AN ASSESSMENT OF RELATIVE EFFICIENCY OF BANKS IN SRI LANKA

Lalith Seelanatha, Hilary E Silva***

Abstract

This paper examines how the financial reforms introduced throughout last 30 year period have improved the managerial efficiency of firms in the banking industry in Sri Lanka. Using non-parametric data envelopment analysis (DEA), this study estimated relative efficiency of banking firms in Sri Lanka using a sample of data collected from 20 year cross section (1989-2008). The study found that the banks in Sri Lanka have recorded relatively higher level of efficiency. Both managerial decisions and scale of operation have been equally contributed to the recorded inefficiency. We found that large banks were relatively more efficient than small banks. However, medium size banks were recorded relatively lower levels of efficiency which were mainly contributed by the managerial factor.

Keywords: Data Envelopment Analysis, Efficiency, Commercial Banking, Sri Lanka.

Classification Codes: G14, G38, G61

**School of Accounting, Faculty of Business, Victoria University, Australia*
Email: Lalith.seelanatha@vu.edu.au
*** Department of Accounting, University of Sri Jayewardenepura, Sri Lanka*
Email: hilarysilva@yahoo.com

1 Introduction

Since 1977, with the introduction of open economic policies, operation of banking industry in Sri Lanka has been drastically changed. The main aim of the economic policy changes was to improve productivity and efficiency of banking industry by creating a competitive market environment. As noted by Karunasena (1999) areas such as, deregulation of the financial industry by relaxing entry and exit requirements and reduction in public equity within the banking industry, reforming financial institutions and instruments, allowing interest rates to be set by market forces and credit to be allocated based on market signals, reducing the cost of financial intermediation, strengthening the legal, accounting and regulatory frameworks for financial institutions, developing money, capital and debt markets and giving operational flexibility to banks in terms of the management of their assets and liabilities were focused on the early reforms of the financial service sector. There were large number of published research in the area of productivity and efficiency in the banking industries in different countries. However, very little studies in this area have been conducted in Sri Lanka. Therefore, this study aims to provide further empirical evidence on relative efficiency of banks in Sri Lanka.

The remaining part of this paper consists with five sections. The next section outlines relevant literature. The third section introduces DEA methodology that was used to measure the efficiency of the Sri Lankan banking sector. The fourth section provides the details of the analysis and discussion of the results. The penultimate section discusses policy implications and the final section summarises the main findings and draws conclusions regarding Sri Lanka's banking industry.

2 Literature Review

2.1 Productivity Concepts

Productivity is generally defined as the relation between output (produced goods) and input (consumed resources) and can be regarded as one of the most vital factors affecting competitiveness of a business firm (Robert, 1998). A firm can achieve productivity gains by producing either a greater amount of output from a given amount of inputs or by using a minimum amount of inputs to produce a given amount of outputs (Coelli, Rao, & Battese, 1998). In this context productivity can be defined as the ratio of the output(s) to the input(s) used.

Productivity measurement may be limited to single physical units or may involve prices of factors and outputs. The concept of productivity is linked closely with the issues of efficiency and encompasses

several efficiency elements such as price efficiency[5], allocative efficiency[6], technical efficiency and scale efficiency. The overall productivity level of an organization depends on all these elements. Gaining improvements in productivity and efficiency can be considered as one of the goals of a firm in a competitive market. Therefore, productivity and efficiency measurements provide supplementary information about the firm's performance. These measurements can be considered as non-financial performance indicators as they consider all of the contributors to the firm's performance. In any organisation, whether it is profit-oriented or not, measurements of productivity help to analyse the efficiency of resource used in the organisation. Moreover, productivity indices help to set realistic targets for monitoring activities during an organizational development process by highlighting bottle-necks and barriers to performance (Reynolds & Thompson, 2002).

Partial-factor productivity which is the ratio of output (measured in specific units) to any input (also measured in specific units) or total factor productivity (TFP) which is the ratio of total outputs to total inputs used in production can be used as measures of productivity. Partial measures are based on specific operational attributes such as total revenue per labour unit, expenses as a percentage of total assets and return on assets. In contrast, TFP measures estimate the overall effectiveness of utilization of inputs to produce the outputs. Production frontier analysis (PFA) and index number approaches have been used to estimate TFP. Our paper uses the production frontier approach to measure the relative efficiency of banks in Sri Lanka. Therefore, the next section briefly explains different production frontier methods.

Production frontier. Production frontier methods have used input and output data to construct the production frontier for estimating productivity and efficiency approaches or linear programming (non-parametric) approaches can be used to construct the production frontier. The relative productivity and efficiency of the firms in a given industry have been measured on the production frontier. Main advantages of using frontier analysis as a tool for measuring productivity and efficiency are that PFA allows an analyst to select the best performing firms (or branches) within a given industry (or within the branches in the same firms) by measuring relative productivity and that it allows management to identify objectively areas of best practice within complex service operations(Berger & Humphrey, 1997).

The productivity and efficiency of a DMU are influenced by three different phenomena (Fried, Lovell, Schmidt, & Yaisawarng, 2002) namely the efficiency with which management organizes production activities, the environment in which production activities are carried out and the impact of 'good and bad luck'. The deterministic nature of DEA ignores the above phenomena when estimating productivity and efficiency of DMUs. Further, Berger and Mester (1997) argued that the parametric approach overcomes many of the shortcomings of non-parametric approaches and showed that the parametric approach can accommodate different definitions of efficiency such as cost efficiency and profit efficiency.

However, both parametric and non-parametric techniques suffer from drawbacks. In many empirical studies, a large number of DMUs is classified as efficient (Griffin & Kvam, 1999). As such, the ranking of DMUs becomes difficult. Neither technique accounts for the distribution of DMU values in the input/output space that typically distinguish smaller firms from larger ones. Furthermore, efficiency scores for all DMUs are stated with equal confidence, even if some of the DMUs are divergent in terms of input and output values.

Choice of frontier analysis methods. Both parametric and non-parametric approaches have advantages as well as disadvantages. There is no specific set of criteria to select the most relevant approach for constructing the production frontier. Tortosa-Ausina (2002) pointed out that the choice of technique, either non-parametric or parametric, is somewhat arbitrary, depending on the aims pursued. Coelli and Perelman (1999) applied corrected ordinary least square method (COLS) (parametric approaches) and the parametric linear programming method[7] and DEA to estimate the production frontier of European railways. The three approaches have been reported similar findings on the relative productive performance of the DMUs. Their findings suggest that researchers can safely select one of PFA approaches. It is also concluded that the choice may have very little impact on the results. However, the use of a parametric approach allows analysts to test hypotheses.

2.2 Efficiency studies in the banking industry

Efficiency improvements in the banking sector in many countries have been investigated by various researcheSLR The majority of the previous studies have focused on the banking sectors of more developed countries. Berger and Humphrey (1997) documented 130 studies on financial institution

[5] Price efficiency is the firm's ability to purchase inputs that meet the required quality and standard of the lowest prices.

