EFFICIENCY OF COOPERATIVE RURAL BANKS IN SRI LANKA

The impact of size and location

Abstract

In recent years, small financial institutions (SFIs) have become the most favoured option for poverty alleviation in developing countries. In Sri Lanka, cooperative rural banks (CRBs), as SFIs, have made significant contributions to credit provisioning and savings mobilisation during the last few decades. The efficiency of these institutions is highlighted in all aspect of stakeholders' recently, due to the collapse of several financial institutions. This paper examines the efficiency of CRBs by using Data Envelopment Analysis (DEA). A comparative analysis of performance evaluation was undertaken to identify similarities and dissimilarities of efficiency improvements among different sizes and different locations of CRBs in Sri Lanka. The results indicate that the overall efficiency of CRBs in Sri Lanka declined over the period 2003-2005. CRBs size has a significant and positive relationship with efficiency in intermediation.

Key words: Efficiency; Small financial institutions; Data envelopment analysis; cooperative rural banks.

1. Introduction

Policy makers view microfinance as one solution to the growing demand for financial services by poor householders, particularly in developing countries (ADB 2000; UN 2005). Most formal commercial banks in these countries are reluctant to provide financial services in their rural sectors due to high risks, high costs involved in small transactions, and perceived low profitability. Hence, most people in rural areas acquire their financial needs from small financial institutions (SFIs) such as rural banks, credit unions, micro finance institutions (MFIs), or other informal financial institutions (ADB 2000) .

Consequently, SFIs serve a large number of customers, deal with a large amount of funds and contribute to the financial services sectors in developing countries. In this context, institutional efficiency is necessary because in the long run, only healthy institutions can offer continuous service to poor householders. The efficiency of these SFIs is of interest not only to householders, but also to managers, regulators and the general public because efficiency assures the smooth functioning of operational activities of institutions (Seibel 1999).

The importance of efficiency has been highlighted more recently in Sri Lanka with the collapse of several formal and informal financial institutions. The failure of Pramuka Bank in 2002 (a licensed specialised bank) and the collapse of Golden Key Credit Card Company in 2008 (a registered finance company and a member of a leading group of companies) in Sri Lanka are two examples. It is clear that poor governance and a lack of transparency are the primary reasons for these failures (Cabraal 2009). Hence, it is essential to continuously improve risk management and corporate governance of financial institutions, to ensure that the general public has confidence

in the financial system (Cabraal 2009). Therefore, a question arises with respect to the identification of which institutions provide financial services efficiently and which do not. A second question relates to how financial institutions can provide services more efficiently.

2. *Operational activities of CRBs*

The first co-operative rural banks (CRBs) in Sri Lanka were established in 1964 initially to provide micro-credit facilities to rural communities. As formal small financial institutions, CRBs have made significant contributions to credit provisioning and savings mobilisation. CRBs are generally focused on meeting the specific needs of rural householders. Over the last few decades, these institutions have gained an increasing share of deposits which has been particularly helpful in satisfying growing demand for loans and advances for the people living in the most rural parts of Sri Lanka.

As formal microcredit providers, CRBs in Sri Lanka have contributed substantial improvements in microcredit activities. The activities of CRBs make these institutions more approachable, people oriented and more attractive to small clients compared with other commercial banks (Charitonenko & De Silva 2002). After several re-organisations of multipurpose cooperative societies (MPCS) during the 1970s, every MPCS[1] established one or more CRB in a particular urban area or village. At the initial stage, the state-owned People's Bank supervised the accounting and finance systems of CRBs (Gant et al. 2002). As a consequence, the People's Bank[2] introduced accounting and finance systems appropriate for CRBs and also introduced a deposit

[1] At the end of 2006, 310 MPCSs established 310 CRBs with 1608 branches in the country (CBSL 2006).

[2] One of the state-owned commercial banks in Sri Lanka.

insurance scheme to invest CRBs' excess savings in the People's Bank. CRBs have been an important source of liquidity for the People's Bank for many years. However, the relationship between the People's Bank and CRBs has been transformed in a number of re-organisation programs over the period 1960 to 1990 (Gant et al. 2002). Since 1992, all CRBs' relationships with the People's Bank were terminated and CRBs have operated as independent financial institutions (Charitonenko & De Silva 2002). Currently, CRBs operate within a federated, four-tier cooperative structure with a network of fifteen district cooperative rural banking unions. The Sri Lanka Cooperative Rural Bank Federation Ltd (SLCRB) is the highest organisation of the movement and represents the National Co-operative Council. Each CRB in a particular district is a member of a district cooperative rural banking union.

