	Deposits	
Seelanatha (2012)	interest expenses,	loans and advances
	personnel costs	interest income
	establishment expenses	
Fukuyama and Weber (2002)	Labour	Loans
	Physical capital	Security investments
	Funds from customers	Other income bearing assets
Grifell-Tatje´ and Lovell (1999)	deposits and other liabilities	value of loans
	Employees	financial investments
	Average fixed assets	Deposits
Seiford and Zhu (1999)	Stage 1	Stage 1
	Employees	Revenue
	Assets	Profit
	Equity	Stage 2
	Stage 2	Market value
	Revenue	Total return to investors
	Profit	
Sathye (2003)	Model A	Model A
	Interest expenses	Net interest income
	Non-interest expenses	Non-interest income
	Model B	Model B
	Deposits	Net loans
	Staff numbers	Non-interest income

Source: literature review

Table 2: Data variables selected for DEA Models

Inputs	**Authors**
Total deposits (x_1)	Grifell-Tatje´ and Lovell (1999): Darrat et al. (2002): Fukuyama and Weber (2002: Seiford and Zhu (1999):
Number of employees (x_2)	Darrat et al. (2002)
Total expenses (x_3)	Bhattacharyya et al. (1997): Seelanatha (2012)
Outputs	
Total loans (y_1)	Sathye (2003): Seelanatha (2012)
Total interest income (y_2)	Seelanatha (2012): Sathye (2003)

Source: literature review

Table 3: Domestic banks Efficiency score results

Year	CCR	BCC	SE
2007	0.818	0.987	0.829
2008	0.757	0.927	0.817
2009	0.820	0.909	0.902
2010	0.803	0.899	0.893
2011	0.755	0.819	0.922
2012	0.853	0.885	0.964
2013	0.878	0.902	0.973
2014	0.882	0.904	0.976
2015	0.893	0.895	0.974
2016	0.885	0.906	0.978
Mean	0.821	0.904	0.908
Min	0.755	0.819	0.817
Max	0.882	0.987	0.976
SD	0.049	0.046	0.058
Range	0.127	0.168	0.159

Source: Authors 2017

Table 4: Foreign Banks Efficiency score results

Year	CCR	BCC	SE
2007	1.000	1.000	1.000
2008	1.000	1.000	1.000
2009	1.000	1.000	1.000
2010	0.988	1.000	0.988
2011	0.956	0.974	0.982
2012	0.974	0.985	0.989
2013	0.988	0.993	0.995
2014	1.000	1.000	1.000
2015	0.978	0.996	0.998
2016	1.000	1.000	1.000
Mean	0.988	0.994	0.994
Min	0.956	0.974	0.982
Max	1.000	1.000	1.000
SD	0.016	0.010	0.007
Range	0.044	0.026	0.018

Source: Authors 2017

Table 5: Foreign Banks Efficiency score results

Year	CCR	BCC	SE
2007	1.000	1.000	1.000
2008	1.000	1.000	1.000
2009	1.000	1.000	1.000
2010	0.988	1.000	0.988
2011	0.956	0.974	0.982
2012	0.974	0.985	0.989
2013	0.988	0.993	0.995
2014	1.000	1.000	1.000
2015	0.978	0.996	0.998
2016	1.000	1.000	1.000
Mean	0.988	0.994	0.994
Min	0.956	0.974	0.982
Max	1.000	1.000	1.000
SD	0.016	0.010	0.007
Range	0.044	0.026	0.018

Source: Authors 2017

Table 6: Efficiency Scores for Banks group wise

Banks	Foreign Banks			Domestic Banks		
Years	CCR	BCC	SE	CCR	BCC	SE
2007	1.000	1.000	1.000	0.818	0.987	0.829
2008	1.000	1.000	1.000	0.757	0.927	0.817
2009	1.000	1.000	1.000	0.820	0.909	0.902
2010	0.988	1.000	0.988	0.803	0.899	0.893
2011	0.956	0.974	0.982	0.755	0.819	0.922
2012	0.974	0.985	0.989	0.853	0.885	0.964
2013	0.988	0.993	0.995	0.878	0.902	0.973
2014	1.000	1.000	1.000	0.882	0.904	0.976
2015	0.978	0.996	0.998	0.893	0.895	0.974
2016	1.000	1.000	1.000	0.885	0.906	0.978
Mean	0.988	0.994	0.994	0.821	0.904	0.908
Min	0.956	0.974	0.982	0.755	0.819	0.817
Max	1.000	1.000	1.000	0.882	0.987	0.976
SD	0.016	0.010	0.007	0.049	0.046	0.058
Range	0.044	0.026	0.018	0.127	0.168	0.159

Source: Authors 2017

Table 7: Reference sets for inefficient Domestic Banks

Banks	OTE score	Reference set
Azania	0.866	NMB(0.071); CRDB(0.363); Exim (0.250)
Kilimanjaro	0.753	NMB(0.023); CRDB(0.463)

Source: Authors: Note: reference set figures are λ values obtained from solution for individual inefficiency domestic banks

Table 8: Reference Sets for Inefficient Foreign Banks

Bank	OTE score	Reference set
NBC	0.973	Barclays (0.020); Standard(0.014)
Stanbic	0.988	Citibank(0.095); Standard(0.462)

Source: Authors: Note: reference set figures are λ values for individual inefficient foreign banks

Table 9: Slacks and targets for inefficient foreign banks

		Slacks			Targets					Inputs Reductions (%)		
Year	score	x_1	x_2	x_3	x_1	x_2	x_3	y_1	y_2	x_1	x_2	x_3
2010	0.974	961091	1278	11670	6493484	6030	441768	4122160	475534	2.6	2.6	2.6
2011	0.985	779724	967	8557	7771383	6666	555113	5124275	575669	1.4	1.4	1.4
2012	0.993	491783	589	4737	9339661	7446	694214	6354101	698558	0.7	0.7	0.7

Source: Authors: Notes: x_1=Total deposits. x_2=Number of employees, x_3 total expenses, y_1=Total loans, y_2=Total interest income

Table 10: Slacks and targets for inefficient Domestic banks

		Slacks			Targets					Inputs Reductions (%)		
Year	Score	x_1	x_2	x_3	x_1	x_2	x_3	y_1	y_2	x_1	x_2	x_3
2009	0.909	7847	60	877.54	78212	231	8746	60155	10166	9.1	9.1	9.1
2010	0.873	18423	40.	2016.1	126539	322	13848	93319	15958	12.7	12.7	12.7
2011	0.945	8391	0	1258.9	142989	564	21453	121009	21689	5.5	5.5	5.5
2012	0.952	7703	36.	1342.7	151247	777	26365	138542	25214	4.8	4.8	4.8

Source: Authors: Notes: x_1=Total deposits. x_2=Number of employees, x_3 total expenses, y_1=Total loans, y_2=Total interest income