[6] Allocative efficiency exists when a firm is able to select an input mix to produce an output mix at a minimum cost

[7] The parametric estimation is based on the translog Cobb-Douglas functional form.

efficiency which related to 21 countries[8]. These reports have covered different circumstances, such as the impact of deregulation, market structure, entry of foreign banks, and factors affecting banking productivity. However, only limited information is available from developing countries.

DEA is widely used in empirical research in the field of productivity analysis in financial institutions (eg. Avkiran, 2000b; Devaney & Weber, 2000; Grigorian & Manole, 2002). However, no specific set of criteria is available for selecting the most appropriate approach for constructing a 'production frontier'. The choice of either non-parametric or parametric techniques is somewhat arbitrary, depending on the aims of each study (eg. Tortosa-Ausina, 2002).

Coelli and Perelman (1999) have applied both non-parametric and parametric approaches to estimate the 'production frontier' of European railways. They used a corrected ordinary least squares method and the parametric linear programming method (PLP)9 and DEA. The approaches used in their study report similar information that reflects the relative productive performance of the investigated DMUs. Based on the results they suggested that researchers can validly select any one of the productivity and efficiency analytical approaches without too much concern that their choice will have a significant influence on results. As an alternative, they stressed that the use of the parametric approach allows analysts to test their hypotheses. However, they highlighted that the geometric average of the efficiency indices identified by alternative approaches have provided the best estimation of the firm's efficiency.

Input and output specification. A fundamental problem in relation to input and output specification arises due to different treatment of deposits. A significant portion of the loan and investment portfolio of a bank is sourced mainly from deposits. On the other hand, commercial banks offer deposit products with various features such as integrated deposit accounts, checking accounts, and accounts linked to loan plans to enhance the banks' competitive positions (Leong & Dollery, 2002).

Previous researchers have highlighted five approaches which can be used for specifying input and output variables in the banking industry namely; production intermediation (Favero & Papi, 1995; Leong & Dollery, 2002; Mester, 1987) assets approaches (Favero & Papi, 1995; Leong & Dollery, 2002) user cost and value-added (Favero & Papi, 1995) approaches. Production, intermediation and assets approaches are directly linked to operational functions of banks. However, user-cost and value added approaches are not directly linked to the operational functions of banks. In practice, researchers have selected different variables even though they have used identical approaches (see Appendix 1 & 2 for input and output used in previous studies).

Sealey and Lindley (1977) pointed out that the transformation process for a financial firm involves borrowing of funds from savers (surplus spending units) and lending those funds to borrowers (deficit spending units), i.e., financial intermediation. Therefore, outputs of authorised depository institutions (ADI) in a technical sense are a set of financial services provided to depositors and borroweSLR Accordingly, ADI provides three categories of services namely (1) administration of the payments mechanism for demand deposit customers, (2) intermediation services to depositor and borrowers and (3) other services such as trust department activities and portfolio advisory services. They showed that both borrowers and depositors have received some utility from the banking services. Hence, they suggested that the value addition to each input and output should be considered when defining the firm's products in an economic sense. Based on the theory of the firm, Sealey and Lindley emphasised that the firms must consider the output of economic production to be priced higher when compared with input prices. Further, market prices should be used to value products. Hence, some services which are considered as outputs in financial institutions in technical sense do not have market prices and they cannot be considered as output in the economic sense.

Table 1 shows number of input and output specification approaches used in the previous research. Among them, intermediation and production approaches have been widely used. Elyasiani and Mehdian (1990) stressed that the production approach can be applied only when functional cost analysis data are available. Since the data on the number of deposits and loan accounts are available only as a part of the functional cost analysis, the ability to use the production approach appears to be limited. Contrarily, the intermediation approach allows the use of the value of the input and output variables. Elyasiani and Mehdian (1990) highlighted the following advantages of the intermediation approach over the production approach.

[8] Out of 130 studies, 66 studies were in USA, 11 studies in Spain, 5 studies in United Kingdom, 5 studies in Norway and the rest in other countries.

[9] The parametric estimation is based on the translog Cobb-Douglas functional form.

Table 1. Input and output specification approaches

Specification Approach	Description
Production approach	- treats banks as producers of services which use labour and capital to generate deposits and loans (Avkiran, 2000b). - regards Deposits as an output viewing as a part of the banking services offered (Golany & Storbeck, 1999).
Intermediation approach	- regards deposits as an input which is used for producing the other banking outputs - assumes that the main role of banks is to arrange a meeting place for the savers and borrowers to make financial transactions (Favero & Papi, 1995)
Assets approach	- is similar to the intermediation approach (Camanho & Dyson, 2004). - Outputs are strictly defined by assets and mainly by the production of loans. - recognises labour, capital, deposits and other liabilities as inputs
User cost approach	- considers the net contribution the banking revenue when determining input and output. - is based on the comparison of opportunity costs of each asset and liability item with the financial cost and return (If the opportunity cost of a liability is greater than the financial cost, the item is recognized as an output; otherwise it should be considered as an input)
Value-added approach	- regards items in the balance sheet with a substantial share of value-added as outputs. - considers both deposits and loans as outputs of banks (Berger & Mester, 1997).
Profit approach	- rely on standard profit function - specifies all revenues as output variables and all expenses (mainly variable costs) as input variables

- The intermediation approach is more inclusive of total banking costs. These expenses constitute a substantial portion of banks' total costs and their exclusion may distort the empirical results.
- Since the deposits are used for making loans and investments with other inputs, they should be considered as inputs.
- By using the currency value of the input output data, the intermediation approach reduces the potential quality problems of input/output data.

Appropriate method of measurement is the second major problem related to the input and output specification. In practice, there are three measurement approaches used for measuring banking outputs and inputs. They are (1) flow measures (the number of transactions processed on deposits and loan accounts), (2) stock measures based on money value (the real or constant monetary values of funds in the deposit and loan accounts), and (3) stock measures based on the number of deposit and loan accounts serviced (Humphrey, 1991). The majority of productivity studies in banks have applied stock measures based on monetary values due to the more ready availability of the required information. However, the use of monetary-value-based measures in the stock method may also distort estimated efficiency. For instance, Drake and Hall (2003) signalled that the use of personnel expenses rather than employee numbers could result in some bias against those banks which hire quality workers at a higher cost. Some banks hire high-calibre banking professionals and pay relatively higher salaries. Since a high personnel cost could be a result of employing high quality labour, analysts have to be mindful of the objective of the research as there is a possibility to bias results.

A considerable number of previous studies have examined the impact of financial reforms on banks' productivity and efficiency. Most of these studies have reported that the short-term effects of deregulation on the financial sector's productivity and efficiency are negative. In essence, the studies have typically concluded that the benefits of liberalisation and deregulation can only be expected as a longer term consequence. Furthermore, it is apparent that the outcomes of liberalisation in different countries were not similar. Elyasiani and Mehdian (1990) reported that the efficiency gap between small banks and large banks in the United States (US) has been widened during the post-deregulation period (after 1979). Their results indicated relatively low average estimated efficiency for small banks in both pooled and separate 'production frontiers'. However, the small banks recorded considerable technological progress over the period 1979 to 1986. They also suggested that small banks in the US were adversely affected by the relaxation of some presumed favorable regulatory restrictions that were considered appropriate to small banks, such as the branching restriction and interest rate ceilings. In another study, new banks in Portugal reported relatively higher efficiency scores than the old banks, indicating 59% overall efficiency improvement in their sector of the banking industry,

after the deregulation initiative (eg. Camanho & Dyson, 2004). Their opinion was that a rapid deregulation process with a well-staffed banking system may lead to positive efficiency gains from deregulation.

