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Bank outreach and performance: Evidence from banking efficiency in Sri Lanka

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Abstract

This study evaluates the impact of geographical dispersion of bank branches and their growth on banking sector efficiency in Sri Lanka for the period 2006–2014. Deviating from conventional models used in literature this study employs double-bootstrap semi-parametric truncated regression models based on data envelopment analysis (DEA). Our empirical results show that bank efficiency is not significantly influenced by branch expansion and geographical dispersion in an environment of higher economic growth. This study concludes that a likely decline in bank efficiency with expansion in branch networks, as asserted in the mainstream literature, is not valid when there is a high demand for banking services in line with overall economic growth. Further, this study suggests that geographical dispersion of the banking sector can be used as a policy tool to achieve broad-based and inclusive growth for emerging and rapidly growing economies such as Sri Lanka.

Keywords: Aggregate-efficiency; semi-parametric; Bootstrap; Intermediation approach; Sri Lanka

JEL Codes: G21, D24, D22.

Disclaimer: The views expressed in this paper are those of the author(s) and do not necessarily represent the institutions to which they are affiliated. The paper describes research in progress by the authors and is published to elicit feedback and comments.

1. Introduction

Once the quarter-century long bloody civil-conflict in Sri Lanka ended in mid-2009 the banking sector expanded in terms of its geographical dispersion, number of branches and business volumes. The impetus for these developments can be categorised into three avenues: 1) a conducive macroeconomic environment prevailed in the country with the achievement of long lasting peace after the end of the armed conflict; 2) increased demand for banking services in the conflict-affected areas with the revival of economic activities; 3) directives issued by the Central Bank of Sri Lanka (CBSL) for geographical dispersion of bank branches targeting improvements in access to finance for inclusive growth. Although the improvement in banking density is generally identified as a salutary move by policymakers in emerging countries, the literature highlights the risk of a decline in efficiency due to over expansion in branch networks. Some studies have highlighted an increase in cost components, particularly with respect to monitoring, employees and fixed assets, to explain the decline in efficiency subsequent to branch expansion (Berger *et al.* 1997; Battese *et al.* 2000; Berger & De Young 2006; Vu & Turnell 2010). Further, negative impacts from informational asymmetries, lack of knowledge of new market conditions and insufficient assessment on socio-economic conditions on banking efficiency is also discussed in the literature (Bhattacharyya *et al.* 1997; Buch 2003; Das & Ghosh 2006; Bhattacharyya & Pal 2013).

This study evaluates the impact of banking sector expansion on the efficiency of Sri Lankan banks in a post-conflict era which offers an ideal case study for research into the effect of branch network density in similar emerging economies. The reference period of the study is 2006–2014 which covers the period before the ending of armed conflict and the post-conflict era of Sri Lanka. The impact of these recent developments on the banking sector is vital for formulating future policies targeting high bank efficiency and the recovery and sustainability of economic growth over the long run. In the first part of this empirical analysis DEA is employed to estimate the production frontier of the banking sector which is then used to calculate efficiency. A bootstrapping simulation method is used to compile DEA efficiency scores in order to avoid possible biasness in nonparametric frontier methods due to non-measurement of random errors and the existence of sampling errors (Simar & Wilson 1998).¹

¹Bootstrap techniques employ a large number of pseudo samples drawn from the given data to estimate efficiency scores and confidence intervals. The large number of pseudo samples is used by the bootstrapping technique to form an approximation for the true distribution asymptotically.

Since a quantitative derivation of efficiency does not identify factors influencing banking efficiency the standard practice in the literature is to then separately use traditional ordinary Least squares (OLS) or Tobit regression models to evaluate the determinants of efficiency. Unlike such conventional models the double-bootstrap truncated regression model developed by Simar and Wilson (2007) has been employed in our study to identify the impact of geographical and branch expansion on banking efficiency along with other influential factors. This model provides consistent estimates avoiding possible serial correlation between efficiency scores which is not addressed by traditional models. Prior to the regression analysis sound statistical tests introduced by Simar and Zelenyuk (2007) for comparing efficiency between subsamples are employed for preliminary assessment of bank efficiency between groups of banks based on geographical dispersion and growth of their branch networks.