With the introduction of Government poverty alleviation programs during the 1990s microfinance activities in Sri Lanka were expanded. In this context, during the period 1990 to 1995, a number of small and medium enterprises were promoted to established. As a result, most financial institutions encouraged microfinance activities (Charitonenko & De Silva 2002). Commercial banks, such as the Hatton National Bank and the Seylan Bank introduced many innovative microfinance programs. These programs were effective in most rural areas during the period 1991 to 1998 (Conroy 2000). Further, the Sanasa Development Bank, a small licensed specialised bank established on the cooperative model, has also become involved in microlending activities in urban and rural areas since 1998 (Charitonenko & De Silva 2002). The number of microlending activities has further increased due to large scale injection of foreign aid from multilateral funding agencies such as the Asian Development Bank, the World Bank and from bilateral agencies such as USAID, GTZ and AusAID since 2000 (Ameer 2001). Consequently, more government and donor agency funds have

been directed to CRBs to serve the needs of the rural financial sector (Ministry of Finance 2001). Moreover, the Sri Lankan Government expects to enhance the rural financial sector through several restructuring programss[3]. A principle goal of these changes has been to promote efficient and sustainable services to the rural financial sector.

Institutions engaging in microfinance activities around the world are not renowned for their commitment to financial transparency and this factor contributes to the fragile nature of institutions (Desrochersa & Lamberteb 2003; Rosenberg et al. 2003; Duflos et al. 2006; Florendo 2007). Further, no published research into the importance of SFIs as CRBs in Sri Lanka has been identified from reviews of the literature. Many financial institutions introduced a wide range of financial services to the rural financial sector after 2000. The number of SFIs operating in the rural finance market increased. This increase in SFIs may have resulted in greater competition and may have affected the overall efficiency of CRBs activities. Hence, an evaluation of their financial strength is of importance to the developing rural financial sector. Therefore, a quantitative assessment of the efficiency of CRBs in Sri Lanka fills this gap.

3. *Methodology*

For the assessment of efficiency, data envelopment analysis (DEA) was used to evaluate the efficiency of CRBs in Sri Lanka over the period 2003 to 2005. DEA is a methodology based on the concept of relative efficiency and is widely used in productivity and efficiency analyses of financial institutions (Brockett et al. 1997; Murthi, Choi & Desai 1997; Schaffnit, Rosen & Paradi 1997; Taylor et al. 1997;

[3] The Ministry of Finance in Sri Lanka launched the CRB restructuring project and the rural finance development project in 2006. These projects were funded by Asian Development Bank (ADB) to provide an efficient and sustainable financial service that will contribute to the economic growth of the rural community.

Soteriou & Zenios 1999; Saha & Ravisankar 2000; Portela & Thanassoulis 2007). It permits the selection of efficient firms within the industry. DEA was used in prior studies on the efficiency of financial institutions to examine the impact of some specific changes such as financial reforms, the impact of financial practices and the impact of different ownership groups. Gutiérrez-Nietoa, Serrano-Cincaa and Molinerob (2007) for example use DEA to analyse the efficiency of Latin American MFIs.

DEA assesses the efficiency frontier on the basis of all input and output information from the sample (Rogers 1998). Thus, the relative efficiency of firms operating in the same industry can be estimated (Fried et al. 2002). Hence, identification of performance indicators in CRBs is useful for identifying a benchmark for the whole industry. Moreover, the DEA methodology has the capacity to analyse multi-inputs and multi-outputs to assess the efficiency of institutions (Coelli, Rao & Battese 1998). While many efficiency studies of SFIs use traditional financial ratios (Gibbons & Meehan 1999; Jansson & Taborga 2000; Tucker & Miles 2004) these ratios provide only partial measures of efficiency. Partial measures can be misleading when attempting to draw conclusions about the overall efficiency of institutions (Berger & Humphrey 1997; Coelli, Rao & Battese 1998). The DEA approach does not suffer this constraint.

