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## Bank ownership and efficiency in post-conflict era of Sri Lanka: evidence from aggregate efficiency technique

### Abstract

Deviating from conventional methods in comparing the group performance of banks this study extends the established literature to compare efficiency between foreign and domestic banks, by employing comprehensive weighted aggregate efficiency measures derived through bootstrap simulations for the banking sector for the post - conflict era of Sri Lanka. The study also compares the banking sector performance between initial and later parts of the post - conflict period, using weighted aggregate efficiency measures. At the end of the armed conflict between LTTE 1 and Sri Lankan government forces the banking sector experienced considerable expansion in terms of banking density and services volume, concurrent with overall economic expansion. This study concludes that there was no significant difference in the efficiency levels between domestic and foreign banks operating in Sri Lanka in the post conflict era. Further, it reveals that banking sector efficiency during the period 2010 - 2013 outperformed efficiency during the period 2008 - 2009. The major findings from this study are of importance to policy makers, as they enable evaluation of banking efficiency dynamics when the banking sector records higher expansion during a period of rapid economic growth.

### Keywords

ownership, bank, evidence, lanka, sri, era, conflict, technique, post, aggregate, efficiency

### Disciplines

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## **Bank Ownership and Efficiency in Post-conflict Era of Sri Lanka: Evidence from Aggregate Efficiency Technique**

Bolanda Hewa Thilakaweera<sup>a\*</sup>, Charles Harvie<sup>b</sup> and Amir Arjomandi<sup>c</sup>

*Deviating from conventional methods in comparing the group performance of banks this study extends the established literature to compare efficiency between foreign and domestic banks, by employing comprehensive weighted aggregate efficiency measures derived through bootstrap simulations for the banking sector for the post-conflict era of Sri Lanka. The study also compares the banking sector performance between initial and later parts of the post-conflict period, using weighted aggregate efficiency measures. At the end of the armed conflict between LTTE1 and Sri Lankan government forces the banking sector experienced considerable expansion in terms of banking density and services volume, concurrent with overall economic expansion. This study concludes that there was no significant difference in the efficiency levels between domestic and foreign banks operating in Sri Lanka in the post conflict era. Further, it reveals that banking sector efficiency during the period 2010-2013 outperformed efficiency during the period 2008-2009. The major findings from this study are of importance to policy makers, as they enable evaluation of banking efficiency dynamics when the banking sector records higher expansion during a period of rapid economic growth.*

**JEL Codes:** G21, D24 and D22

**Keywords:** Data Envelopment analysis, Bank Ownership, Intermediation Approach, Bootstrap, Sri Lanka, Aggregate Efficiency

### **1. Introduction**

As in other developing countries the commercial banking sector in Sri Lanka is the dominant player in financial intermediation services. The commercial banking sector in the country comprises domestic banks and foreign banks, a situation which existed even before the country achieved independence in 1948. Currently there are 12 foreign commercial banks and 12 domestic commercial banks<sup>2</sup> operating in the country. Ownership structure of the commercial banking sector was influenced by the major economic reforms introduced in 1977, particularly in the financial sector, aimed at improving private and foreign participation in banking. Although the domestic private and foreign banks continued to grow moderately with an array of reforms in the financial sector after 1977, the negative impact of the fragile economic and security conditions due to an armed-conflict between government troops and the LTTE, which began in the early 1980s, limited high growth potential.

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Once the quarter century long bloody civil-conflict in Sri Lanka ended in mid-2009<sup>3</sup> the banking sector showed significant growth in terms of branch networks, assets and liabilities, against a background of unprecedented economic growth achieved as a dividend from the establishment of long-lasting peace in the country<sup>4</sup>. Necessary ingredients for banking institutions to expand their services was provided by the growth momentum in the Sri Lankan economy, due to improvements in investor sentiments, public investments in infrastructure, expansion in agricultural land<sup>5</sup>, domestic trade and services with the revival of livelihood activities in war affected areas as a peaceful environment prevailed in the post-conflict period (CBSL 2011,2012). Most domestic banks exploited these opportunities in order to expand their operations. Some foreign banks also expanded their operations albeit at a lower rate than that of domestic banks. Although an expansion in the banking sector is observable during the post-conflict era, inequality in efficiency levels across the banks could limit the contribution of financial intermediation to the economy. Literature in banking efficiency has mostly highlighted ownership type as an underpinning factor for inequality in banking efficiency (Bhattacharyya *et al.*1997, Buch 2003, Zajc 2006, Das & Ghosh 2006, Zhao *et al.* 2010, Burki & Niazi 2010, Burki & Ahmad 2010, Wanniarachchige & Uddin 2011, Bhattacharyya & Pal 2013, Thilakaweera *et al.* 2014). It is vital, therefore, to investigate differences in banking efficiency across ownership categories not only to facilitate Sri Lankan policymakers formulating effective and necessary policies to improve the economic contribution of the banking sector, but also to address lacuna in the literature on the evaluating banking efficiency in post-conflict eras. Among the literature on ownership structures and banking efficiency too little attention has been paid to differences in banking efficiency when an economy experiences a post-conflict favourable economic shock (Altunbas *et al.* 2001, Demir *et al.* 2005, Fries & Taci 2005, Das & Gosh 2006, Berger 2007, Burki & Niazi 2010, Ray & Das 2010). Therefore, a major contribution of this study is to better understand the efficiency-ownership nexus when an economy moves into a higher growth path in a post-conflict era.

In comparing technical efficiency between domestic banks and foreign banks in Sri Lanka during the post-conflict era, data envelopment analysis (DEA), a widely accepted non-parametric method in efficiency analysis, is used in this study (Sharmen and Gold 1985, Grabowski *et al.* 1993, Casu & Molyneux 2003, Kenjegalieva *et al.* 2009, Burki & Niazi 2010, Andries 2011). In addition to the commonly used average technical efficiency scores in comparing efficiency between groups, this study also employs theoretically sound weighted aggregate efficiency scores using bootstrapping simulation introduced by Simar and Zelenyuk(2007a) to compare efficiency levels between different ownership categories of banks in Sri Lanka. Unlike equally weighted average efficiency scores, a more representative measure of the technical efficiency of a subgroup is provided by the aggregate efficiency score which is based on weights proportional to the contribution to output. Although DEA does not require a presumed functional form between inputs and output, which is prone to errors particularly with small samples of firms, DEA efficiency scores based on small samples have also been criticised in the recent literature due to biasedness generated from non-measurement of random errors and the existence of sampling errors (Simar & Wilson 1998, 2000, Keramidou & Mimis 2011). The bootstrapping simulation technique is identified as a remedial measure to alleviate the biasedness in technical efficiency scores derived from DEA (Simar & Wilson 1998, 2000, Keramidou & Mimis 2011). Therefore, this is among the first studies to apply aggregation of efficiency to compare the performances of sub-groups of banks and the first to apply this to banks in Sri Lanka and a developing country in general.