The contribution of this study to the literature is twofold. First, the study contributes to the literature by assessing banking efficiency dynamics when the banking sector expands in terms of number of branches and geographical dispersion with specific reference to the emerging market of Sri Lanka. The study is not only the first to examine the dynamics of efficiency in a banking sector in a post-conflict economic boom along with dispersion and growth in branch networks, but is also an original contribution to examine changes in banking efficiency in a post-conflict era for the case of Sri Lanka.² Second, the study is among a limited literature which employs a semi-parametric double-bootstrap truncated regression model in evaluating the expansion-efficiency nexus in the context of a banking sector.

Following this introduction, section 2 reviews the literature on the impact of branch and geographical expansion on banking sector efficiency in the context of Sri Lanka. Section 3 provides an overview of the Sri Lankan banking sector and a discussion about contemporary issues relating to dispersion of bank branches during a post-conflict period. The production theory behind DEA and the concept of efficiency are presented in section 4. This section also explores inferences behind the double-bootstrap truncated regression model which is employed to find the determinants of banking efficiency. Justification of the selected inputs

²The results and the methodology used in the study are highly applicable to developing economies in a post-conflict development era envisaging expansion of the banking sector for the attainment of sustainable and balanced economic growth.

and outputs and description about the data used for the analysis is provided in section 5. An empirical analysis is presented in section 6 while section 7 concludes the study.

2. Literature Review

Improvement in geographical coverage of banks, nationally and globally, has led to an increase in the number of branches operated under one bank while providing a basis for economists to study the impact of branch networks on bank efficiency. The literature has mostly identified that an increased number of bank branches exerts a negative influence on bank efficiency since it could lead to an increase in the cost of the banks particularly with respect to that of employees, monitoring and fixed assets (Berger *et al.* 1997; Battese *et al.* 2000; Berger & De Young 2006; Vu & Turnell 2010). When banks penetrate across territorial borders, higher cost and lower bank efficiency can be explained by the home field advantage hypothesis relating to a lack of knowledge about the local market and socio economic condition of the new area, informational asymmetries and difficulties in establishing networks (Bhattacharyya *et al.* 1997; Buch 2003; Das & Ghosh 2006; Bhattacharyya & Pal 2013). However, geographical dispersion of branches is identified by some studies as a strategy to improve revenue and minimise banking sector risk (Berger *et al.* 1997; Hughes *et al.* 1999; Shiers 2002).

Studies that find in favour of improved efficiency with branch and geographical expansion have highlighted a number of arguments. Some of them argue that the parent organization can use their superior skills, policies, controls and practices to improve the efficiency of regional level branches and the negative impact of distance could be overcome through this efficiency gain (Berger & De Young 2001; Grabowski *et al.* 1993).³ Advancement in information technology (IT) is also identified as a factor which makes it easier to monitor the branch operation of banks and some researchers argue that the impact of technological advancement with geographical dispersion negates any efficiency decline (Berger & DeYoung 2006; Havrylchyk 2006; Berger 2007; Lensink *et al.* 2008). A possible increase in the volume of banking services consequent to the increase in branches is also identified as a positive factor for improvement in banking efficiency (Berger & De Young 2001; Bos & Kolari 2005; Pasiouras 2008; Mahathanaseth & Tauer 2014). In the banking efficiency

³ The US banking system has commonly been used to test the impact of branch networks on bank efficiency in the literature due to deregulation in branch expansion with the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994, which encouraged interstate branching from mid-1997.

literature focus tends to be given to the importance of acquisitions, mergers, liberalisation and other reforms but empirical evidence on the importance of geographical dispersion along with growth in branch networks on bank efficiency remains elusive.

Previous studies have mostly used the number of branches in assessing the impact of branch network growth on banking efficiency. Deviating from this conventional approach to assessing branch network growth and efficiency the approach of this study is to not only include the number of branches but also the geographical dispersion of bank networks on efficiency within a single holistic assessment framework.. This study also contributes to the limited literature focusing on bank branch expansion in emerging economies such as Sri Lanka. The post-conflict bank branch growth and geographical dispersion of bank networks in Sri Lanka provides a proper case study with which to evaluate the impact on banking efficiency from branch network density and dispersion. To the best of the authors' knowledge this study is the first to apply a semi-parametric method in evaluating the impact of branch network expansion on the technical efficiency of banks.