3.1 DEA formulation

Several DEA models have been presented in the literature. The basic DEA model evaluates efficiency based on the productivity ratio which is the ratio of outputs to inputs. This study applied Charnes, Cooper and Rhodes's (CCR) (1978) model and Banker, Charnes and Cooper (BCC) (1984) model. The production frontier has

constant returns to scale in the CCR model. The basic CCR formulation (dual problem/envelopment form) is provided in Equation One (See Appendix A).

In this Equation, θ denotes the efficiency of DMU_j. while y_{rj} is the amount of r^{th} outputs produced by DMU_j using x_{ij} amount of i^{th} input. Both y_{rj} and x_{ij} are exogenous variables and λ_j represents the benchmarks for a specific DMU under evaluation (Zhu 2003). Slack variables are represented by s_i and s_r. According to Cooper, Seiford and Tone (2004) the constraints of this model are:

i. the combination of the input of firm j is less than or equal to the linear combination of inputs for the firm on the frontier;

ii. the output of firm j is less than or equal to a linear combination of inputs for the firm on the frontier; and

iii. the main decision variable θ_j lies between one and zero.

Further, the model assumes that all firms are operating at an optimal scale. However, imperfect competition and constraints to finance may cause some firms to operate at some level different to the optimal scale (Coelli, Rao & Battese 1998). Hence, the Banker, Charnes and Cooper (1984) BCC model is developed with a production frontier that has variable returns to scale. The BCC model forms a convex combination of DMUs (Coelli, Rao & Battese 1998). Then the constant returns to scale linear programming problem can be modified to one with variable returns to scale by adding the convexity constraint $\sum_{\lambda j} = 1$ (Zhu 2003). Equation Two illustrates (see Appendix A) the basic BCC formulation (dual problem/envelopment form).

This approach forms a convex hull of intersecting planes (Coelli, Rao & Battese 1998). These planes envelop the data points more tightly than the constant returns to scale (CRS) conical hull. As a result, the variable returns to scale (VRS) approach provides technical efficiency (TE) scores that are greater than or equal to scores obtained from the CRS approach (Coelli, Rao & Battese 1998). Moreover, VRS specifications will permit the calculation of TE decomposed into two components: scale of efficiency (SE) and pure technical efficiency (PTE). The relationship of these concepts is shown in the Equation Three (Appendix A). Hence, this study first uses the CCR model to assess TE then applies the BCC model to identify PTE and SE in each DMU.

4. Institution-specific characteristics - location and efficiency

Prior literature provides evidence that the institution's specific characteristics influence efficiency. Drake and Hall (2003) use DEA to assess the efficiency of Japanese banks and report that larger banks tend to operate above the minimum efficient scale. Hughes et al. (1996) find geographic diversification and deposit diversification enhance efficiency. The number of deposits and branches are positively related to performance (Hughes et al. 1996). In their sample of German cooperative banks, Lang and Welzel (1996) find that bank size deviates considerably from the best practice frontier. Neal (2004) finds that regional Australian banks are less efficient than national banks. Further, Neal discovers that the Australian banking institutions were less efficient in 1999 than they had been in 1995. Elyasiani and Mehdian (1990) find that US commercial banks with more branches are more efficient than those with small numbers of branches. In contrast, Eisenbeis, Ferrier

and Kwan (1999) and Drake and Hall (2003) argue that efficiency has a negative relationship with bank size in cooperatives.

CRBs in Sri Lanka are located across the country. They operate in urban areas and in the rural regions. Hence, this study explores how regional disparities impact on the efficiency of these SFIs. Further, there are differences in the number of operating branches, deposits, loans, and investments of institutions (size) operated in different districts.

The first step in this part of the analysis was to establish if the specific characteristics and location effects are independent. Results from the assessment of independence determined the testing approach. For example, if specific characteristics and location are unrelated, correlation coefficients can be used to test the association between specific characteristics and efficiency. The Kruskal-Wallis test for differences was then used to test for efficiency attributable to geographic location. This paper seeks to test whether CRBs size and location have a significant impact on efficiency of CRBs in Sri Lanka. The following hypotheses were formulated.

(H_1) CRBs in Sri Lanka operate efficiently in providing microcredit activities.

(H_{2a}) CRB size and (H_{2b}) location affect efficiency.