The reminder of the paper is structured as follows. Section 2 briefly reviews the literature on banking efficiency and ownership while Section 3 presents an overview of the banking sector in Sri Lanka. A theoretical explanation of efficiency along with the methodological framework adopted for the empirical analysis in this study is provided in section 4. Specification of input, output and data is explored in section 5. The empirical analysis and findings are presented in section 6, followed by concluding remarks along with policy recommendations for improving efficiency in the Sri Lankan banking sector in section 7.

## **2. Literature review**

An unprecedented growth in banking efficiency studies occurred subsequent to the introduction of using frontier methods in evaluating bank efficiency by Sharmen and Gold (1985). Although researchers of banking efficiency initially focused on developed countries, the US and European banking sectors in particular, a number of studies focusing on developing countries increased later with improvement in data availability and financial reforms in those countries (Berger & Humphrey 1991, Berger *et al.* 1993, De Guevara & Maudos 2002, Hasan & Marton 2003, Drake *et al.* 2006, Das & Ghosh 2006, Sufian 2009, Sahoo & Tone 2009, Barros *et al.* 2011, Arjomandi *et al.* 2012, Seelanatha 2012). Ownership structure of the banking sector in most countries was impacted by these reforms, which encouraged foreign participation by allowing them to compete freely with domestic banks. On the other hand financial sector reforms throughout the world, and ever increasing financial flows with international trade and improvement in FDI (Foreign Direct Investment) flows, provided the necessary ingredients for expansion in the banking sector across territorial borders. Advancements in information technology (IT) also made it easier to monitor the branch operations of foreign banks (Berger & DeYoung 2006, Havrylchyk 2006, Berger 2007, Lensink *et al.* 2008). The diversified market structure in the banking sector following these developments paved the way for researchers to compare bank efficiency based upon type of ownership.

Although most studies focusing on this topic have highlighted differences in efficiency between domestic and foreign banks, they have not provided concrete evidence about the existence of a superior ownership category. Some banking efficiency studies, single country and cross country, conclude, however, that foreign banks outperform domestic banks, and many arguments have been established to justify their findings based on theoretical and empirical concepts (Isik & Hassan 2002, Hasan & Marton 2003, Isik & Hassan 2003, Weill 2003, Bos & Kolari 2005, Fries & Taci 2005, Berger *et al.* 2005, Grigorian & Manole 2006, Havrylchyk 2006, Staikouras *et al.* 2008, Burki & Niazi 2010, Huang *et al.* 2011, Banerjee 2012, Bokpin 2013). These studies attribute the higher efficiency of foreign banks to their superior skills, better policies and practices, risk management, advanced technology, lower cost of funds from the parent bank and the merging and acquisition of local banks by foreign banks. However, some studies argue that higher foreign bank efficiency could be maintained in countries with developed institutional and regulatory frameworks (Berger & De Young 2001, Ataullah & Le 2006, Berger 2007, Lensink *et al.* 2008) and they identified the institutional and regulatory framework of the host country<sup>6</sup> as a crucial contributory factor to the efficiency of foreign banks.

Studies finding superior efficiency in domestic banks compared to that of foreign banks in developing countries, also cite a poor institutional and regulatory framework as a factor for lower efficiency in foreign banks (Berger 2007, Lensink *et al.* 2008, Hadad *et al.* 2011). In addition, the so-called home field advantage hypothesis highlights a lack of knowledge about local market and socio-economic conditions of host countries, informational asymmetries and difficulties in establishing networks as factors influencing the higher cost and lower level of efficiency of foreign banks (Bhattacharyya *et al.* 1997, Buch 2003, Zajc 2006, Das & Ghosh 2006, Bhattacharyya & Pal 2013). Further, geographical distance between the host country and the home country of the foreign bank is also identified in the literature as a negative factor on the efficiency of foreign banks due to higher informational and agency costs (Mian 2006). As against this view some studies have argued that the impact of this negative factor is off-set by efficiency gains, as parent banks can use their superior skills, policies and practices to improve the efficiency of branches away from headquarters (Berger & De Young 2001, Berger 2007, Berger & De Young 2006). When banks are expanding their operations across territorial borders, in general they carefully weigh-up the entire positive and negative factors which could influence their performance.

Banking efficiency studies focused on the South Asian region have also provided mixed results on the efficiency of foreign banks compared to that of domestic banks, and some studies have highlighted key factors behind these differences in efficiency (Bhattacharyya *et al.* 1997, Das & Ghosh 2006, Zhao *et al.* 2010, Burki & Niazi 2010, Burki & Ahmad 2010, Wanniarachchige & Uddin 2011, Bhattacharyya & Pal 2013, Thilakaweera *et al.* 2014). In the context of the Sri Lankan banking sector, two recent studies, Thilakaweera *et al.* (2014) and Wanniarachchige and Uddin (2011), find superior performances of foreign banks operating in Sri Lanka. Since previous studies have mostly used average efficiency scores, or regression models, in comparing banking efficiency between domestic and foreign banks in the absence of a representative point estimate, this study compares banking efficiency across ownership type based upon aggregate efficiency using a more logical and representative point estimator. In addition, it is the first study to evaluate changes in banking efficiency between different ownership categories in a post-conflict period of economic expansion.

### **3. Banking Sector in Sri Lanka**

With the regaining of the country's independence in 1948 the banking sector primarily catered to the plantation industry<sup>7</sup> developed by the British rulers who occupied the entire Island from 1815. There were 9 foreign banks and 2 domestic banks<sup>8</sup> operating in Sri Lanka, while a few finance companies and savings institutions were in operation and mostly based in the capital of Colombo. The banking sector was dominated by foreign banks whose services were limited to Colombo and other major cities, that had strong links to the plantation industry.