Deregulation may provide an opportunity for banks to improve their operational performance [i.e., its technical efficiency (TE)] and to promote the scale of operations [i.e., scale efficiency (SE)]. Operational performance could thereby improve customer services quality via the introduction of more appropriate technologies [i.e., technological change (TC)]. An investigation of the productivity improvements due to deregulation of the banking industry in Turkey revealed that these changes have resulted from better management practices rather than improved scale (eg. Isik, 2003). The investigation further indicated that an inefficient bank may subsequently adopt some of the practices and processes of the more efficient banks to catch up with best practices. In another study, Isik and Hassan (1995) revealed that the impact of deregulation on different banking groups was not uniform. Even though all banks reported significant improvements in productivity after deregulation, their technology may not have advanced as expected. Diseconomies of scale were the main factor which has affected estimated productivity and efficiency.

Previous studies in productivity and efficiency in bank have recorded evidence from banking industries in other parts of the world. Very little evidence can be found in the developing country perspective, in particular from banking industry in Sri Lanka. This paper attempts to cover that gap and the rest of this paper focuses on the assessing efficiency of banking industry.

3 Theoretical Framework

3.1 DEA

Relatively small sample size limits the application of parametric frontier approaches to the Sri Lankan banking industry as those approaches need a relatively large sample to make unbiased predictions. Hence, we apply the DEA to measure relative efficiency of banks in Sri Lanka.

Charnes, Cooper and Rhodes (1978) introduced the DEA formulation (called the CCR model) which determines the relative efficiency measure for a DMU by maximising the ratio of weighted outputs to inputs based on the condition that similar ratios for all DMUs are less than or equal to one. Hence, each efficient DMU has a weight equal to unity and inefficient DMUs should have a weight equal or less than one. The CCR model and Banker, Charnes, and Cooper (1984) model (called the BCC model) are the two basic DEA formulations which have been commonly used in empirical studies. The CCR model uses an optimization method of mathematical programming to generalize the single output/input technical measure to the multiple output/multiple input case. It is based on CRS when enveloping the actual data to determine the shape of the production frontier. Contrary to the CCR model, the BCC model uses variable returns to scale (VRS) for identifying the envelopment surface.

As stated above, CCR ignores the relative size of the DMUs when estimating efficiency. It is assumed that an increase in output is always proportional to an increase in inputs and thus the scale of production is ignored. On the other hand, BCC models give precedence to the scale of operation in estimating efficiency. Hence, productivity and efficiency estimated using BCC refer to pure-technical efficiency while estimates using CCR refer to technical efficiency. The difference between estimated CCR and BCC efficiency scores is denoted as scale efficiency.

The traditional DEA limits the efficiency scores of efficient units to 100% in both input-oriented models and output-oriented models. Inefficient units' DEA scores are lower than 100%. Both input-oriented and output-oriented models recognize the same DMUs as efficient. However, scores assigned to the inefficient units are not the same in the two projection modes (Lovell & Rouse, 2003).

DEA uses three projection paths of inefficient units to the envelopment surface for measuring the productivity and efficiency, namely: input-oriented, output-oriented and additive. The input-oriented model identifies technical inefficiency as a proportional reduction in input usage for a given level of output. Contrarily, the output-oriented model identifies technical inefficiency as a proportional augmentation of output for a given level of input. Additive models combine both effects of input utilization and output augmentation (Coelli et al., 1998).

Thus, this paper adopts constant to return DEA model which is called CCR (Charnes et al., 1978) and variable return to model which is called as BCC (Banker et al., 1984), in order to evaluate the efficiency of banks in Sri Lanka following the previous studies (Barr, Killgo, Siems, & Zimmel, 1999; Drake, 2001; Elyasiani & Mehdian, 1990). Furthermore, this study adopts input-oriented[10] DEA models following previous research (Barr et al., 1999; Denizer, Dinç, & Tarimcilar, 2000; Dietsch & Lozano-Vivas, 1996; Drake, 2001; Elyasiani & Mehdian, 1990), assuming that operational efficiency in intermediation are dependent on banks ability to produce maximum amount of product and services using minimum amount of inputs.

CCR and BCC DEA formulations are applied to estimate the TE and PTE respectively. Previous

[10] The input-oriented model identifies technical inefficiency as a proportional reduction in input usage for a given level of output (Coelli, Rao and Battese (1998).

studies have employed a MPI like index[11] to decompose scale effect on a DMU's inefficiency. A firm's TE is a function of PTE and the SE. Therefore, PTE should be separated from the TE to identify SE (Coelli et al., 1998). Descriptive statistics, window analysis and longitudinal graphical analysis are used in this study to investigate the influence of deregulation on banking firms in Sri Lanka. Descriptive statistics are used to make conclusions in regard to overall productivity and efficiency distributions of the banking firms. Further, descriptive statistics for each cluster of banks (foreign, private and state) were calculated and compared. The significance of the identified differences in efficiency of the different form of banks were tested using the Mann-Whitney Test[12] (Sprent, 1990) statistics.

3.2 Input and output specification

As explained before, there is no apparent consensus evident in the literature concerning the most appropriate approach for identifying input and output variables in banking firms. The model used in this paper specifies inputs and outputs based on the standard intermediation and the profit approaches (which is a variation of value-added approach). Thus, it allows incorporating the impact of both risk and return of intermediation process in efficiency estimation. The factors such as, availability of required data, small sample size, the restriction on number of inputs and outputs which can be incorporated into a DEA model (Cooper et al., 2000) and the discrimination power of the specific DEA models have been considered in selection of the input and output specification.

The model is aimed to assess operational efficiency of the banks (Drake, Hall, & Simper, 2003). It includes interest expenses, personnel costs, other expenses and non-performed loan balances as inputs and interest income and other income as outputs. Respective definition for each inputs and outputs are provided in the Table 2. Respective data on all variables in the model have been extracted from the banks' income statements.

3.3 Data and Sample

A 20-year (1989-2008) unbalanced panel data set which was directly extracted from published annual reports of locally established commercial banks in Sri Lanka has been used in this study. For the purpose of the study, banks were defined as financial institutions which mainly use deposit mobilisation for banking activities. We exclude, savings banks from our sample, since their line of products are more different from the commercial banks' product line. Therefore, the study sample included all commercial banks which are allowed to take all categories of deposits including current savings and time deposits.