3. Banking Sector in Sri Lanka

Before regaining the country's independence in 1948 banking sector operations were mostly based in the capital Colombo and other urban cities. Banks also operated in a limited number of small cities in the central part of the country that had strong links to the plantation industry. Establishment of the CBSL in 1950, which replaced the previous currency board system, is a land mark in the post-independence history of the country's financial sector. Initiatives were taken by the CBSL to expand the branch networks of the banking sector as the apex body of the financial system of Sri Lanka. A significant increase in banking penetration was recorded with the establishment of two state-owned commercial banks in 1959 and 1961, along with the establishment of some state-owned savings banks.⁴ Adoption of financial sector liberalisation policies in 1977 stimulated the growth in bank branch networks with improvement in foreign and private sector participation in the banking industry (CBSL 1998). An array of reforms were introduced to the banking sector and the economy as whole in the post-liberalised period and the CBSL was empowered with more regulations and controls over the banking sector by the Banking Act 1988. Most of the banks showed a tendency of expanding their branch network in urban areas amidst continuous development in

⁴ Bank penetration is commonly defined to as the number of bank branches per 100,000 people.

the banking sector reflecting the greater demand for financial services in urban areas. Therefore, disparities in banking penetration between the Western region and other regions resulted in an increase in regional economic and income disparities across the regions.

In 2008 a policy directive to all commercial and specialised banks in Sri Lanka was issued by the CBSL to open two bank branches in other regions when a bank opens one bank branch in the Western region, aimed at minimising disparities in banking services (CBSL 2011a; CBSL 2011b). Expansion in the economy and revival of economic activities in the post-conflict era, along with the directives issued by the CBSL in 2008, significantly influenced the geographical coverage in bank branch networks in Sri Lanka particularly in the immediate aftermath of the armed conflict.

Currently, the banking sector of Sri Lanka mainly comprises 25 licensed commercial banks (LCB) and 7 licenced specialized savings banks (LSB) operating in the country (CBSL 2015). The commercial and specialised banks account for more than 56% of the total financial sector assets of the country and are the dominant players in the financial sector. Out of the 25 commercial banks operating in Sri Lanka, 2 banks are fully owned by the government while the domestic private sector owned 11 banks and 12 are foreign owned banks. Among the 7 specialised banks, 5 banks are owned by the government while the other two are owned by the private sector.⁵ The commercial and specialised banks expanded their branch networks by 57% from 2,118 to 3,329 during the period 2006–2014.⁶

Since an efficient banking sector is crucial for sustainable economic growth through minimising the cost of funds, enhancing access to funding and improving investments, an evaluation of the impact of the spread and growth of bank branches on banking sector efficiency in the post-conflict period is important for Sri Lanka (Lucchetti *et al.* 2001; Koetter & Wedow 2010). Therefore, findings from this study will be useful in formulating effective policies to maintain the highest possible level of banking efficiency in a geographically expanded banking network.

⁵ Government sector institutions also have equity investment in private banks and majority ownership can vary between government and the private sector. Therefore, banks are categorised as private banks based on banking practices.

⁶ The number of bank branches is calculated based on annual reports of all commercial and specialised banks and various issues of the CBSL publication “Economic and Social Statistics of Sri Lanka”.

4. Methodology

The two frontier methods namely stochastic frontier analysis (SFA) and data envelopment analysis (DEA) are widely used in efficiency analysis of the banking sector. Fried *et al.* (2008) argued that both DEA and SFA provide consistent results with quality data. In this analysis, DEA is chosen as the appropriate method to compile efficiency for the empirical analysis. There are three main reasons for employing DEA in this study. First, there is no specific functional form imposed on the sample of data. This avoids misspecification of the functional form of the banking sector which could be more complex than that of the manufacturing sector. Second, DEA provides more consistent parameters based on small samples relative to SFA.⁷ Hence, DEA is recommended in the literature for efficiency analysis of small samples which is pertinent for the case of the banking sector in Sri Lanka (Seiford & Thrall 1990; Sathye 2001; Coelli *et al.* 2005; Wilson 2006). Third, DEA provides for the incorporation of multiple-outputs and multiple inputs produced by banks into the efficiency analysis. The analysis consists of two stages.

Stage 1: Compilation of individual efficiency scores

The study employed DEA under the variable returns to scale (VRS) assumption by Afriat (1972), Färe *et al.* (1983) and Banker *et al.* (1984) since banks are mostly not operating at optimum scale due to imperfect competition, regulations, and limitations. Efficiency is compiled based on output-orientation which considers the maximum possible output from given inputs. This assumes that banks and the country as a whole are trying to maximise intermediation services so as to achieve higher growth. In the context of the banking industry the methodology can be explained for a sample of n banks.