Banking sector expansion in the post-independence period was initiated by the establishment of the Central Bank of Sri Lanka<sup>9</sup> (CBSL) in 1950, which replaced the previous currency board system. Banking penetration increased gradually with the establishment of two state-owned commercial banks in 1959 and 1961, along with the establishment of some state-owned savings banks. The services provided by private and foreign banks further expanded after 1977<sup>10</sup> with improvement in foreign and

private sector participation in the banking industry, due to the adoption of financial sector liberalization policies (CBSL 1998). After an array of reforms<sup>11</sup> were introduced to the banking sector and the economy as whole, the Banking Act 1988 empowered the CBSL with more regulations and controls over the banking sector. Subsequent to the amendments in the Banking Act in 1988 the CBSL continued to issue directions to the banking sector on different aspects such as broad disclosure requirements, single borrower limits, statutory reserve requirements (SRR), a risk-weighted capital-adequacy ratio (CAR), limits on foreign ownership, improvements to corporate governance, branch expansion and other banking operations to ensure the smooth and efficient functioning of the banking sector<sup>12</sup>. With all these reforms the total assets owned by private and foreign commercial banks surpassed total assets owned by state-owned commercial banks in 2002, while significantly changing the structure of ownership in the banking sector (Hemachandra 2009).

Despite a series of reforms, growth in the banking sector in terms of services, coverage and transaction volume was below their potential level due to deterioration of the overall economic environment with the eruption of an armed struggle between LTTE rebels and government forces in 1983. The economy subsequently moved onto a higher growth path with an improved business climate<sup>13</sup> after the ending of the 26 year long armed conflict in 2009, and the banking sector also expanded in terms of service volumes and branch networks with these peace dividends. Private and state-owned banks were the major beneficiaries of pent-up demand for banking services with the revival of economic activities in the conflict-affected areas through an expansion of their branch networks while foreign banks also showed a limited expansion in those areas.

**Table 1: Assets and deposit structure of Sri Lankan financial institutions at end 2013**

<b>Institutions</b>	<b>Assets (%)</b>	<b>Deposits (%)</b>
Central Bank of Sri Lanka	12.1	n.a
Financial Institutions Regulated by the Central Bank:		
Deposit Taking Institutions		
Licensed Commercial Banks	48.7	77.7
Licensed Specialized Banks	8.9	13.5
Licensed Finance Companies	6.3	7.4
Other Financial Institutions		
Primary Dealers	2.1	n.a.
Specialized Leasing companies	0.6	n.a.
Institutions not Regulated by the Central Bank(a)	21.3	1.4
All	100	100

Source: Central Bank of Sri Lanka

(a) Institutions not regulated by the Central Bank of Sri Lanka include Rural Banks, Thrift and Credit Co-operative Societies, Employees' Provident Funds, Insurance Companies, Stock Broking Companies, Unit Trusts/ Unit Trust Management Companies, Market Intermediaries such as Underwriters, Margin Providers, Investment Managers, Credit Rating Agencies and Venture Capital Companies.

n.a – not applicable

There are 24 licensed commercial banks (LCB), 9 licenced specialized banks (LSB) and 47 registered finance companies operating in the country<sup>14</sup> today (CBSL 2012). The commercial banks are the dominant players in the financial sector controlling and possessing more than 67% of banking sector assets and 48.7 percent of the total financial sector assets of the country (see Table 1). As depicted in Table 2, one foreign commercial bank and one domestic commercial bank entered in to the banking industry during the period from 2008 to 2013. The total number of commercial bank branches and outlets of the domestic commercial banks increased by 20% from 2071 to 2582 with the high economic growth and geographical expansion in branch networks during this period.

**Table 2: Expansion in the branch network of commercial banks**

Category	2008	2013
Number of Licensed Commercial Banks (LCBs)	22	24
Domestic banks	11	12
Foreign banks	11	12
Number of LCB Branches and Other Outlets	2214	2803
Domestic Bank Branches	2000	2582
Foreign Bank Branches	214	221
Student Savings Units and Other Outlets	2788	2864
Automated Teller Machines	1757	2358

Source: Central Bank of Sri Lanka

As well as the expansion in services, coverage and transaction volume, the higher efficiency of the banking sector stimulated the economy by minimising the cost of funds and improving investments (Lucchetti *et al.* 2001, Koetter & Wedow 2010). Hence, the existence of low efficiency levels in some banking institutions could be a barrier to achieving the optimum level of economic growth for the country. Since the literature has highlighted the possibility of inequalities in banking efficiency between different types of ownership categories, the findings of this study are useful for policy makers in order to compare efficiency between foreign and domestic banks in Sri Lanka and in the formulation of effective financial policies. The sustainability of high economic growth achieved during the 2008–2013 period in the aftermath of the armed-conflict, will be dependent on the implementation of these policy recommendations.

## 4. Methodology

The parametric stochastic frontier analysis (SFA) and non-parametric DEA are the two most commonly adopted methods in estimating banking sector technical efficiency. Both methods estimate the efficiency of a firm (bank) against an estimated efficient frontier. SFA derives efficiency by disentangling an inefficiency term from a composite error term. Then the purely random error is assumed to be due to the impact of factors beyond the control of the production process. In contrast DEA estimates efficiency based on deviations of firms from an estimated frontier assuming that random errors average out to zero over time. Since SFA and DEA have their own weaknesses and strengths, the researcher's choice<sup>15</sup> of using one method over the other for measuring efficiency is mainly dependent on many aspects such as characteristics of the data set, the industry, the research question and sample size.

This study employs DEA for the empirical analysis for three main reasons. First, DEA does not necessitate a specific functional form to be followed by the data<sup>16</sup>. This avoids the risk of contaminating efficiency measures due to misspecification of the functional form of bank production. In general, the production processes of the services sector, particularly banking services, are more complex than the production sector and it is challenging to accurately specify the functional form. Second, DEA works well with small samples relative to SFA. Unlike SFA, which needs a relatively large sample to estimate a substantial number of parameters, more consistent coefficients can be derived from DEA based on a small sample due to estimation of a lower number of parameters (Coelli *et al.* 2005, Wilson 2006, Murillo-Zamorano 2004, Sathye 2001, Seiford and Thrall 1990). The first DEA, introduced by Charnes *et al.* (1978), is based on the assumption of constant returns to scale (CRS) and it assumes that firms are operating at optimal scale. However, financial sector institutions, particularly banks, are not operating at optimum scale most of the time due to imperfect competition, regulations, and limitations. Therefore, DEA under the variable returns to scale (VRS) assumption, as introduced by Afriat (1972), Fare *et al.* (1983) and Banker *et al.* (1984) is used in this study. The output-orientation approach, which measures the technical efficiency of firms by evaluating maximum possible output from given inputs, is also used in this study which assumes that banks are trying to maximise the output of intermediation services from given inputs.