This study is based on a sample which comprises a small number of banks. DEAs ability to discriminate efficient decision making units (DMU) from inefficient units is mainly depending on the sample size and the number of input and output variables used in the study (Avkiran, 1990). Previous studies have used the moving window approach to overcome the small sample problem is (Asmild, Paradi, Aggarwall, & Schaffnit, 2004; Avkiran, 2000a; Charnes, Cooper, Golany, Seiford, & Stutz, 1985; Fu & Heffernan, 2005). The moving window approached allowed to pool data in a predetermine window period and construct the production frontier there on. It ignores the medium time technological change. Each DMU within a window period is considered as a separate DMU. The analysis of estimated efficiency scores is made based on the mean efficiency scores of each year in a given window (based on window analysis) and the mean efficiency scores of each window for different types of banks. The mid year of each window considered as the point of estimation. Following the previous studies, we used three-year moving windows to construct production frontiers for estimating relative efficiency using DEA.

4 Assessment of Efficiency

4.1 Descriptive Statistics

The sample comprised 20-year unbalanced panel data set which included all the local banks in Sri Lanka. The first year of the sample included only six banks; this number grew to 9 banks in the last year, with 158 observations. Based on the pooled data of 18 three-year moving windows drawn from the sample, 18 production frontiers have been constructed. The three-year windows were named by their respective middle yeaSLR Table 3 presents descriptive statistics of all input and output variables used in this study.

[11] Technical efficiency (TE) is the product of pure technical efficiency (PTE) and the scale efficiency. Thus, the SE can be estimated by dividing the estimated efficiency scores of CCR (which measures TE) by the estimated efficiency scores of BCC BCC(Coelli, Rao and Battese (1998).

[12] The Mann Whitney test, also known as the Wilcoxon Rank Sum Test, is a non-parametric test use for testing difference between the medians of two independent groups (Sprent, 1990)

Table 2. Definition Input and Output variables

Inputs	Description
Interest expenses	The amount paid as interest on all liabilities including deposits, debentures and other long-term and short-term loans.
Personnel costs	The total expenses of banking staff, such as wages and retirement benefits.
Other expenses	Expenses incurred in providing other basic infrastructure such as communication, rent, depreciation and insurance.
UPL	Loans which are considered as not collectables
Outputs	
Interest Income	The amount collected as interest by providing lending facilities to the borrowers
Other income	The income generated from sources, other than banking activities

Table 3. Descriptive statistics of input and output data

Year	Interest Income	Other Income	Interest Expenses	Personnel expenses	Other expenses
1989	1,217.67 [1,390.21]	303.83 [315.51]	705.67 [823.59]	319.67 [397.94]	204.00 [216.70]
1990	1,724.83 [1,971.56]	332.17 [327.17]	1,042.83 [1,160.20]	378.33 [451.22]	310.83 [372.08]
1991	2,181.67 [2,286.80]	428.67 [403.75]	1,379.00 [1,401.49]	552.83 [678.37]	426.83 [514.65]
1992	2,749.00 [2,643.52]	597.83 [472.40]	1,954.83 [1,872.80]	616.67 [691.45]	427.00 [399.65]
1993	3,655.33 [3,415.48]	873.50 [738.33]	2,391.67 [2,141.68]	792.17 [877.00]	559.50 [540.17]
1994	4,368.83 [3,984.30]	902.33 [867.16]	2,709.17 [2,402.24]	990.50 [1,091.41]	660.00 [606.15]
1995	4,065.25 [4,785.59]	791.13 [905.87]	2,429.50 [2,786.00]	835.25 [1,037.78]	613.13 [757.25]
1996	4,876.00 [5,428.48]	955.50 [1,145.35]	3,186.88 [3,522.43]	899.63 [1,084.17]	755.63 [895.11]
1997	5,485.63 [5,914.09]	1,236.75 [1,487.98]	3,527.63 [3,747.84]	1,099.00 [1,357.80]	874.75 [972.14]
1998	5,608.25 [5,845.47]	1,217.88 [1,229.93]	3,297.50 [3,412.01]	1,243.00 [1,463.69]	993.63 [1,108.58]
1999	5,386.44 [5,820.45]	1,008.33 [1,245.45]	3,588.33 [4,021.84]	1,239.00 [1,510.82]	810.44 [800.44]
2000	6,538.22 [6,746.32]	1,269.78 [1,480.14]	4,238.11 [4,482.12]	1,439.33 [1,761.40]	1,036.89 [1,134.92]
2001	8,448.22 [8,872.42]	1,372.33 [1,334.29]	6,070.11 [6,248.95]	1,574.67 [1,849.96]	1,191.78 [1,488.70]
2002	8,015.11 [8,079.93]	1,389.00 [1,216.72]	5,004.89 [5,074.87]	1,694.11 [1,899.98]	1,303.33 [1,142.95]
2003	7,905.33 [7,098.81]	1,872.33 [1,575.84]	4,181.89 [3,623.94]	2,131.56 [2,405.76]	1,452.33 [1,134.04]
2004	8,095.22 [6,901.91]	2,214.00 [2,075.48]	4,086.78 [3,370.57]	2,398.67 [2,710.90]	1,614.22 [1,186.07]
2005	10,800.00 [8,663.80]	2,291.33 [2,023.68]	5,816.89 [4,506.58]	2,494.89 [2,579.97]	2,234.67 [1,667.72]
2006	14,649.11 [11,178.84]	2,883.00 [2,691.64]	8,295.89 [5,959.06]	3,552.22 [3,746.11]	2,676.22 [1,784.45]
2007	21,169.44 [16,227.00]	3,115.78 [2,576.66]	13,622.11 [10,417.72]	3,642.00 [3,640.60]	3,215.33 [2,218.26]
2008	26,051.00 [19,184.55]	3,742.33 [3,159.60]	17,476.22 [12,841.83]	4,006.89 [3,789.96]	4,104.78 [2,748.62]
All	8,286.00 [10,314.84]	1,548.51 [1,828.83]	5,139.63 [6,579.95]	1,722.00 [2,310.88]	1,380.92 [1,619.66]
All values in the table are in millions of Sri Lankan rupees. Standard deviations are given in parenthesis					

Descriptive statistics recorded in the Table 3 indicate that the banks have been evolved significantly during the study period. Estimated average values for interest income indicate 24-fold increase (1989-Rs1,217 million and 2008–SLR 26,051 million). Average other income has been increased by 12 folds (1989- SLR 303 million to 2008 SLR 3742 million). Input variables have also recorded a similar trend to the output variables. Bank interest expense has been increased from SLR 705 million in 1989 to Rs 5139 million in 2008. Personnel cost has increased from SLR319 million in 1989 to SLR4006 million in 2008. Increases in personnel cost may have been due to both nominal salary increases and the accompanying increases in payment to skilled banking professionals. Almost all of the variables showed relatively higher standard deviations indicating the impact of large variation in the size of banks. When compared to other variables, higher values in interest income and expense of banks indicate the significance of intermediary roles played by the banking system in Sri Lanka.