5. Sample and selection of inputs and outputs

5.1 Sample

The study was based on 108 CRBs established in Sri Lanka. The required data was obtained from CRBs for the three years 2003 to 2005. The comparison of efficiency was made between years 2003 to 2005. The sample period was chosen to measure the

baseline for efficiency after the introduction of wide range of financial services to the rural financial sector in many SFIs.

5.2 Inputs and outputs

There is considerable debate in the empirical literature about the selection of input and output combinations. Three basic approaches for financial institutions were used in DEA research. These were the intermediation, production and asset approaches. The intermediation approach views financial institutions mainly as mediators of funds between savers and investors (Yue 1992; Avkiran 1999). The production approach emphasises the role of financial institutions as providers of services for account holders (Drake & Weyman-Jones 1992). With the asset approach, outputs were strictly defined by assets and the productivity of loans (Favero & Papi 1995).

Intermediation and asset approach were used in this study to assess the efficiency of CRBs in Sri Lanka. The other approaches have not been used as the appropriate internal data were unavailable. Individual CRB was considered as a DMU. The efficiency scores were estimated for individual CRB and mean efficiency scores are calculated for the sample as a whole. The annual trends in estimated efficiency were also examined with mean estimated scores over the study period. The Table 1 (see Appendix B) presents the input-output specifications. These inputs and outputs have been identified from prior studies conducted in different contexts.

6. Analysis and findings

6.1 Efficiency in intermediation

Table 2 (Appendix B) presents the summary of efficiency analysis on intermediation. The TE (I) represents technical efficiency (intermediation) in the Charnes, Cooper,

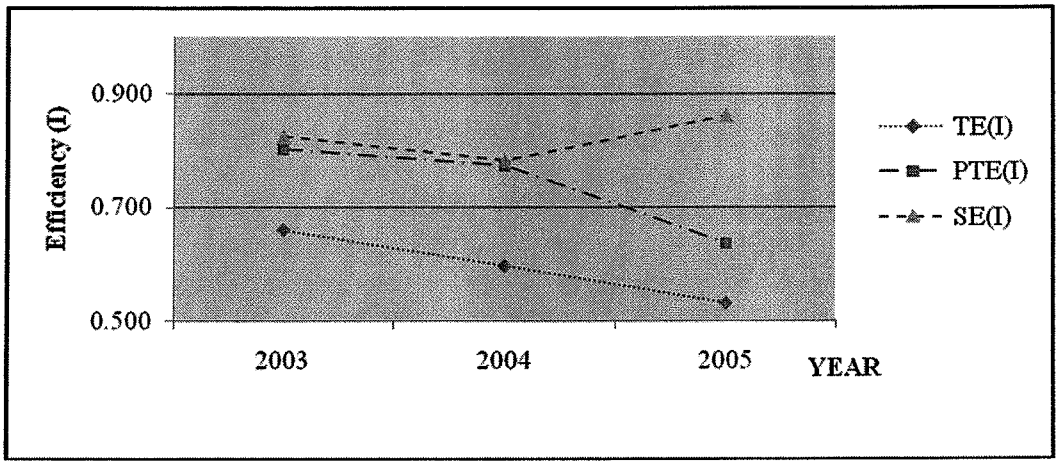
and Rhodes (CCR) model [Constant returns to scale (CRS) specification]; PTE (I) represents pure-technical efficiency (intermediation) in the Banker, Charnes, and Cooper (BCC) model [Variable returns to scale (VRS) specification]; and SE (I) represents scale efficiency (intermediation) with VRS. As stated previously, CRS ignores scale differences and assumes that all CRBs are operating at the optimal scale. In contrast, VRS assesses efficiency after controlling for scale differences. Efficiency scores are calculated for both CRS and VRS to shed light on the potential impacts of scale differences on efficiency.

The TE (I) scores in Table 2 (Appendix B) show eight CRBs (10%) in 2003, five (5%) in 2004 and six (6%) in 2005 are efficient as indicated by efficiency scores equal to 1.00. The PTE (I) scores show 24 (30%) CRBs are efficient in 2003, 18 (19%) in 2004 and 18 (18%) in 2005. The number of efficient CRBs on SE (I) are consistent with the TE (I) except for 2005.