In compiling technical efficiency based on the above approaches, DEA uses a set of mathematical formulations incorporating a number of assumptions on the production process to mimic the technology set, using data gathered from firms (banks) in the real-world. It is assumed that all firms (banks) have access to the same technology and that this technology set  $T$  satisfies regulatory axioms<sup>17</sup>. Although this assumption is required to establish one efficiency frontier for all firms (banks), some firms (banks) could deviate from the technological frontier due to endogenous reasons such as management strategies or principal-agent problems linked with ownership type and exogenous factors<sup>18</sup> such as the regulatory environment, macroeconomic environment, business environment and random shocks (Sickles & Zelenyuk 2014). Among these factors, many studies have highlighted the influence of ownership type on bank efficiency and explore changes in banking efficiency across different ownership types (Bhattacharyya *et al.* 1997, Isik & Hassan 2002, Weill 2003, Berger *et al.* 2005, Fries & Taci 2005, Das & Ghosh 2006, Zhao *et al.* 2010, Burki & Niazi 2010, Burki & Ahmad 2010, Huang *et al.* 2011, Banerjee 2012, Bokpin 2013). In evaluating differences in technical efficiency between sub-groups of banks based on ownership, this study employs weighted aggregate efficiency as introduced by Simar & Zelenyuk (2007).

The methodology of comparing sub-groups using aggregate efficiency can be explained in the context of the banking industry by considering a sample of  $n$  banks. For each bank  $k$  ( $k=1, 2 \dots n$ ) an inputs vector  $x^k = (x_1^k, \dots, x_N^k)' \in \mathcal{R}_+^N$  comprised of  $N$  inputs is used for the production of  $M$  outputs, denoted by  $y^k = (y_1^k, \dots, y_M^k)' \in \mathcal{R}_+^M$ . Each  $k$  firm is free to use different technology that can be characterised by the technology set  $T^k$ .

$$T^k = \left\{ (x^k, y^k) : x^k \text{ can produce } y^k \right\}$$

Equivalently, the technology can be characterised by the following output set  $P^k$ .

$$P^k(x^k) \equiv \{y^k : x^k \text{ can produce } y^k\}, x^k \in \mathfrak{R}_+^N.$$

Assuming the regularity axiom of production theory the output oriented Shepherd (1970) distance function can be defined as,

$$D_0^k(x^k, y^k) \equiv \inf\{\theta : y^k/\theta \in p^k(x^k)\} \quad \text{where } D_0^k : \mathfrak{R}_+^N \times \mathfrak{R}_+^M \rightarrow \mathfrak{R}_+^1 \cup \{\infty\}$$

For a complete characterisation of the technology of bank  $k$ ,

$$D_0^k(x^k, y^k) \leq 1 \leftrightarrow y^k \in p^k(x^k).$$

Accordingly technical efficiency<sup>19</sup> based on the Farrell output oriented approach is defined for all outputs  $y^k$  as,

$$TE^k(x^k, y^k) \equiv \max\{\theta : \theta y^k \in p^k(x^k)\} = 1/D_0^k(x^k, y^k).$$

When the bank is fully efficient,  $TE^k = 1$ . If the  $TE^k > 1$  the bank is considered as technically inefficient.

Since output sets are unknown due to the unobserved true technology, DEA is employed to estimate the technical efficiency of individual banks. The DEA estimate of the output set  $p^k(x^k)$  is defined as,

$$\widehat{p^k}(x^k) \equiv \{y : \sum_{k=1}^n z^k y^k \leq y, \quad \sum_{k=1}^n z^k x^k \geq x, \quad \sum_{k=1}^n z^k = 1, \quad z^k \geq 1, \quad k = 1, \dots, n\}$$

where  $z^k$  is an intensity variable.

The output set is estimated based on VRS assuming that banks are not operating at optimal scale due to the exogenous and endogenous factors mentioned above. Accordingly, individual bank efficiency scores based on DEA at a fixed point  $(x^k, y^k)$  can be derived by solving the following linear programming problem.

$$\widehat{TE}_{VRS}^k\{x, y : \widehat{p^k}(x^k)\} \equiv \max_{\theta, z^1, z^2, \dots, z^k} \{y : \theta y \in \widehat{p^k}(x^k)\}$$

Since DEA assumes the nonexistence of random errors,  $\widehat{TE}_{VRS}^k\{x, y : \widehat{p^k}(x^k)\}$  is a downward biased estimator of  $TE_{VRS}^k\{x, y : p^k(x^k)\}$  for the finite sample of banks. Therefore, DEA could rate banks as more efficient than they truly are. Although the bias could be avoided asymptotically with large samples<sup>20</sup>, efficiency studies in banking mostly do not deal with large samples. A bootstrap simulation procedure, however, introduced by Efron (1979) has been employed in later studies to correct this bias. Simar (1992), Simar and Wilson (1998, 2000) and Kneip *et al.* (2003) are among the pioneer studies which have discussed and used this bootstrap simulation technique to minimise possible bias in DEA estimates. The large number of pseudo samples derived from the given data with replacement is used in the bootstrap technique to construct an approximation for the true frontier asymptotically. Then the distribution of the difference between the estimated and true frontier is derived while treating the bootstrap frontier as the true frontier. Consistent individual efficiency scores and confidence intervals can be estimated through these techniques. The procedures and algorithms for generating DEA estimates based on the bootstrap technique are given in Simar and Wilson (1998, 2000).

Although DEA provides efficiency scores for individual banks for each time period, there is no sound estimate to compare the performances between two groups of banks or two time periods. The typical estimate for comparing efficiency between two groups of banks is a simple average which does not incorporate or allow for the varying sizes of the banks<sup>21</sup>. Therefore, this study has employed a point estimate for comparing groups of banks based on the weighted aggregate efficiency concept introduced and explored by Färe & Zelenyuk (2003) and Simar & Zelenyuk (2007). In compiling the aggregate efficiency of a group of banks, weights are assigned for each bank based on their output share. Accordingly, the aggregate technical efficiency of that group could be disaggregated into a weighted average of technical efficiency of all the banks in the group  $l$ .

$$\widehat{TE}^l \equiv \sum_{i=1}^n \widehat{TE}^{l,i} \cdot S^{l,k}$$

where  $S^{l,k} = p\bar{Y}^{l,i} / p \sum_{i=1}^L \bar{Y}^{l,k}$ ,  $l = 1, \dots, L$ .