Table 4. Correlation of Input and Output Variables. Pooled data for whole sample

	Interest Income	Other Income	Interest Expenses	Personnel expenses	Other expenses
Other Income	0.892				
Interest Expenses	0.990	0.871			
Personnel expenses	0.928	0.868	0.891		
Other expenses	0.927	0.839	0.893	0.840	
UPL	0.796	0.728	0.759	0.873	0.787

Table 4 presents the correlations among input and output variables. Almost all of the variables indicated high correlations. The correlation coefficients between input and output variables shows the appropriateness of selected input and output variables for performance evaluations (Avkiran, 1990).

4.2 Efficiency of banks

We used three-year moving windows to estimate the relative efficiency of local commercial banks. In our analysis, we first report the estimated efficiency scores using the three-year windows. Figures 1 (TE), 2 (PTE) and 3 (SE) represent estimated mean efficiency scores of 18 three-year moving windows.

These graphs clearly deficit two eras of efficiency trend in Sri Lankan banks. The first era is recorded from 1989 to 1997. During this period, a negative trend in efficiency has been recorded. This is the period which the financial services sector underwent a deregulation process. In previous studies, it was evident that during the transition period of deregulation, banks may loose their efficiency. As indicated in the figure-seven significant part of these efficiency losses has been recorded due to the scale effect not because of the managerial inefficiency. The second era of the efficiency changes has been recoded during the period from 1997 to 2008. During this period a clear positive trend in efficiency can be observed.

Figure 1. Average technical efficiency

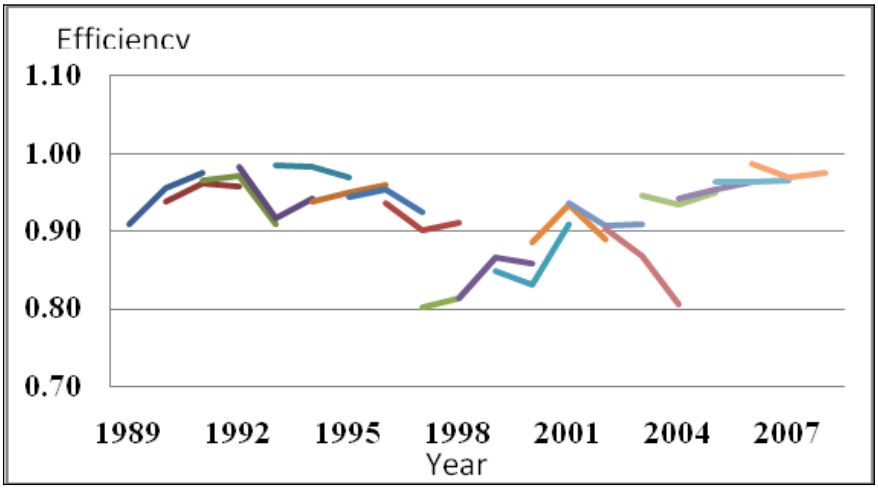


Figure 2. Average pure efficiency

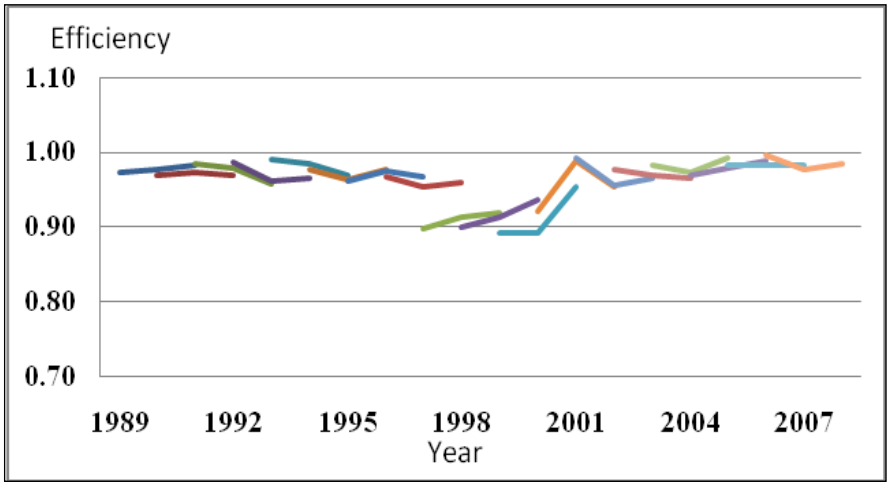
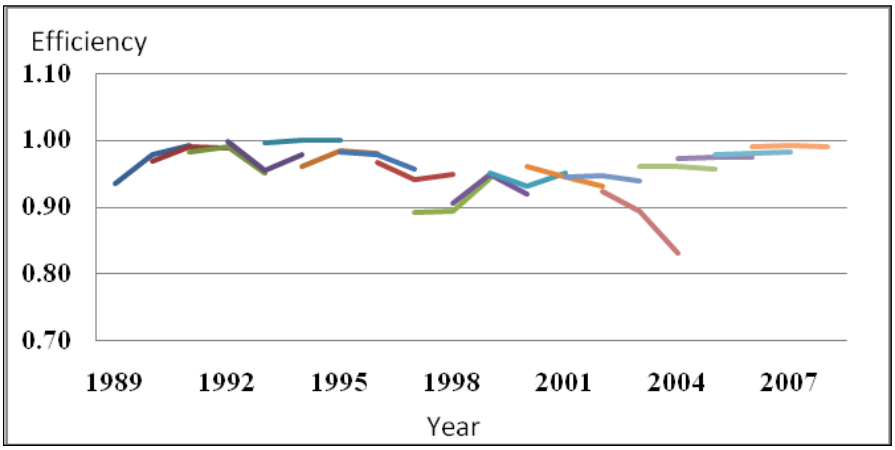


Figure 3. Average scale efficiency



The first window (in Figure 1) shows that the average TE score is 90.1% in 1989, indicating a low wastage of inputs (inefficiency) in the production processes. Further to that, in 2008 the estimated TE has increased to 97.5%, indicating an overall upward trend in efficiency. A similar trend is also exhibited in PTE (1989-97.22%, versus 2008-98.5%) and SE (1989-93.49%, versus 2008-98.97%). The remaining part of this section discusses the efficiency trends and the potential grounds for those trends.

During the first phase, the regulations that controlled entry barriers were relaxed through the introduction of the Banking Act 1988 along with the establishment of the Credit Information Bureau (CIB) and the repurchase market for government securities was opened. The Act also amended the regulatory and supervisory role of the Central Bank of Sri Lanka. This followed the adoption of Article VIII of IMF which facilitated the removal of restrictions on international financial transactions (Seelanatha & Wickremasinghe, 2009).

The opening of two new private sector banks subsequently increased the concentration in the financial markets. During this period, the Colombo Stock Exchange recorded a peak in the market price index. The improvement in the market attracted a substantial portion of Sri Lanka's financial assets to the stock market. The introduction of unit trusts and primary share issues by many publicly-listed companies considerably increased the attraction of Sri Lanka's financial markets. The relative scarcity of skilled staff and the immediate need for more labour inputs were the initial causal factors in a noticeable rise in the personnel costs of Sri Lanka's banking industry. The relatively high interest rate also impacted on the banks' efficiency during this period.