Regarding mean scores, there is a downward trend in average TE (I) from 2003 to 2005 (66.0% in 2003, 59.7% in 2004 and 53.2% in 2005) (Figure 1). A similar trend exists for PTE (I) (80.2% in 2003, 77.4% in 2004 and 63.7% in 2005). However, although SE (I) declines from 82.0% to 78.0% from 2003 to 2004, it recovers to 86.0% in 2005. The average efficiency scores of the least efficient CRBs in the sample are also continuously declining over the study period. This is evident in the minimum efficiency scores reported (Table 1) (Appendix B). The minimum score for TE (I) in 2003 (33%) fell to 16% in 2005. Although the estimated average efficiency scores for all CRBs show a declining trend throughout the study period, there was a slight upward trend in SE (I). This is attributed to scale differences in CRBs. These

results suggest that CRBs do not use their inputs efficiently and they could produce the same outputs while reducing inputs.

Figure 1 : Mean efficiency in intermediation, 2003-2005



TE (I) = Technical efficiency in intermediation. PTE (I) = Pure technical efficiency in intermediation.
SE (I) = Scale efficiency in intermediation. Efficiency (I) = Efficiency in intermediation.

Further, the efficiency in intermediation was analysed by CRBs size and location. CRB were categorised as large, medium and small size. The size was measured with the number of branches, employees and loans of each bank. CRB's location was determined by the district of operations. Kruskal-Wallis tests (for differences in mean efficiency attributable to size[4]) were used to assess the differences (Table 3 Appendix B) presents the results of the Kruskal-Wallis test

The Kruskal-Wallis statistics in Table 3 (Appendix B) show that there were significant differences ($p< 0.05$) in TE (I) and PTE (I) for all CRBs' sizes. Overall, the results show that there were efficiency gaps between large scale CRBs and small and medium CRBs operating in Sri Lanka. Further, Kruskal-Wallis test scores show there were significant differences in TE (I) for the sample districts.

[4] Mean efficiency and Kruskal-Wallis statistics are reported using only three metrics, number of branches, number of employees and loans. With the exception of the 'members' measure of size, results for other size metrics (income, deposit and investments) are broadly consistent with those reported here for efficiency in intermediation.

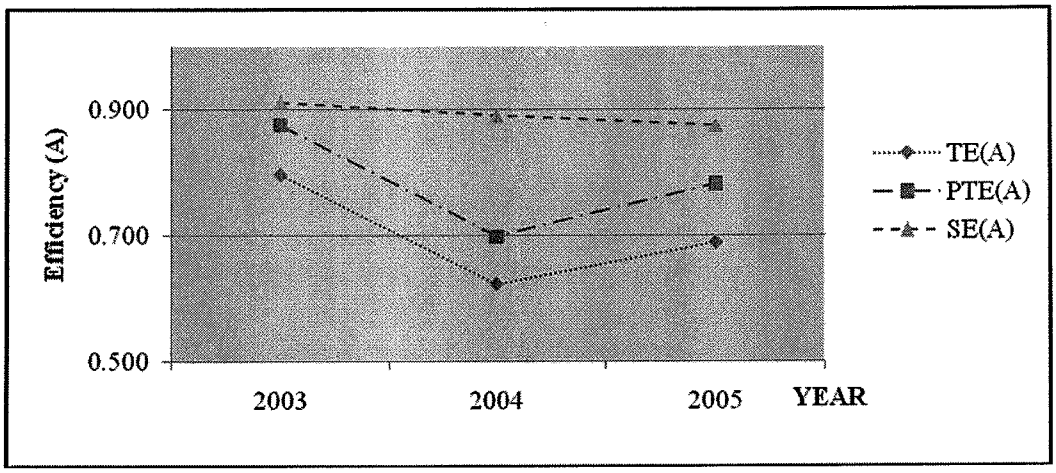
6.2 Efficiency in asset transformation

In addition to evaluating efficiency in intermediation, this study evaluated efficiency in the asset transformation process. Asset transformation requires the maximisation of the usage of assets, turning idle assets into working capital for income generation uses. CRBs maximising the usage of assets perform better than those that don't. The evaluation of efficiency in asset transformation of CRBs based on estimated efficiency scores from model two are presented in this section.

TE (A) represents technical efficiency in asset transformation from the CCR model (CRS specification). PTE (A) represents pure-technical efficiency in asset transformation from the BCC model (VRS specification). SE (A) represents scale efficiency in asset transformation from the VRS model. Table 4 (Appendix B) presents a summary of the estimated efficiency scores in asset transformation. The estimated efficiency scores for each DMU and the estimated mean efficiency scores in the three year window for each DMU are shown.