Similarly, when the population is comprised of non-overlapping groups, technical efficiency could be disaggregated into a weighted average of technical efficiency of all bank groups. This clearly shows that the technical efficiency of a sample of banks derived from a common frontier using linear aggregation could be obtained by the weighted average technical efficiency of different groups, namely domestic and foreign banks in this study. The weights used to compile aggregate efficiency measures are based on the share of total output for each group of banks. Since all these efficiency scores are estimated based on DEA in the absence of a true frontier, this study employed bootstrap simulation techniques to construct confidence intervals and remove possible bias in aggregate efficiency estimates<sup>22</sup> (Simar and Wilson 1998, 2000, Simar & Zelenyuk 2007, Henderson & Zelenyuk 2007).

Although the biased-corrected estimates and confidence interval derived through bootstrap simulation is generally used to compare the two groups of banks, relatively strong conclusions can be derived through a hypothesis test based on point estimates. Therefore, this study employs a point estimate, as presented in Simar & Zelenyuk (2007), to compare efficiency between the two groups. This point estimate ( $RD_{AB}$ ) is based on the ratio between the efficiency of the two groups and the null hypothesis is defined as “equal efficiency” between the two groups. The null hypothesis is rejected when the confidence interval of  $RD_{AB}$  includes “1” (unity). In addition to this estimate, Simar & Zelenyuk (2006) employed the Li (1996) test to compare the efficiency scores of two groups<sup>23</sup>. The Li (1996) test compares the densities of efficiency scores between two groups of firms. Therefore, this study used both tests discussed above to compare the efficiency between foreign and domestic banks in Sri Lanka<sup>24</sup>. To the best of the knowledge of the authors, this is the first time such an approach has been used when comparing banking efficiency across different ownership types.

### ***Specification of inputs and outputs, and data***

Unlike the case of industrial and agricultural output, measuring the production of services, particularly in the banking sector, is a challenge due to the complexity of banking services today. Modern banks jointly produce services and offer prices for a bundle of services such as providing credit facilities and guarantees with professional services for liquidity management. However, the core service of the banking sector has

been identified in the literature as being the provision of financial intermediation services by matching short-term liabilities with long-term assets (Diamond & Dybvig 1983, Diamond & Rajan 2001, Song & Thakor 2007). The ability of banks to produce intermediation services was used by Sealey and Lindley (1977) to introduce the intermediation approach which provides a benchmark to identify the inputs and outputs for DEA. Accordingly, most previous studies have identified the facilities granted by banking institutions, particularly credit, as an output and the resources utilised for the production of banking services, such as labour, fixed assets and funds, as the inputs<sup>25</sup> (Berger *et al.* 1987, Altunbas *et al.* 2001, Maudos *et al.* 2002, Bos & Kolari 2005, Burki & Niazi 2010, Ray & Das 2010, Sufian 2011, Arjomandi *et al.* 2012, Halkos and Tzeremes 2013, Arjomandi *et al.* 2014, Hou *et al.* 2014).

**Table 3: Distribution of assets among the commercial banks in Sri Lanka**

Name of the bank	Ownership Category	Total Assets (US\$ million) as at end 2013	Market share at end 2013 (%)
1. Bank of Ceylon	State-owned	9128.7	23.8
2. People's Bank	State-owned	7117.3	18.5
3. Commercial Bank	Private-Domestic	4643.9	12.1
4. Hatton National Bank	Private-Domestic	3902.9	10.2
5. Sampath Bank	Private-Domestic	2921.9	7.6
6. HSBC	Foreign	2412.4	6.3
7. Seylan Bank	Private-Domestic	1645.6	4.3
8. National Development Bank	Private-Domestic	1539.3	4.0
9. Nations Trust Bank	Private-Domestic	1077.8	2.8
10. Standard Chartered Bank	Foreign	989.9	2.6
11. DFCC Vardhana Bank	Private-Domestic	611.4	1.6
12. Pan Asia Banking Corporation	Private-Domestic	496.5	1.3
13. Indian Bank	Foreign	335.6	0.9
14. Union Bank	Private-Domestic	267.8	0.7
15. State Bank of India	Foreign	105.1	0.3
Other commercial Banks(a)	1 domestic private & 8 foreign banks(a)	1214.1	3.2
All Commercial Banks		38410.3	100.0

Source: Annual financial reports of the respective commercial banks and publications of the Central Bank of Sri Lanka.

(a) One domestic private bank: Amana Bank and eight foreign banks: Deutsche Bank AG.; ICICI Bank; MCB Bank; Public Bank Berhad; Habib Bank; Axis Bank; City bank; Indian Overseas Bank.

This study has also adopted the intermediation approach in identifying the inputs and outputs of the banks analysed. The total number of permanent employees ( $x_1$ ), total value of fixed assets ( $x_2$ ) and cumulative deposits balance ( $x_3$ ) collected are taken as the inputs for the intermediation approach, while output is defined as the cumulative balance of the advances ( $y_1$ ). Due to the unavailability of annual financial flows of the relevant inputs and outputs, cumulative figures (stock of financial flows) are commonly

used as proxies assuming flows are proportional to the stock of the financial value (Berger & Humphrey 1991, Berger & Humphrey 1997). The data used in this study was extracted from the annual reports of the respective banks and publications of the Central Bank of Sri Lanka. The sample consists of 2 state-owned banks, 9 private banks and 4 foreign banks for the period 2008 - 2013. Although the armed conflict completely ended in mid-2009 this study covers the period 2008 – 2013, since the eastern province achieved long lasting peace at the end of 2007 after Sri Lankan government forces captured all rebel held areas in this province. Table 3 shows the distribution of banking assets among the selected 15 banks.

## 5. Empirical Results

The results presented in Table 4 are derived based on the DEA approach along with the bootstrap simulation technique explained previously, for the period 2008 - 2013. Table 4 provides a summary of the averages of the output oriented original efficiencies, bias corrected efficiencies and the respective confidence interval for the sample of foreign and domestic banks operating in Sri Lanka during the reference period. A comparison of the annual bias corrected efficiency levels for foreign banks and domestic banks indicate an improvement in average efficiency among domestic banks while that for foreign banks does not provide clear trend. Therefore, it is hard to derive any conclusion about the equality between the two distributions of efficiency scores.