During the second phase, Sri Lankan banks recorded gains in efficiency. The introduction of new electronic trading systems in the government bond market and strengthening of the CBSL's supervisory and monitoring roles were observed in this period. The introduction of Sri Lanka's Inter Bank Offer Rate (SLIBOR), the removal of restrictions on foreign individuals trading and investing on the Colombo Stock Exchange (CSE), the relaxation of limits on foreign shareholdings and ownership of Sri Lankan commercial banks and the introduction of Sri Lanka's floating exchange rate also took place during this

period. Banks were also forced to become more competitive to counter pressure from other forms of financial service providers such as leasing companies, development banks and insurance firms.

Due to the growing threats of terrorism, the Sri Lankan government increased its defence expenditure in 2000 which resulted in a considerable budget deficit. It escalated the government fiscal operation in the financial system. The government relied on domestic borrowings to finance the fiscal deficit. First, the use of domestic debt for financing the deficit created a risk-less demand for the local commercial banks funds. On the other hand, the government introduced a tax on debit transactions on all deposit accounts in banks as of 2002 discouraging the deposit withdrawal. These actions had an impact on the estimated efficiency scores (especially to the estimated efficiency scores for the window period 2000-2002) of the Sri Lankan banking system.

Further to that, administrative changes such as the withdrawal of the lower limits on statutory reserve requirements (SRR); the increase in the risk-weighted capital adequacy ratio (by 10%); the introduction of daily determination of SRR on commercial banks' deposits; the removal of stamp-duty and the national-security-levy from financial transactions; the reduction of the repurchase rate and reverse repurchase rate; and the introduction of single borrower limits were introduced during the same period. These regulatory changes might have positive influences on the evident performance of the banks.

Figures 4, 5 and 6 depict mid-year estimated average efficiency scores in three-year windows. These figures illustrate differences in efficiency of the different forms of banks.

The estimated average efficiency scores based on mid-year results in each domain are better indications of the banks' efficiency. These figures identify a similar trend in efficiency improvements to those represented in figures five, six and seven. We used scale of operation as the main focal point in identifying efficiency trends. To facilitate that, we group banks in Sri Lanka into three clusters as large (three banks), medium (three banks) and small (three banks). All graphs representing different types of Sri Lankan banks have recorded a declining trend in efficiency during the first half of the study period (1989-1996). However, during the second half of the sample period and an upward trend in the second half.

All banks. The estimated overall means of the TE, PTE and SE scores are 83.20%, 86.81% and 86.32% respectively. This average efficiency scores signalled that both managerial and scale operation have equally contributed to the overall efficiency of commercial banks in Sri Lanka. Technical efficiency indicates the management's ability to getting maximum output level.

As indicated in the figure eight, the sharp drop in technical efficiency in the period of 2002-2004 is mainly sourced by the non-optimal scale of operation. The drop in technical efficiency from 1997-2004 may be due to the combined effect of the entry of new banks; the investment on adaptation of technology; and competition with new entrants for the market share in unit-trusts, leasing firms and other specialised financial services. Furthermore, developments in capital markets, especially in the CSE may have affected the financial-services industry in Sri Lanka.

Figure 5 reproduces the estimated efficiency scores for large banks. We included Bank of Ceylon, People's Bank and Hatton National Bank into the large bank cluster. Fairly, a higher level of technical efficiency has been maintained by the large banks. However, the managerial inefficiency has been caused the recorded inefficiency of these banks. The scale of operation did not have a big effect on the reported efficiency.

As indicated in the table 5 and figure 6, medium banks have recorded the lowest level of efficiency. Medium bank cluster included Commercial Bank, Seylan Bank and Sampath bank. The main reason for the recorded lower efficiency is the scale of operation. These banks were able to achieve relatively higher level of managerial efficiency (PTE). The overall trend in the recorded efficiency scores in different size of banks is much similar. It is indicating that the banks were affected by the other macroeconomic factors. Figure seven presents the relative efficiency of small banks. Those banks enjoyed highest level of efficiency. However, this bank cluster comprises with fairly new banks. Because of that, it is difficult to conclude that small banks were having greater efficiency than the large bank.

Table 5. Descriptive statistics of estimated efficiency for 1989-2008 (Three-year windows)

Year	Technical efficiency (TE)				Pure technical efficiency (PTE)				Scale efficiency (SE)			
	Big	Medium	Small	All	Big	Medium	Small	All	Big	Medium	Small	All
1990	0.975 (0.019)	0.918 (0.071)		0.946 (0.056)	0.995 (0.006)	0.960 (0.048)		0.977 (0.035)	0.980 (0.014)	0.957 (0.049)		0.968 (0.037)
1991	0.970 (0.023)	0.937 (0.042)		0.953 (0.035)	0.989 (0.016)	0.951 (0.039)		0.970 (0.007)	0.980 (0.009)	0.985 (0.006)		0.982 (0.181)
1992	0.960 (0.023)	0.938 (0.032)		0.949 (0.028)	0.995 (0.009)	0.953 (0.045)		0.974 (0.024)	0.965 (0.030)	0.985 (0.015)		0.975 (0.206)
1993	0.951 (0.015)	0.944 (0.050)		0.948 (0.033)	0.978 (0.035)	0.963 (0.033)		0.970 (0.018)	0.973 (0.020)	0.981 (0.019)		0.977 (0.084)
1994	0.977 (0.034)	0.974 (0.029)	1.000 (0.000)	0.982 (0.026)	0.980 (0.035)	0.975 (0.028)	1.000 (0.572)	0.983 (0.002)	0.998 (0.004)	0.999 (0.000)	1.000 (0.000)	0.999 (0.256)
1995	0.971 (0.046)	0.907 (0.082)	1.000 (0.000)	0.954 (0.065)	0.977 (0.039)	0.955 (0.067)	1.000 (0.565)	0.975 (0.035)	0.994 (0.008)	0.949 (0.045)	1.000 (0.000)	0.979 (0.203)
1996	0.967 (0.043)	0.899 (0.086)	0.965 (0.049)	0.941 (0.065)	0.982 (0.031)	0.956 (0.068)	0.965 (0.522)	0.968 (0.043)	0.985 (0.015)	0.942 (0.062)	1.000 (0.000)	0.973 (0.145)
1997	0.961 (0.048)	0.881 (0.070)	0.902 (0.089)	0.916 (0.068)	0.978 (0.035)	0.944 (0.049)	0.958 (0.474)	0.960 (0.037)	0.983 (0.016)	0.933 (0.027)	0.937 (0.056)	0.952 (0.109)
1998	0.820 (0.083)	0.788 (0.050)	0.917 (0.073)	0.841 (0.084)	0.866 (0.074)	0.919 (0.064)	0.968 (0.467)	0.918 (0.060)	0.952 (0.061)	0.857 (0.005)	0.942 (0.051)	0.917 (0.501)
1999	0.844 (0.103)	0.781 (0.042)	0.933 (0.051)	0.852 (0.090)	0.887 (0.093)	0.894 (0.083)	0.980 (0.488)	0.920 (0.058)	0.956 (0.068)	0.876 (0.036)	0.951 (0.038)	0.928 (0.241)
2000	0.872 (0.111)	0.795 (0.022)	0.920 (0.027)	0.862 (0.080)	0.903 (0.085)	0.896 (0.075)	0.939 (0.500)	0.913 (0.051)	0.966 (0.031)	0.891 (0.049)	0.978 (0.021)	0.945 (0.176)
2001	0.928 (0.046)	0.845 (0.017)	0.936 (0.015)	0.903 (0.051)	0.972 (0.031)	0.941 (0.057)	0.951 (0.523)	0.955 (0.043)	0.955 (0.017)	0.901 (0.042)	0.983 (0.009)	0.946 (0.109)
2002	0.948 (0.067)	0.854 (0.020)	0.950 (0.013)	0.917 (0.059)	0.978 (0.029)	0.951 (0.035)	0.985 (0.532)	0.971 (0.043)	0.969 (0.040)	0.898 (0.021)	0.965 (0.025)	0.944 (0.142)
2003	0.856 (0.145)	0.752 (0.078)	0.968 (0.029)	0.859 (0.125)	0.974 (0.045)	0.959 (0.041)	0.979 (0.514)	0.971 (0.112)	0.875 (0.118)	0.783 (0.047)	0.990 (0.043)	0.883 (0.146)
2004	0.958 (0.065)	0.892 (0.025)	0.981 (0.014)	0.944 (0.053)	0.991 (0.016)	0.969 (0.027)	0.990 (0.547)	0.983 (0.045)	0.966 (0.050)	0.921 (0.040)	0.991 (0.011)	0.959 (0.127)
2005	0.964 (0.059)	0.923 (0.036)	0.973 (0.024)	0.954 (0.043)	0.984 (0.024)	0.965 (0.022)	0.987 (0.543)	0.979 (0.028)	0.978 (0.037)	0.957 (0.031)	0.986 (0.013)	0.974 (0.115)
2006	0.977 (0.040)	0.950 (0.048)	0.965 (0.035)	0.964 (0.038)	0.997 (0.005)	0.976 (0.029)	0.974 (0.537)	0.983 (0.023)	0.980 (0.035)	0.972 (0.024)	0.991 (0.010)	0.981 (0.107)
2007	0.995 (0.008)	0.968 (0.051)	0.969 (0.034)	0.977 (0.034)	0.997 (0.005)	0.979 (0.033)	0.982 (0.542)	0.986 (0.013)	0.998 (0.003)	0.988 (0.019)	0.986 (0.013)	0.991 (0.078)
Average scores are estimated based on the middle year of the three year window period; Standard deviations are given in parenthesis. Reported based on relative size												