It is assumed that the inputs vector $x^k = (x_1^k, \dots, x_N^k)' \in \mathfrak{R}_+^N$ of each bank k ($k=1, 2 \dots n$) is comprised of N inputs which is used to produce output vector $y^k = (y_1^k, \dots, y_M^k)' \in \mathfrak{R}_+^M$ which is comprised of M outputs. Each firm k is free to use technology that can be characterised by the technology set T .⁸

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

The technology set T can also be characterised by using output set P^k as follows:

⁷ More consistent parameters are expected from DEA since it estimates a limited number of parameters relative to SFA (Maudos *et al.* 2002)

⁸ Common technology is used for the compilation of efficiency scores based on one frontier.

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

Incorporating a regularity axiom in the context of production theory, an output oriented Shepherd (1970) distance function is defined as,

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

Accordingly, Farrell's output oriented technical efficiency is defined for all outputs y^k as,

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

Banks are considered as technically inefficient when $TE^k > 1$. Further, fully efficient banks record a technical efficiency of $TE^k = 1$. Since true technology is unobserved and the output set is also unknown, DEA is used to compile the technical efficiency of the banks. The DEA estimate of the output set $p^k(x^k)$ is defined as,

$$\hat{p}^k(x^k) \equiv \left\{ y : \sum_{k=1}^n z^k y^k \leq y, \sum_{k=1}^n z^k x^k \geq x, \sum_{k=1}^n z^k = 1, z^k \geq 1, k = 1, \dots, n \right\} \text{ where } z^k \text{ is an intensity}$$

variable.

The VRS assumption is used to estimate the output set since banks are not operating at optimal scale with the influence of bank specific and external factors. Accordingly, the following equation derives the individual efficiency scores based on DEA at a fixed point (x^k, y^k) .

$$\square TE_{VRS}^k \left\{ x, y : \square p^k(x^k) \right\} \equiv \max_{\theta, z^1, z^2, \dots, z^k} \left\{ y : \theta y \in \square p^k(x^k) \right\}$$

In the absence of provisions for random errors in the DEA framework, $\square TE_{VRS}^k$ is a downward biased estimator given the finite size of the sample. Therefore, this study has used a bootstrap simulation introduced by Simar and Wilson (1998) as an extension of Efron (1979) to minimise the biasedness in the estimated efficiencies. Simar and Wilson (1998) provide the procedures and algorithms for generating DEA estimates based on the bootstrap technique.

Prior to the regression analysis, efficiency levels are compared between bank groups with respect to the high and low dispersion of branch networks. In the same way, efficiency levels are also compared between bank groups with respect to the higher and lower growth recorded in branch networks. The group-wise aggregate-efficiencies based on subsampling developed by Simar and Zelenyuk (2007) are used for this comparison. First, the sample of banks are categorised into two groups based on geographical dispersion of the bank branches and

growth of the branch network. Second, each pair of groups is compared using the group-wise aggregate-efficiencies. The measures of aggregate-efficiency provide indicators with which to compare the performance level between sub groups while accounting for the size of the output in each bank in the sample. Therefore aggregate-efficiency is an ideal measure for comparing performance between subgroups of banks particularly when each bank group is comprised of different bank sizes.

Stage 2: Analysis of determinants of efficiency

In addition to the variables used as inputs and outputs, studies in this area have shown the existence of influences from other environmental variables on bank efficiency. The impact of environmental variables on banking efficiency has been identified from the literature mostly using regression methodologies. Among all the methodologies, OLS and Tobit regression models, which regress efficiency scores against selected explanatory variables, have been frequently used in the recent literature (Chang & Chiu 2006; Burki & Niazi 2010). The main weakness of these models is, however, violation of a basic assumption in regression analysis, since DEA efficiency scores are serially correlated with the explanatory variables and the error term. Simar and Wilson (2007) introduced a double-bootstrapped truncated regression technique to avoid violation of this basic assumption and provided more sensible results for the regression by incorporating the underlying data generating process. Therefore, the double-bootstrap truncated regression technique is used in this study to estimate the coefficients and confidence intervals of the coefficients of the regression model. A comprehensive description of the bootstrap truncated regression analysis along with the algorithms is provided in Simar and Wilson (2007).

DEA bootstrap efficiency scores will be regressed against potential environment variables, as identified in the following equation:

$$\hat{\theta}_{vrs_i} = a + X_i\delta + \epsilon_i \quad i = 1, 2, \dots, n$$

In this equation a is a constant, ϵ_i is the statistical error term, and X_i is the vector of potential environmental variables or determinants of efficiency. δ provides the coefficients of the determinants included in the model. The selection of environmental variables used in the model is based on the determinants of banking efficiency identified more generally in the literature and from banking sector developments in Sri Lanka.