**Table 4: Output-oriented average efficiency measures of domestic and foreign banks (2008 – 2013)**

Year	Domestic Banks				Foreign Banks				All Banks			
	Efficiency	Bias-Corr. Efficiency	Confidence Interval		Efficiency	Bias-Corr. Efficiency	Confidence Interval		Efficiency	Bias-Corr. Efficiency	Confidence Interval	
			Lower	Upper			Lower	Upper			Lower	Upper
2013	1.327	1.433	1.316	1.522	1.458	1.625	1.371	1.774	1.362	1.484	1.330	1.589
2012	1.344	1.437	1.335	1.515	1.266	1.365	1.203	1.448	1.323	1.418	1.300	1.497
2011	1.370	1.450	1.359	1.514	1.402	1.542	1.342	1.661	1.379	1.475	1.354	1.554
2010	1.576	1.666	1.564	1.738	1.645	1.811	1.574	1.953	1.594	1.705	1.567	1.796
2009	1.884	1.988	1.868	2.070	1.149	1.300	1.069	1.435	1.688	1.804	1.655	1.900
2008	1.615	1.698	1.600	1.763	1.196	1.363	1.113	1.516	1.503	1.609	1.470	1.697

Source: calculated by the authors

The bias corrected efficiency of all banks in the sample shows an increasing trend particularly from 2009. Banking efficiency for the period 2008 - 2009 recorded a relatively lower level as against the period 2010-2013. This provides evidence for an increase in banking efficiency concurrent with the post conflict banking sector expansion along with higher economic growth during the 2010-2013 period.

**Table 5: Results of the Li (1996) test comparing the technical efficiency between Domestic and Foreign Banks**

Ho (f is the density Function.)	Li (1996) Test Statistic	P-value	Decision on Ho
$f_1(\text{Domestic banks}) = f_2(\text{Foreign Banks})$	-0.2883	0.7355	Accept Ho

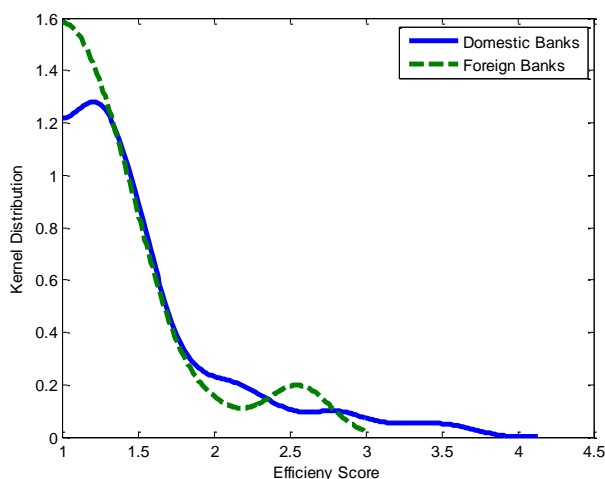
**Table 6: Results of the Li (1996) test comparing technical efficiency between the period 2010 - 2013 and the period 2008-2009**

Ho (f is the density Function.)	Li (1996) Test Statistic	P-value	Decision on Ho
f1(Post War Period) = f2(During the War)	-0.130826113	0.8785	Accept Ho

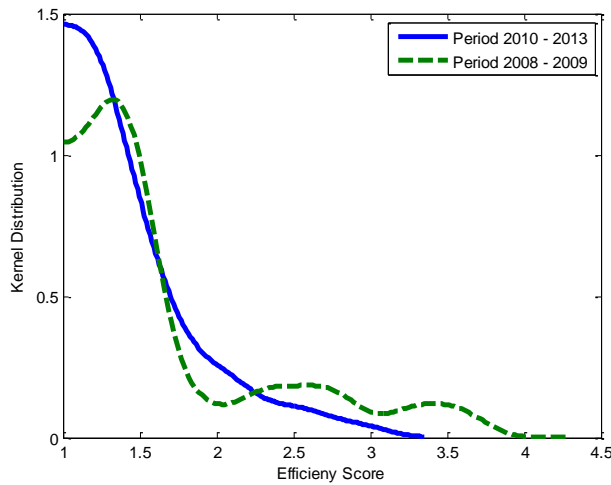
In addition to the averages of the bias corrected efficiency scores the distribution of densities of the efficiency estimations are used for evaluating the efficiency levels between two groups of banks and also between two periods (adapted by Simar & Zelenyuk (2006), Henderson & Zelenyuk (2007) and Simar & Zelenyuk (2007) in the context of DEA). First, equality in banking efficiency between foreign and domestic banks, and for two periods 2008-2009 and 2010-2013, is evaluated using the test established by Li (1996) for comparing equality of densities of two random variables (see Simar and Zelenyuk 2007). The test statistics and the p-values of the Li (1996) test for comparing the distribution of banking efficiencies between two sub-groups are given in Tables 5 & 6. Acceptance of the null hypothesis according to the test statistics in Table 5 indicate equality in the distribution of efficiency scores relating to domestic and foreign banks. Similarly, acceptance of the null hypothesis according to the test statistics in Table 6 indicate equality in the distribution of efficiency scores between time periods 2008-09 and 2010-2013.

Second, efficiency between domestic and foreign banks is compared by using the visualization of kernel densities. The graphical presentation of densities of efficiency estimates for the foreign and domestic banks as well as for the periods 2008-2009 and 2010-2013 are given in Figure 1 and Figure 2 respectively. According to Figure 1 the distribution of densities of efficiency scores derived for domestic banks and foreign banks does not show a clear difference. This is further confirmed by the outcome of the Li (1996) test in Table 5, by accepting the null hypothesis that the efficiency scores for the two groups of banks are equal. Similarly, Figure 2 does not provide evidence of a difference in banking efficiency between the periods 2008-2009 and the 2010-2013. This is also confirmed by the Li (1996) test in Table 6 with acceptance of the null hypothesis that the efficiency scores of the selected banks for the two periods are equal.

**Figure 1: Kernel-estimated densities of efficiency scores for domestic and foreign banks**



**Figure 2: Kernel-estimated densities of efficiency scores for the period 2010 – 2013 and 2008 - 2009**



As explained in the methodology section, Simar & Zelenyuk (2007a) used aggregated efficiencies incorporating output weights to compare two groups of firms in a DEA context. This provides a more comprehensive framework to compare the efficiency of two groups based on their weight in output, assuming heterogeneity between the groups and allowing for homogeneity within the group.

Therefore the statistics derived based on weighted aggregate efficiencies can be considered as more representative and comprehensive than the statistics based on non-weighted means of the sub-groups. DEA efficiency scores, bias corrected efficiencies and respective confidence intervals for the domestic and foreign private banks, based on aggregate efficiencies and typical average efficiencies, are presented in Table 7. The overlapping confidence intervals of both aggregate efficiencies and average efficiencies for foreign and domestic banks do not support the existence of significant differences between these two groups of banking institutions. In addition to the confidence intervals, Simar & Zelenyuk (2007) introduced point estimation (RD statistics in Tables 7 & 8) based on the ratio between the efficiencies of the two groups to measure the significance of the differences in efficiency. If the confidence interval of the RD statistic includes “1”, it accepts the null hypothesis of equality in aggregate efficiency between the two groups. Accordingly, both RD statistics derived from aggregate efficiencies and average efficiencies in Table 7 accepts the null hypothesis by providing evidence for equality in efficiency between domestic and foreign banks.