For TE (A) scores, 22 CRBs (27%) in 2003, 17 (20%) in 2004 and 18 (18%) in 2005 were efficient. A similar trend exists for PTE (A) scores; 40 (48%) CRBs were efficient in 2003, 25 (25%) in 2004, and 31 (31%) were efficient in 2005. SE (A) scores, too, show a very similar downward trend for CRBs during this period.

Figure 2: Mean efficiency in asset transformation, 2003-2005



TE (A) = Technical efficiency in asset transformation. PTE (A) = Pure technical efficiency in assets transformation. SE (A) = Scale efficiency in assets transformation. Efficiency (A) = Efficiency in asset transformation.

Mean efficiency scores in asset transformation show a downward trend in average TE (A) from 2003 to 2004 (79.6% in 2003 and 62.2% in 2004) and a little recovery to 68.8% in 2005 (Figure 2). A similar trend exists for PTE (A); 87.5% in 2003, 69.8% in 2004 and 78.1% in 2005. SE (A) declines from 91.1% in 2003 to 89.0% to 2004, and to 87.4% in 2005. Generally, estimated average efficiency scores for all CRBs show a falling trend throughout the study period. These results suggest that, with respect to efficiency in asset transformation, CRBs do not maximise the usage of their assets and their performance in this area is deteriorating.

Efficiency scores in the asset transformation model also are calculated for the CRBs' size categories. The Kruskal-Wallis statistics (in asset transformation by CRBs size and location) show ($p > 0.05$) there were no substantial differences in TE (I) and PTE (I) for CRB size (except size metric in numbers of employees) (Table 5 Appendix B). However, there was a substantial difference in SE (A) with changes in number of employees and loans. Although there gaps in efficiency were identified between large

scale CRBs and small and medium CRBs for efficiency in intermediation the evidence for asset transformation was less clear.

Overall, only eight (10% of the sample) CRBs with TE (I) scores of 1.00 could be classified as very strong in terms of the intermediation process where as twenty two (27% of the sample) CRBs with TE (A) scores of 1.00 were operating at the optimal scale of asset transformation in 2003. The mean of estimated efficiency scores in both models show that most of CRBs over the study period did not use their inputs efficiently. Mean scores for efficiency in intermediation and efficiency in assets transformation over the study period show a continuous decline. This indicates that the majority of CRBs have become less efficient over the study period. Recorded efficiency scores for both models are well below 100% (TE (I) of 53.2% and TE (A) of 68.8% in 2005), indicating that the majority of the CRBs in the sample did not maintain a high level of intermediation and asset transformation during the study period. These results suggest that CRBs can save more than 30% of their inputs while maintaining the same levels of outputs.

In Sri Lanka, many new financial institutions entered the rural finance market in Sri Lanka and other commercial banks diversified their activities to include microfinance services after 2000. In addition, several structural changes occurred in the financial sector, along with the establishment of wider operating activities in the commercial banking sector. Many financial institutions introduced innovative service delivery mechanisms in financial services to attract customers (CBSL 2006). However, internal constraints, such as lack of awareness of best practices in microfinance, weak institutional capacity and a negative perception of the commercialisation decision, hamper diversification of activities of MFIs and result in decreasing membership

(Charitonenko & De Silva 2002). These circumstances appear to have adversely affected CRBs functions and their efficiency.

Overall, there is no substantive improvement in efficiency in either the intermediation or asset transformation processes. This negative trend in efficiency over the period suggests that on the whole, CRBs have become less efficient. Therefore, H_1 is rejected and it is concluded that overall, CRBs in Sri Lanka do not operate efficiently in providing microcredit activities.

6.3 Size and location effects

However, when analysing CRBs of different sizes, a different picture emerges. In terms of efficiency scores in the intermediation model, large and medium size CRBs (56% of the sample, which dominates the rural financial sector in Sri Lanka) are most efficient. The higher efficiency scores for large and medium CRBs indicates that large and medium size CRBs managed their inputs and outputs efficiently. These results reveal efficiency gaps between large and small scale CRBs in Sri Lanka. However, in terms of the asset transformation model, the Kruskal-Wallis tests do not provide clear indications of differences in efficiency on asset transformation by CRB size.