5. Specification of inputs, outputs and explanatory variables in the regression model

Different approaches have been used in the literature to enable identification of inputs and outputs to be used in measuring banking efficiency. These approaches are mainly focused on the services provided by banks in financial intermediation, production of loans and deposits, revenue generation and bank profit. Among them the intermediation approach, introduced by Sealey and Lindley (1977), is identified as the most suitable one for this analysis for two reasons. First, the provision of financial intermediation services by matching short-term liabilities with long-term assets is the core service of the banking sector aimed at stimulating the economy (Chang & Chiu 2006; Pasiouras *et al.* 2009; Chortareas *et al.* 2013). Second, policy makers are concerned about efficiency in the provision of banking intermediation services in an environment of banking sector expansion for an emerging economy such as that of Sri Lanka's (Jaffry *et al.* 2007; Thagunna & Poudel 2013).

Under the intermediation approach all types of loans, advances and investments are the best indicators of banking services provided (Havrylchyk 2006; Burki & Niazi 2010; Hou *et al.* 2014). The volume of deposits, labour, operational cost and physical capital are the most common inputs used in evaluating the efficiency of intermediation services provided by banks. Accordingly, total loans (y_1) and investments (y_2) are used as the output variables for this study. The defined input variables are total number of employees (x_1), total deposits (x_2), total borrowing (x_3) and fixed assets (x_4) of the banks (Bos & Kolari 2005; Ray & Das 2010; Arjomandi *et al.* 2012; 2014; Hou *et al.* 2014). The descriptive statistics of the inputs and outputs used for the efficiency calculations are given in Table 1.

Table 1: Descriptive statistics of the input and output variables

Input/output	Mean	SD	Min.	Max.
Employees (x_1)	1,521	2,238	9	9,645
Fixed Assets (x_2)	1,104	1,803	3	8,475
Deposits (x_3)	59,932	97,786	44	488,930
Borrowing (x_4)	13,834	24,660	1	168,301
Advances (y_1)	51,641	83,368	345	461,935
Investment (y_2)	22,450	42,761	1	274,753

Source: Annual reports and published financial accounts of the respective commercial banks.

Note: All the monetary values are in Sri Lankan rupees (millions).

In order to evaluate the impact of branch expansion the following two explanatory variables have been included in the double-bootstrap truncated regression model which uses the technical inefficiency of each bank as the dependent variable; 1) the geographical dispersion of bank branches, defined in this study as the percentage of bank branches or service points located outside the Western region (GEO). 2) growth of branch networks which is defined as the annual growth of the number of bank branches or service points (BANKG) owned by a particular bank. A number of control variables are also included in the model that are based on recent literature and recent developments in the Sri Lankan banking sector. Accordingly, an explanatory variable capturing capital strength (COCAP) is defined as the ratio of total capital to total assets, nonperforming advances (NPA) to total advances ratio as an indicator of product quality, advances to assets ratio as an indicator of liquidity (ADASSETS), real growth in gross domestic product (GDPG) as an indicator for overall economic development, the natural logarithm of total assets as a proxy for size of the bank (SIZE), return on assets (ROA) as an indicator of profitability, dummy variables for foreign ownership (OWNFD) and a time trend (TREND) are introduced into the double-bootstrap truncated regression model in order to control for other influential factors. The descriptive statistics of the explanatory variables are presented in Table 2. Data used for this research has been extracted from the published accounts of all 24 commercial banks and 9 specialised banks that operated during the period 2006–2014. The unbalanced panel data used in this study comprises 270 bank observations for the reference period.⁹

Table 2: Explanatory variables used in a two-stage, semi-parametric DEA model

Regressors	Mean	SD	Minimum	Maximum
GEO	0.41	0.30	0.00	0.88
BANKG	0.16	0.79	0.00	12.00
COCAP	0.20	0.16	0.00	0.75
NPA	0.07	0.10	0.00	0.56
ADASSETS	0.59	0.19	0.11	1.00
GDPG	6.83	1.33	3.50	8.20
SIZE	17.15	1.56	14.19	20.36
ROA	0.03	0.03	-0.05	0.21
OWNFD	0.64	0.48	0.00	1.00

⁹The determinants of banking efficiency are evaluated by using the MATLAB codes developed by A/Professor Valentin Zelenyuk to carry out the double-bootstrap truncated regression modes.