**Table 7: Summary of banking efficiency statistics for domestic and foreign banks**

Statistic	DEA Estimation	Standard Error	Bias Corrected Estimation	95% Confidence Interval Bounds	
				Lower	Upper
Aggregate Efficiency-Domestic Banks	1.21	0.04	1.30	1.22	1.37
Aggregate Efficiency-Foreign Banks	1.24	0.07	1.35	1.18	1.46
Aggregate Efficiency-All banks	1.47	0.09	1.67	1.48	1.84
<b><i>RD<sub>Aggregate</sub></i></b>	<b>0.98</b>	<b>0.07</b>	<b>0.96</b>	<b>0.84</b>	<b>1.09</b>
Mean Efficiency-Domestic Banks	1.52	0.12	1.70	1.44	1.90

Mean Efficiency-Foreign Banks	1.35	0.11	1.54	1.26	1.69
Mean Efficiency-All banks	1.47	0.09	1.67	1.48	1.84
<b><i>RD</i><sub>Mean</sub></b>	<b>1.09</b>	<b>0.14</b>	<b>1.02</b>	<b>0.73</b>	<b>1.28</b>

**Table 8: Summary of banking efficiency statistics for the period 2010-2013 and 2008-2009.**

Statistic	DEA Estimation	Standard Error	Bias Corrected Estimation	95% Confidence Interval Bounds	
				Lower	Upper
Aggregate Efficiency (2010-2013)	1.17	0.03	1.25	1.17	1.31
Aggregate Efficiency (2008-2009)	1.36	0.09	1.49	1.31	1.64
Aggregate Efficiency (2008-2013)	1.21	0.04	1.30	1.22	1.37
<b><i>RD</i><sub>Aggregate</sub></b>	<b>0.86</b>	<b>0.06</b>	<b>0.83</b>	<b>0.71</b>	<b>0.94</b>
Mean Efficiency (2010-2013)	1.41	0.09	1.60	1.40	1.75
Mean Efficiency (2008-2009)	1.60	0.18	1.82	1.39	2.10
Mean Efficiency (2008-2013)	1.47	0.10	1.67	1.45	1.84
<b><i>RD</i><sub>Mean</sub></b>	<b>0.87</b>	<b>0.12</b>	<b>0.84</b>	<b>0.59</b>	<b>1.06</b>

When the sample is divided into two groups for the period 2008-2009 and 2010-2013, DEA efficiency scores, bias corrected efficiencies and respective confidence intervals for each group are presented in Table 8. Although the confidence intervals based on non-weighted mean efficiency do not provide evidence for a difference in banking efficiency between these two time periods, the weighted aggregate efficiency scores suggest significant differences in banking efficiency with the existence of non-overlapping confidence intervals. The claim is further confirmed by the confidence interval of the ***RD*<sub>Aggregate</sub>** statistics which does not include "1". The bootstrap confidence intervals and bootstrap ***RD*<sub>Aggregate</sub>** statistics provide solid statistical based evidence for these conclusions since the aggregate efficiency scores are derived incorporating weights in banking output. This shows that banking efficiency improved in the country with the conducive macroeconomic environment and banking sector expansion in the latter part of the post war period.

## 6. Conclusion

Deviating from conventional ways of comparing the performance of bank groups, this paper extended the established literature to compare the efficiency of foreign and domestic banks by employing comprehensive weighted aggregate efficiency measures derived through bootstrap simulations for the banking sector of Sri Lanka. The study focused on banking sector performance in the post conflict era (from 2008 to 2013), and banking sector performance between the initial and latter parts of the post-conflict period were also compared using weighted aggregate efficiency measures.

In the aftermath of the armed conflict between LTTE and government forces the banking sector showed a considerable expansion in terms of banking density and services volume along with overall economic expansion. The findings from this study are vital for policy makers as they facilitate a better evaluation of how foreign or domestic ownership matters in terms of bank efficiency, when the banking sector records higher expansion and the overall economy moves onto a higher growth path. A comparison of banking efficiency between the initial and latter period of the post war era

also provides evidence of changes in banking efficiency dynamics with this structural break in the Sri Lankan economy.

The analysis provided in this study concludes that there was an absence of significant differences in efficiency levels between domestic and foreign banks in Sri Lanka. Conventional non-weighted mean efficiencies, and Simar and Zelenyuk's (2007) aggregate efficiency figures, provide evidence for this conclusion. The equality in efficiency levels of these two groups of banks can be considered as a reflection of a common regulatory platform offered by policy makers for all banking institutions in Sri Lanka (Berger, 2007, Berger & De Young, 2001). Domestic banks aggressively expanded their branch network to exploit the advantages of higher demand for credit in the country and meet pent up demand for banking services in conflict affected areas during the post conflict era, while foreign banks showed moderate expansion in their branch networks. A decline in banking efficiency in domestic banks could be expected since previous studies have mostly reported a negative impact of branch expansion on their efficiency (Berger *et al.* 1997, Battese *et al.* 2000, Berger & De Young 2001, Cebula *et al.* 2011 ). Despite aggressive branch expansion, the aggregate efficiency level of domestic banks has not significantly deviated from foreign banks. This could be due to the high credit demand in parallel to the branch expansion of domestic banks in the post-conflict era. Private sector credit expanded by 34.5%, 17.6% and 7.5% in 2011, 2012 and 2013 respectively with the post-conflict economic expansion (CBSL 2011, 2012, 2013). Therefore, policy makers should be concerned about the risk of decline in efficiency of domestic banks if branch expansion is continued. The literature highlights weaknesses in the regulatory environment in developing countries as a main reason for the low efficiency of intermediation services by foreign banks while exploitation of comparative advantages is identified as a positive factor for them to record a higher performance (Bhattacharyya *et al.* 1997, Berger & De Young 2001, Grigorian & Manole 2002, Hasan & Marton, 2003, Isik & Hassan 2002, Zajc 2006, Berger 2007). Therefore, a holistic approach should be taken by policy makers to ensure a conducive regulatory and market environment for foreign banks in the context of domestic bank expansion. The existence of foreign banks which have access to foreign capital are also vital for Sri Lanka as an emerging market.