The number of branches, the number of employees, and average loans, are the size metrics of CRBs in this analysis. Spearman correlation coefficients were calculated to test for associations of size and efficiency (Table 6 Appendix B). The results confirm that the CRB size metrics and efficiency in intermediation [TE (I)] have significant positive correlations. This provides some support for H_{2a} which predicts CRB size variables are related to efficiency of CRBs. This shows that larger CRBs are more efficient in TE (I). Support for H_{2a} is weaker when efficiency is measured by the asset

transformation [TE (A)] model. However, TE (A) scores are uncorrelated with number of branches, number of employees, and loans. The results show that CRB size metrics do not affect the efficiency in asset transformation process.

The districts of CRBs' operations were used to identify location. The Kruskal-Wallis statistics were used to test for differences in the efficiency of CRBs attributable to operating in different geographical locations (Table 7 Appendix B). The Kruskal-Wallis scores *($p<0.05$)* indicate that there is a statistically significant difference in efficiency scores for both the TE (I) and TE (A) models. The results suggest that a difference in the operational environment contributes to differences in CRBs' efficiencies. Hypothesis H_{2b} is supported, although size may be a confounding variable in this analysis. This may be due to the governance practices existing in several district unions of CRBs. CRB district unions provide financial guidance, innovative approaches to human resources development and advice on modern technology to enhance the efficiency of their members. CRBs that operate in urban areas apply more innovative approaches to diversify their activities than CRBs operating in rural areas.

7. Conclusion

The main objective of this study was to investigate the efficiency of CRBs in Sri Lanka. It also investigated the size and location of these institutions and their affect on efficiency. Having obtained the efficiency measures, a correlation analysis was undertaken to explain variation in estimated efficiency scores to size and location of CRBs.

It was found that there was no substantive improvement in efficiency over the sample period in either the intermediation or assets transformation approach. However, when analysing size of CRBs, large CRBs were more efficient than small CRBs in intermediation approach. Further, the study found that there is a statistically significant difference in different geographical locations in efficiency scores for both intermediation and assets transformation models.

The findings of this study, although only suggestive of certain correlations, would help bank managers and other authorities to understand the underlying problems in improving efficiency of these CRBs. It could also support policy makers to establish more comprehensive policy settings for promoting SFIs in the rural finance sector in Sri Lanka. Further, the findings may help to provide some directions for developing efficient financial services in the rural finance sector which is one of the ways of poverty alleviation in the country. Moreover, findings may provide sufficient motivation to undertake further studies to refine measures of efficiency for SFIs.

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Appendix A- Equations

Equation One: The basic CCR formulation (dual problem/envelopment form)

$$Min\theta - \varepsilon\left(\sum_{j=1}^{m} s_j^{-} + \sum_{r=1}^{s} s_r^{+}\right)$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s^{-} = \theta x_{io} \quad (i = 1, \ldots\ldots, m)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^{+} = y_{ro} \quad (r = 1 \ldots\ldots, s)$$

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

Source: Zhu (2003, p.13)

Equation Two: The basic BCC formulation (dual problem/envelopment form)

$$Min\theta - \varepsilon\left(\sum_{j=1}^{m} s_j^{-} + \sum_{r=1}^{s} s_r^{+}\right)$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s^{-} = \theta x_{io} \qquad (i = 1, \ldots\ldots, m)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^{+} = y_{ro} \qquad (r = 1 \ldots\ldots, s)$$

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

$$\sum_{j=1}^{n} \lambda_j = 1$$

Source: Zhu (2003 , p.13)

Equation Three: Relationship between TE, PTE and SE

$$TE_{CRS} = PTE_{VRS} * SE$$

where

TE_{CRS} = Technical efficiency of constant returns to scale
PTE_{VRS} = Technical efficiency of variable returns to scale
SE = Scale of efficiency

Source: Coelli, Rao and Battese (1998)

Appendix B-Tables

Table 1: Input-output specifications

Variables	Definition	Intermediation approach
		Input/ Output
Total expenses	Amount paid as interest on deposits, wages and other benefits to employees, and expenses incurred on other facilities	Input
Loans	Amount of loan provided	Output
Pawning	Amount of advances provided on pawning	Output
Interest income	Income received on investments as interest	Output
Other income	Income received on other investments	Output
Variables	**Definition**	**Assets Transformation approach**
		Input/ Output
Deposits	Amounts collected as deposits	Input
Other funds	Funds received from other sources	Input
No. of employees	Full time workers in the bank	Input
Loans	Amount of loans provided	Output
Pawning	Amount of advances provided on pawning	Output
Investments	All investments in the banks	Output