TREND	5.14	2.57	1.00	9.00
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Source: Annual reports and published financial accounts of the respective commercial banks, and CBSL publications.

Note: GEO is the percentage of bank branches outside the Western region; BANKG is the annual growth in branch networks; COCAP is the ratio of total equity to assets; NPA is the ratio between nonperforming advances and total advances; ADASSETS is the ratio between advances and total assets; GDPG is real growth GDP; SIZE is the natural logarithm of bank total assets; ROA is the ratio of net profit before tax to total assets of the bank; OWNFD is a dummy variable for foreign ownership; TREND is the time trend.

6. Empirical Results

Stage 1: DEA efficiency results

Prior to the regression analysis the Simar-Zelenyuk weighted aggregate-efficiency measures for subsamples are used to compare banking sector efficiency with respect to geographical dispersion of the branches and growth of branch networks. The sample is divided into two groups based on the geographical dispersion of the branch network and growth of branch networks, thereby making two pairs.

In forming two groups based on the geographical dispersion of branch networks, banks that operated with less than 50% of their branches outside the Western region are categorised as the “low” geographically dispersed group of banks while other banks are categorised as the “high” geographically dispersed group for the purpose of assessing the relationship between efficiency and the geographical dispersion of branch networks.¹⁰ Changes in banking efficiency with the growth of branch networks are also analysed in this study. The growth of bank branches for each bank is proxied by the annual growth in number of bank branches. The sample of banks is divided into two groups based on their growth of branch networks during the reference period. The compound growth recorded by all the banks in the sample is 5.1% for the reference period. Therefore, banks which recorded more than a 5.1% annual growth in branch networks are put in the “high expansion” group while other banks are put in the “low expansion” group.

Table 3 provides the ratios of aggregate-efficiency (RD_aggregate) when the sample is divided based on geographical dispersion and growth in branch networks. The ratios of average efficiency (RD_mean) are also provided to complement aggregate-efficiency. The ratios of efficiency between these two groups are defined as the RD statistics. If the

¹⁰ Banking services, particularly branches, are concentrated in the rich Western region. Even within the Western region bank branch density is inversely proportional to the distance to Colombo, which is the country’s capital city and located in the middle of the Western region.

confidence interval of the RD statistic includes “1”, it accepts the null hypothesis of equality in efficiency between the two groups. The results show that the ratio of weighted aggregate-efficiency between the banks with higher geographical dispersion and banks with lower dispersion (RD_aggregate) is smaller than unity. Further, unity is not included in the confidence interval of RD_aggregate. This indicates significantly higher efficiency in the bank group with greater geographical dispersion at the 1% significance level. The ratio between the mean efficiency of these bank groups (RD_Mean) also provides evidence of significantly higher efficiency among the banks with higher geographical dispersion without considering the sizes of the banks. When the banks are grouped with respect to the growth in branch networks, the RD-aggregate indicates a similar level of aggregate-efficiency between the two groups of banks which recorded high and low growth in their branch networks. However, this difference is significant at 1% with respect to the mean efficiency levels between the two groups.

Overall, the findings reveal that there is no negative impact of bank expansion on the efficiency of the banking sector in Sri Lanka. In fact, the influence of the geographical dispersion of branch networks on banking performance is positive. Aggregate-efficiency provides a comparison of the performance of bank groups with respect to geographical dispersion and growth in bank branches without considering other influential environmental variables on efficiency. Therefore, the next section incorporates a double-bootstrap regression model to evaluate the impact of geographical dispersion and branch growth on efficiency while controlling for other environmental variables.

Table 4: Weighted and mean efficiencies for comparison of banks

RD Statistics	Bias Corr. Estimates	Standard Error	95% Confidence Interval Bounds	
			Lower	Upper
RD_aggregate (High dispersion vs low dispersion)	0.9300***	0.0296	0.8373	0.6510
RD_mean(High dispersion vs low dispersion)	0.8597***	0.0532	0.9580	0.8637
RD_aggregate (Higher growth vs lower growth)	0.9991	0.0345	0.9383	1.0457
RD_mean (Higher growth vs lower growth)	0.9283***	0.0569	0.7477	0.9563

Note: The ratios of aggregate-efficiency (RD_aggregate) and mean efficiency (RD_mean) with *** are significant at 1% level.