Figure 4. Average efficiency of banks in Sri Lanka

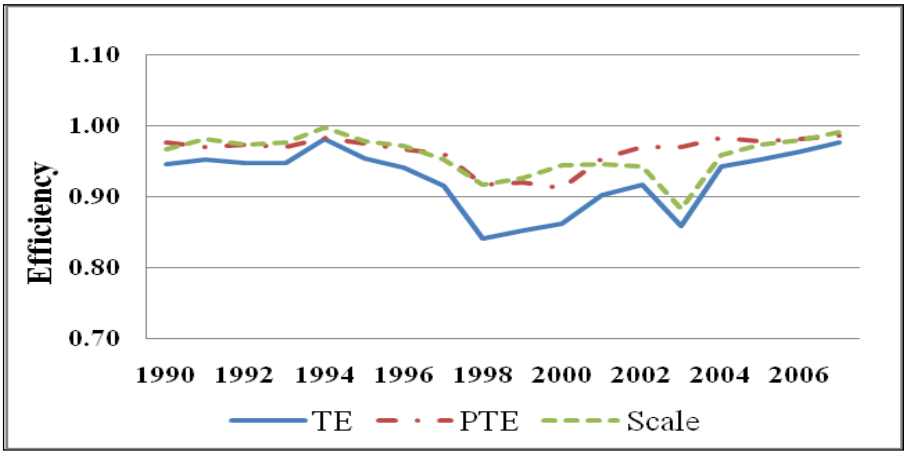


Figure 5. Average efficiency of large banks in Sri Lanka

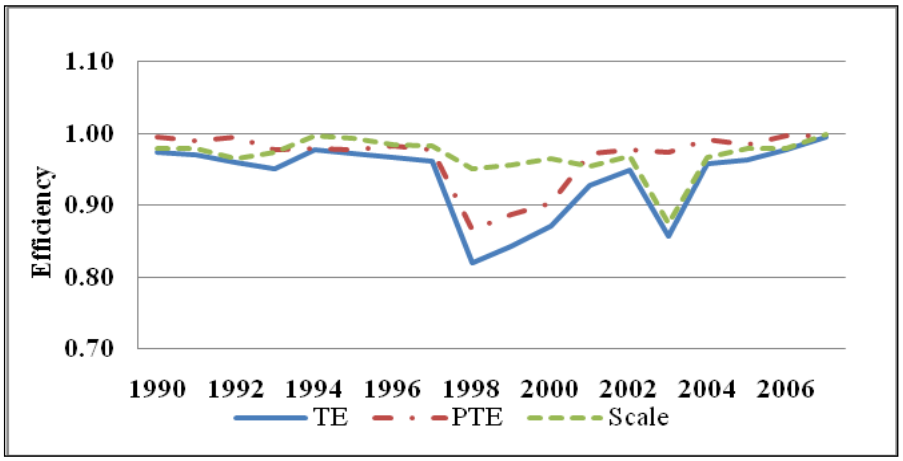


Figure 6. Average efficiency of medium size banks in Sri Lanka

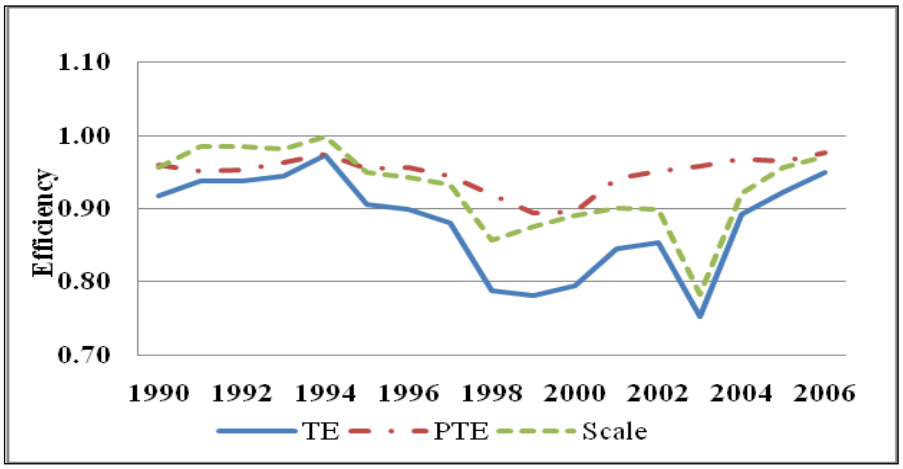
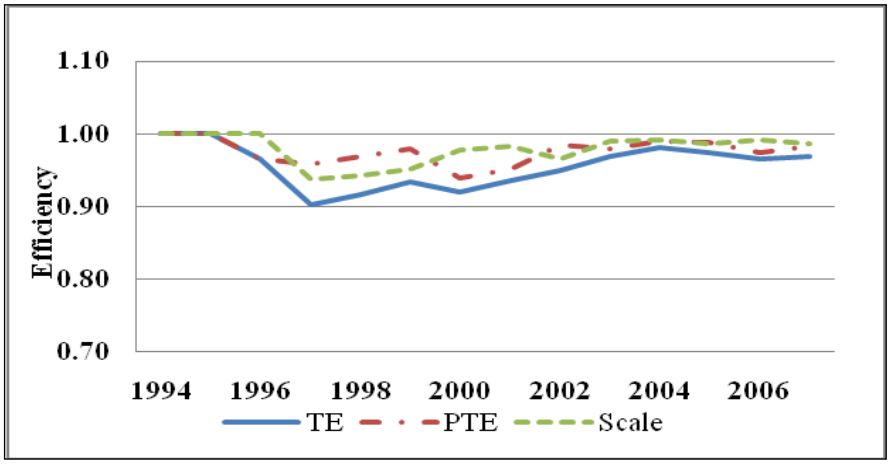