An upward trend in efficiency is observed in the annual average banking efficiency scores for the period 2008-2013, and Simar and Zelenyuk's (2007a) aggregate efficiency statistics also show that banking sector efficiency during the period 2010-2013 outperformed efficiency during the period 2008-2009. This could be considered as a salutary move since efficiency in the banking sector minimises the underutilisation of limited financial resources in the banking system and improves any sub-optimal allocation of funds.

This study provides evidence that an expansion of the banking sector was in line with the expansion in the economy in the post-conflict period, as the findings do not support the view of a possible decline in efficiency with branch expansion in the banking sector as asserted in the mainstream literature. The improvement in efficiency, by exploiting advantages arising from high demand for credit along with economic expansion, can be considered as a peace dividend received in the post conflict period and maintenance of a higher level of banking efficiency. Attaining minimum inequality in efficiency across the banks is an ongoing challenge for regulators and policy makers in the country.

## End Note

<sup>1</sup> The Liberation Tigers for Tamil Eelam (LTTE) fought for a separate state called “Tamil Eelam” from 1983 to 2009. Government forces defeated the LTTE rebels in mid-2009 through military operations and capturing all the land belonging to their *de facto* state for more than a decade.

<sup>2</sup> Two fully state-owned banks which accounted for 40% of total commercial bank assets are also included in these 12 domestic banks.

<sup>3</sup> The security situation of the Eastern province continued to improve from 2007, since all the rebel held areas in the Eastern province were captured by Sri Lankan government forces in this year.

<sup>4</sup> With the recent peaceful domestic environment achieved through military operations, Sri Lanka recorded unprecedented real GDP growth of over 8% in both 2010 and 2011. Despite fragile economic conditions in the advanced countries in 2012, Sri Lanka achieved a 6.4% economic growth rate with continued expansion in economic activities.

<sup>5</sup> After the end of the armed conflict people gained access to agricultural lands in rebel held areas.

<sup>6</sup> A country is treated as a host country, if the citizens of that country own less than 50% of the shares of a particular bank. Similarly a country is treated as the home country if more than 50% of the shares of that particular bank is owned by the citizens of the country.

<sup>7</sup> Tea, rubber and coconuts are the main plantation crops in Sri Lanka, accounting for 18% of annual export revenue in 2012 (CBSL 2012).

<sup>8</sup> Among the two domestic banks the first domestic bank, the Hatton Bank, was established in 1888 and the Bank of Ceylon was established in 1939 as a private and government sector partnership.

<sup>9</sup> CBSL is the apex body of the financial system of Sri Lanka. Price stability and financial system stability are the two main objectives of CBSL, and the broad goal of CBSL is to facilitate economic growth.

<sup>10</sup> The government that came into power in 1977 introduced an array of economic reforms including that of the financial sector with the aim of achieving faster economic growth.

<sup>11</sup> The array of reforms during the period 1977-1998 included: introducing a managed floating exchange rate regime, opening the banking sector to more private and foreign banks, relaxing restrictions on the branch expansion of existing banks, controlling the money supply through statutory reserve requirements (SRR) and open market operations (OMO), allowing banks to open FCBUs (foreign currency banking units), removing credit ceilings on non-priority sectors and establishing a secondary market for treasury bills.

<sup>12</sup> Reforms introduced by the Central Bank of Sri Lanka mostly focused on improving the soundness, stability and governance of the banking sector while providing equal opportunities for private and foreign banks to establish in the market.

<sup>13</sup> As a backdrop to the recent peaceful domestic environment achieved through military operations, Sri Lanka recorded unprecedented real GDP growth of over 8% in both 2010 and 2011. Despite fragile economic conditions in the advanced countries in 2012 and 2013, Sri Lanka achieved a 6.4% and 7.3% economic growth rate respectively with continued expansion in economic activities.

<sup>14</sup> The 24 licensed commercial banks are allowed to engage in any banking activity in Sri Lanka. Nine LSBs are mostly focused on savings and development banking rather than commercial banking activities. These LSBs are not allowed to accept demand deposits which are not entitled to an interest payment from the banks.

<sup>15</sup> According to Fried *et al.* (2008) a similar conclusion can be expected from both DEA and SFA for good quality data, and choosing one method for an efficiency analysis does not discount usage of the other method. In fact it may be useful to use both as they can provide complementary outcomes and information.

<sup>17</sup> Please see Fare *et al.* (1994), Fare & Primont (1995) and Sickles & Zelenyuk (2014) for axioms of technology characterisation

<sup>18</sup> The influences of exogenous factors are not equal among the banks due to reasons such as differences in product portfolios, business scope, geographical coverage and customer base.

<sup>19</sup> The firm (bank) related to observation  $(x^k, y^k)$  is inefficient when  $D_0^k(x^k, y^k) < 1 \Leftrightarrow P^k(x^k), y^k \notin \partial P^k(x^k), y^k \neq 0$  where the technological frontier is the upper bound of the output set  $P^k(x^k)$  defined as,

$\partial p^k(x^k) = \{y \in \mathfrak{R}_+^m : y \in P^k(x^k), \lambda y \notin P^k(x^k), \forall \lambda \in (1, \infty)\}$ . If  $D_0^k(x^k, y^k) = 1 \Leftrightarrow y^k \in \partial P^k(x^k)$ , a firm (bank) related to  $(x^k, y^k)$  is technically efficient.

<sup>20</sup> The consistency of DEA estimates improves with increasing sample size for given input and output dimensions. However an increase in the dimensions of DEA models reduces the consistency of the DEA estimates.

<sup>21</sup> Since efficiency is a relative figure based on the frontier which is not influenced by the size of the banks, the average efficiency of a group of banks does not give a representative measure about the efficiency of that group.

<sup>22</sup> The procedures and algorithms for compiling bootstrap aggregate efficiency scores are presented in Simar & Zelenyuk (2007a).

<sup>23</sup> The procedures and algorithms for comparing the distribution of efficiency scores between two groups are presented in Simar & Zelenyuk (2006).

<sup>24</sup> This study used the MATLAB software and the codes developed for group-wise heterogeneous sub-sampling procedures for DEA and Li-test by Simar & Zelenyuk (2006) and Simar & Zelenyuk (2007).

<sup>25</sup> Berger and Humphrey (1997), based on their survey of banking sector efficiency studies, highlighted that the inputs and outputs used for analysing the performance of banks are mostly dependent on the approach employed by the individual researcher, and that there is no consensus among researchers about the appropriate inputs and outputs to be used.

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