Stage 2: Analysis of determinants of efficiencies

In the second stage of the analysis output-oriented efficiency estimates are regressed against a set of environmental variables, including those proxied for expansion of banks with respect to geographical dispersion and growth in branch networks. The models include two proxy variables for bank expansion, namely geographical dispersion (GEO) and growth in number of branches (BANKG), while proxies for capital strength (COCAP), quality of advances (NPA), liquidity (ADASSETS), overall economic growth (GDPG), bank size (SIZE) and profitability (ROA) are incorporated as control variables. Further two dummy variables for foreign ownership (OWNFD) and time trend (TREND) are also incorporated as control variables. Model 1 includes all ten regressors mentioned above. Since 5 regressors were not found to be significant even at the 10% level, based on the bootstrap confidence interval of their coefficients, the same regression relationship was re-estimated in models 2, 3,4,5 and 6 excluding insignificant regressors to check for the stability of model 1. All 6 models presented in Table 4 suggest consistent conclusions and approximately similar quantitative results indicating stability of the relationship between the regressors and the dependent variable (inefficiency scores).

Table 4: Results of double-bootstrap truncated regression analysis

Regressors	Estimated coefficients					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
CONSTANT	14.4973***	14.3441***	14.4963***	14.6867***	14.4566***	14.4823***
GEO	-0.1048		-0.1187	-0.1536	-0.1159	-0.1316
BANKG	-0.1146	-0.1158		-0.0099	-0.1162	-0.0614
COCAP	-2.8251***	-2.9209***	-2.9423***	-2.8224***	-2.9719***	-3.0599***
NPA	-1.0785**	-1.0692**	-1.0111*	-1.0493**	-1.0718**	-0.9459**
ADASSETS	-1.3059***	-1.3776***	-1.3320***	-1.3540***	-1.3684***	-1.2555***
GDPG	0.0510	0.0507	0.0508		0.0561	0.0522*
SIZE	-0.7196***	-0.7081***	-0.7183***	-0.7082***	-0.7203***	-0.7135***
ROA	-1.7396	-1.6113	-1.3735	-2.2787		-2.3612
OWNFD	0.1500	0.1168	0.1211	0.1322	0.1705	
TREND	-0.0322*	-0.0328*	-0.0277	-0.0266	-0.0272	-0.0255

Note: GEO is the percentage of bank branches outside the Western region; BANKG is the annual growth in branch networks; COCAP is the ratio of total equity to assets; NPA is the ratio between nonperforming advances and total advances; ADASSETS is the ratio between advances and total assets; GDPG is the real growth GDP; SIZE is the natural logarithm of bank total assets; ROA is the ratio of net profit before tax to total assets of the bank; OWNFD is a dummy variable for foreign ownership; TREND is the time trend.

It is worth noting that Farrell's efficiency score is higher than unity when a bank is relatively inefficient. Thus, a positive sign of a coefficient indicates a positive influence on inefficiency or a negative influence on efficiency. Similarly, a negative coefficient sign indicates a negative influence on inefficiency or a positive influence on efficiency. When interpreting the results of different models the influence on banks' *efficiency* is emphasised rather than their inefficiency

Results from the models indicate that the dispersion of branch networks, as measured by the percentage of bank branches outside the Western region, does not influence the intermediation efficiency of the banks. In addition, the growth of branch networks, as measured by the annual increase in the number of branches, also does not influence efficiency. Although the literature has highlighted a possible decline in efficiency with respect to an increase in costs due to the geographical dispersion of branch networks, our results do not support that view (Berger *et al.* 1997; Battese *et al.* 2000; Berger & De Young 2006). The negative impact of dispersion in the banking sector could be off-set by an increase in demand for banking services during the reference period due to healthy economic growth particularly during the post-conflict period from 2009–2014. Some studies, however, have also identified an increase in the volume of banking services consequent to growth in branches as a positive factor for improvement in banking efficiency (Berger & De Young 2001; Bos & Kolari 2005; Pasiouras 2008; Mahathanaseth & Tauer 2014).

Among the control variables used in the regression analysis the influence of the capital ratio on the efficiency of the banks is significant at the 1% level. Despite an array of regulatory requirements and directions issued by the CBSL on capital requirements the model shows a positive relationship between efficiency and the capital ratio, which is defined as the ratio of total capital to total assets. The impact of the capital adequacy regulation introduced by the CBSL is unlikely to be instrumental on banking performance since the capital ratios of most Sri Lankan banks are much higher than the capital adequacy requirement imposed by the CBSL (CBSL 2010; 2014). The literature also supports a positive relationship between the capital ratio and the performance of banks. Mester (1996) argued that a higher ratio of shareholders capital in banks prevents a moral hazard problem since the management of the banks with a high capital ratio experience higher shareholder scrutiny relative to banks with a lower capital ratio.