Figure 7. Efficiency of small size banks in Sri Lanka



During the first phase, the regulations that controlled entry barriers were relaxed through the introduction of the Banking Act 1988 along with the establishment of the Credit Information Bureau (CIB) and the repurchase market for government securities was opened. The Act also amended the regulatory and supervisory role of the Central Bank of Sri Lanka. This followed the adoption of Article VIII of IMF which facilitated the removal of restrictions on international financial transactions (Seelanatha & Wickremasinghe, 2009).

Table 6. Mann-Whitney test scores

Type of banks	Test	TE	PTE	Scale
Small banks and others	Mann-Whitney U	1,462.50	1,785.50	1,478.00
	Wilcoxon W	7,348.50	7,671.50	7,364.00
	Z	[-2.63**]	[-1.20]	[-2.56**]
Large banks and others	Mann-Whitney U	1,932.00	1,984.00	1,973.00
	Wilcoxon W	6,210.00	6,262.00	6,251.00
	Z	[-2.24**]	[-2.06**]	[-2.07**]
Medium banks and others	Mann-Whitney U	1,342.50	1,717.50	1,399.00
	Wilcoxon W	2,827.50	3,202.50	2,884.00
	Z	[-4.64**]	[-3.15**]	[-4.41**]
'Z' scores are given in parenthesis. '**' indicates that test scores are significant at 5% level				

Table 6 provided the estimated nonparametric statistics which were used to examine the differences in the mean value of two unrelated samples. We examined the differences of recorded efficiency scores in each class of banks with otheSLR. The non-parametric result suggests that estimated technical efficiency scores and scale efficiency scores are significantly different from the other banks. However, there is no significant difference in managerial efficiency (PTE) in large banks with other forms of banks.

5 Conclusion

This study has used DEA input-oriented models to measure efficiency of Sri Lankan banking sector during the last 20 year period. The DEA results show high levels of mean efficiency scores in banks with low standard deviations, indicating Sri Lankan banking industry is relatively efficient. However, this does not necessarily imply that banks in Sri Lanka are equally efficient or inefficient when compared with the banks in the other countries.

Furthermore, the study revealed that inefficient management decisions are the main cause for the inefficiency of Sri Lankan banks. Particularly, the management issue more severely affects medium size banks. However, relatively small, new commercial banks are able to perform better than the old banks. This finding suggests that the size of operation is not adversely affected to banks in Sri Lanka.

This study measured the efficiency of the banks based on existing mix of products and technologies. Efficiency changes from frontier shifts from one year to the next year are beyond the scope of this study. Thus, it is not focused on technical efficiency changes resulting from catching-up of efficient firms in the industry by the inefficient firms and the impact of changes in existing technology. Therefore, further research on efficiency improvement from frontier shift is suggested. Another area of possible future research is to investigate the influences of macro and micro economic factors on efficiency of banks.

As an alternative approach for evaluating the performance of Sri Lankan banks relative to the best practice frontier in the banking industry in the region, a DEA model could be developed with the banks in other countries in the sub-continent which have similar economic and regulatory environment. In such a study, banks should be selected with caution by considering inherent features such as size, ownership and line of business. However, at this stage it is difficult to collect such a full data set due to issues related to disclosures of financial information.

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Appendix 1

Input variables used in previous banking productivity studies

Type	Input
Bank specific	Branch size, Computer terminals, Number of banks, Number of computers Office space, Teller hours
Borrowed funds	Borrowed money , Purchased funds
Capital	Capital, Equity, Financial capital, Net profits
Deposits	Call deposits, Demand deposits /Deposits, Funds from customers, Retail and wholesale deposits, Savings deposits /Short term deposits, Small denomination time and savings deposits, Time and savings deposits
Non interest expenses	Operating expenses, Depreciation cost, Establishment expenses, General and administrative, Non-interest expenses Non-establishment expenses, Non-personnel expenses, Other expenses, Total cost
Interest Expenses	Interest expenditure, Interest spread
Fixed Assets	Fixed assets /Net fixed assets, Net physical capital, Net worth, Physical capital
Labour	Clerical staff, Labour (average salary), Labour (number / hours), Managerial personnel/No. of staff, Number of tellers, Personnel cost
Problem Loan	Credit loss cost, Loan loss provisions, Problem loans
Others	Banking funds/ Net funds from other banks, Economic status of the area, Income from non-banking sources Investments, Loanable funds, Market size, Environmental variables

Source: Seelanatha (2007, p64)

Appendix 2

Output variables used in previous banking productivity studies

Type	Output Variables
Bank specific	Number of business accounts/branches/ employees /service hours, Service variety Interest spread, Transaction volume
Capital	Net worth
Deposits	Total deposits (value/number), New accounts (time savings, certificates of deposits), Core deposits/ Customer deposits, Deposits withdrawals, Commercial accounts, Current accounts(value/ number), Deposit not at call, Time and saving deposits, Transaction deposits,
Investment	Earning assets, Investment/Investment securities/ Bonds/other, Liquid assets Other productive assets, Securities
Loan and Advances	Loans and advances/Net loan, Number of loans, Long-term loan/ Short-term loan, Commercial and industry loans, Personal loan/ Housing loans, Real estate loans/Non-housing loans/Interbank loans/Loans to other banks/Small loans/Other loans , No. credit applications
Non-traditional activity	Non-traditional activity, Risk adjusted off-balance sheet activities, Risk-weighted assets, Travellers' cheques
Revenue	Income(banking and non-banking), Interest income (gross/net/average), Non-interest income (gross/net), Operating income/Other earnings ,Revenues/net profits Net commission income/Fee-based income/Foreign currency income/Investment income/Real estates income
Other	Annual average increase in total assets, Bills discounted, Borrowing, Interbank assets/ liabilities

Source: Seelanatha (Seelanatha, 2007)