Table 2: Summary of efficiency analysis in intermediation

Description	2003			2004			2005		
	TE(I)	PTE(I)	SE(I)	TE(I)	PTE(I)	SE(I)	TE(I)	PTE(I)	SE(I)
No. of evaluated CRBs	78	78	78	97	97	97	101	101	101
No. of efficient CRBs	8	24	8	5	18	5	6	18	7
No. of inefficient CRBs	70	54	70	92	79	92	95	83	94
Mean score	0.660	0.802	0.820	0.597	0.774	0.780	0.532	0.637	0.860
Standard deviation	0.194	0.195	0.120	0.172	0.184	0.150	0.194	0.231	0.170
Maximum score	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Minimum score	0.336	0.352	0.510	0.213	0.223	0.380	0.163	0.236	0.270

TE (I) = Technical efficiency in intermediation. PTE (I) = Pure technical efficiency in intermediation.

SE (I) = Scale efficiency in intermediation.

Table 3 : Kruskal-Wallis test scores in intermediation by CRBs size

Test	Branches	TE(I)	PTE(I)	SE(I)
Kruskal-Wallis Chi-Square		6.709	7.366	.966
p-value		0.035	0.025	0.617
Test	Employees			
Kruskal-Wallis Chi-Square		10.906	8.266	0.346
p-value		0.004	0.016	0.841
Test	Loan			
Kruskal-Wallis Chi-Square		8.848	17.379	1.425
p-value		0.012	0.000	0.490
Test	Locations			
Kruskal-Wallis Chi-Square		54.29	39.24	32.42
ρ -value		0.000	0.000	0.001

Table 4: Summary of efficiency results in asset transformation

Description	2003			2004			2005		
	TE(A)	PTE(A)	SE(A)	TE(A)	PTE(A)	SE(A)	TE(A)	PTE(A)	SE(A)
No.of evaluated DMUs	83	83	83	102	102	102	100	100	100
No. of efficient DMUs	22	40	23	17	25	19	18	31	21
No. of inefficient DMUs	61	43	60	85	77	83	82	69	79
Mean score	.796	.875	.911	.622	.698	.890	.688	.781	.874
Standard deviation	.220	.163	.151	.249	.239	.153	.249	.208	.185
Maximum score	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Minimum score	.067	.486	.067	.089	.222	.089	.084	.265	.084

TE (A) = Technical efficiency in asset transformation. PTE (A) = Pure technical efficiency in assets transformation. SE (A) = Scale efficiency in assets transformation.

Table 5: Kruskal-Wallis test scores in asset transformation by CRBs sizes and locations

Test	Branches	TE(A)	PTE(A)	SE(A)
Kruskal-Wallis Chi-Square		1.081	0.147	2.593
p -value		0.582	0.929	0.273
Test	Employees			
Kruskal-Wallis Chi-Square		1.633	7.305	20.695
p -value		0.442	0.026	0.000
Test	Loans			
Kruskal-Wallis Chi-Square		4.839	5.915	9.408
p -value		0.089	0.052	0.009
Test	Locations			
Kruskal-Wallis Chi-Square		27.149	27.841	28.065
ρ - value		0.004	0.003	0.003

Table 6: Spearman correlation coefficients for CRBs' size and efficiencies

Institution-specific characteristic	Hypothesised correlation to efficiency	Correlation coefficient	Support the hypothesis	Correlation coefficient	Support the hypothesis
		TE (I)		TE (A)	
Number of branches	Positive	**0.240***	Yes	0.037	No
Number of employees	Positive	**0.317****	Yes	0.038	No
Loans	Positive	**0.283****	Yes	0.179	No

** Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level
TE (I) = Technical efficiency in intermediation. TE (A) = Technical efficiency in asset transformation.

Table 7: The Kruskal-Wallis statistics for CRBs' locations and efficiencies

Test	TE (I)	Support the hypothesis	TE (A)	Support the hypothesis
Kruskal-Wallis Chi-Square	54.29	Yes	27.14	Yes
p - value	0.000		0.004	