The NPA ratio shows a positive and significant relationship with banking sector efficiency at the 5% level, a result also found by Berger and De Young (1997) and Hou *et al.* (2014). It is worth mentioning that the NPA ratio is not a critical issue in the context of the Sri Lankan banking sector. The banking sector of Sri Lanka maintained a net NPA ratio below 5% on average during the reference period except for 2009 as a consequence of the GFC. A significant influence of the advances to total assets ratio (ADASSETS) on efficiency indicates that an improvement in the efficiency of banks can be expected with a greater focus on providing loans to customers than direct investment by banks. This can be due to the higher returns from loans relative to direct investment on securities and other assets in an environment of a lower NPA ratio.

The size of banks, as measured by total assets, has also recorded a positive relationship with efficiency at the 1% significance level. The positive effect of bank size on intermediation efficiency is supported by many studies including Drake *et al.* (2006) and Hou *et al.* (2014). In the context of Sri Lanka the majority of small banks are foreign banks and small banks may not be able to exploit the advantages of higher credit demand arising from overall economic growth during this period with their limited branch network. Meanwhile, large banks were able to expand their branch networks during the reference period to meet the demand for credit in the country including that of pent-up demand for banking services in conflict affected areas after the country achieved peace in 2009. Therefore, a positive relationship between size and intermediation efficiency can be expected based upon results from the regression model.

Overall, our results show that geographical dispersion and annual growth of branch networks have not adversely influenced the intermediation efficiency of Sri Lanka's banking sector, which experienced rapid expansion during the reference period.

7. Conclusion

This study has evaluated the impact of geographical dispersion and branch network density on the efficiency of Sri Lankan commercial banks for the period 2006–2014, using DEA based on semi-parametric double-bootstrap truncated regression models. The analysis provided in this study concludes that an expansion of banks in terms of number of branches and geographical coverage has not adversely influenced the efficiency of the Sri Lankan banking sector. Since this finding does not support the view of a possible decline in

efficiency with geographical dispersion and branch network density, as asserted in the literature, our analysis provides evidence in support of banking sector expansion in line with the healthy growth in the economy and increased demand for credit particularly in the post-conflict era of the country (Berger *et al.* 1997; Battese *et al.* 2000; Berger & De Young 2001; Vu & Turnell 2010). The insignificant influence of banking sector dispersion and network density on efficiency could be due to the high credit demand occurring in parallel with banking sector expansion in the post-conflict era. Therefore, policy makers may argue that the efficiency of the banking sector has not been adversely influenced by an increase in dispersion and bank network density in an era of high economic growth and rapid development.

An increase in the geographical dispersion of the banking sector could also be an effective policy tool with which to achieve broad-based and inclusive growth for an emerging post conflict economy such as Sri Lanka's. However, Sri Lankan policy makers who wish to use geographical spread and increased branch network density of the banks as a policy tool should proceed with caution, since the impact of such expansion could depend on the sustainability of higher economic growth of the country. If a decelerating trend of economic growth should occur it could put downward pressure on demand for banking services in the future, so that growth in branch network density and geographical dispersion coverage could negatively impact efficiency. Therefore, policy makers should provide necessary assistance to facilitate banks adjusting their branch networks to optimise their performance. The regulatory directive issued for compulsory branch opening in regional areas can be revised based on the expected overall economic growth and developments in regional areas which generate the demand for banking services.

Our study has broadened the scope of research on the determinants of intermediation efficiency of banks in an emerging market economy during a post-conflict economic boom. The findings of this study could also be applied to formulate strategies for banking sector development with respect to geographical coverage and density of branches targeting broad based economic growth for emerging nations at a similar development stage. Further, this would be an ideal case study for policy makers in emerging war torn nations who expect post-conflict economic revival through financial sector development strategies.

Overall, the empirical evidence presented in this study supports an expansion of the banking sector with beneficial outcomes for broad based, inclusive and sustainable growth. Therefore, strategies for further expansion of the banking sector targeting broad-based and inclusive growth while maintaining the intermediation efficiency of banks should be focused upon by policy makers. However, further expansion of the banking sector, in line with a deceleration in economic growth in future, could be an emerging challenge for regulators and policy makers.

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