

<http://ansinet.com/itj>

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSI*net*

Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Commercial Banking Efficiency in Nepal: Application of DEA and Tobit Model

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Abstract: The competitive scenery of the global economic activity needs the productivity-driven banking industry to be paying special attention for its relative level of efficacy compared to its competitors. The study presents technical efficiency, pure technical efficiency and scale efficiency of the selected eighteen commercial banks in Nepal using input-oriented data envelopment analysis for the period 2005-2010. The mean technical inefficiency of the commercial banks was 16.0% while the average pure technical and scale inefficiencies were 11.16 and 5.50%, respectively. The tobit model to estimate the impact of risk management factors indicates that the capital risk (CAR), Liquidity risk (CDR), profitable ratios (ROA and ROE) have influenced the efficiencies, however, credit risk (NPL) reduced the levels of the commercial banks efficiency. Commercial bank size had consistently inverse impact on technical, pure technical and scale efficiencies. It can be concluded that the Nepalese commercial banks inefficiency was attributed to pure technical inefficiency rather than scale inefficiency, ensuring the commercial banks were performing at their best levels of operations. Furthermore, the joint venture and domestic private banks were more efficient than public sector banks, which suffered managerial underperformance and choice of inappropriate scale size.

Key words: Nepalese commercial banks, data envelopment analysis, inefficiency, ownership, tobit regression analysis

INTRODUCTION

The reliability of commercial banks has been treated as one of the essential factors everywhere since the past few decades. In order to draw global attention for dynamic investments in a competitive international business environment, healthy and efficient commercial banks are needed. The proficient commercial banks help to boost the effectiveness of the macroeconomic management (Kirikal *et al.*, 2004). The dexterous banks are better able to compete because of their lower operational costs and can steal business away from less efficient banks. The cavernous exploration of the relative efficiency of the commercial banks is very essential due to the increasing attention of the stakeholders to genuinely update with their performance and comparative efficiency. Data Envelopment Analysis (DEA) developed by Charnes *et al.* (1978) as a nonparametric technique, has the advantage of being able to handle multiple inputs and outputs (Charnes *et al.*, 1995) to evaluate the relative efficiencies of multiple Decision-Making Units (DMUs). The selection of inputs and outputs is crucial in DEA analysis and the commercial banks under intermediary approach accept deposits to use them for making loans

and generating interest income (Canhoto and Dermine, 2003; Drake and Hall, 2003; Jemric and Vujcic, 2002).

In Nepal, several commercial banks make a way to the business after the liberalization in 1980, deregulation, advancement in information technology and globalization (Gajurel and Pradhan, 2012). Since, then, many Joint-Venture Banks (JVB) and Domestic Private Banks (DPB) entered into the market. Commercial banks presently hold a large share of economic activities of the country constituted 82.10% of total assets (Nepal Rastra Bank, 2011). Stock market has been dominated by the commercial banks since a decade (Poudel, 2002). As the growth of the commercial banks and the improvement in their efficiencies influence economic growth (Staub *et al.*, 2010), understanding the determinants of the commercial bank efficiencies is helpful not only for the design of better management strategies but also general subject of interest for the investors, depositors and for the public concern. However, Nepalese commercial banks have been always working towards the technological advances for efficient banking functions, the commercial banks are facing growing competition due to the globalization of the financial systems (Banstola, 2007; Gajurel and Pradhan, 2012). Despite the significantly technological changes and

growth of commercial banks in Nepal (Gajurel and Pradhan, 2012; Nepal Rastra Bank, 2011), there are no previous studies that handled the subject of technical efficiency of the commercial banking sector in Nepal. The objective of this study was to measure whether the commercial banks in Nepal were efficient and there was a significant difference in their efficiencies among the Nepalese commercial banks due to their ownership. The influence of risk management factors on commercial banks' efficiency has also been examined as well.

THE STRUCTURE OF COMMERCIAL BANKS IN NEPAL

Nepalese commercial banks commenced from the establishment of Nepal Bank Limited (NBL) as a first commercial bank in 1937 (Gajurel and Pradhan, 2012). The establishment of Nepal Rastra Bank (NRB) in 1956 as the central bank of Nepal gave a new dimension to Nepalese financial system (Nepal Rastra Bank, 2011; Poudel, 2002). Nepal adopted financial sector liberalization process during 1980s, which opened the door for many JVBs and DPBs (Nepal Rastra Bank, 2011). There are presently 27 commercial banks comprising 3 public sector banks which include Rastriya Banijya Bank Ltd. (RBBL), Nepal Bank Ltd. (NBL) and Agriculture Development Bank Ltd. (ADBL), 7 JVBs including NABIL Bank Ltd. (NABIL), Standard Chartered Bank Ltd. (SCBL), Himalayan Bank Ltd. (HBL), Nepal SBI Bank Ltd. (NSBI), Nepal Bangladesh Bank Ltd. (NBBL) and Everest Bank Ltd. (EBL) and 17 DPBs including Nepal Investment Bank Ltd. (NIBL), Bank of Kathmandu Ltd. (BOK), Nepal Credit and Commerce Bank Ltd. (NCCBL), Lumbini Bank Ltd. (LBL), Nepal Industrial and Commercial Bank Ltd. (NIC), Machhapuchhre Bank Ltd. (MPBL), Kumari Bank Ltd. (KBL), Laxmi Bank Ltd. (LXBL) and Siddhartha Bank Ltd. (SBL). The public sector banks have the massive branch networks around the country and cover 24.30% of the total assets of the commercial banks (Nepal Rastra Bank, 2011). But the financial health of the public banks namely NBL and RBBL is very poor due to the significant loss of capital, weak assets quality, low profitability, over-staffing and poor management (Jha and Hui, 2012). Whereas joint venture and domestic private banks have very few branch networks and are concentrated in urban centers (Banstola, 2007). However, the domestic private and joint venture banks have increased substantially and adopted new financial technology to align their business process, the severe and prolonged liquidity problem, scarcity of energy, skilled labor problem, political uncertainty are adversely affecting the market conditions.

MATERIALS AND METHODS

Data and variables: This paper analyzes 18 Nepalese commercial banks over the six fiscal years of 2005-2010. The commercial banks, which were established before 2005, were only selected in this analysis in order to ensure comparability of the considered banks. As this investigation for the evaluation of the efficiency using input-oriented DEA approach was treated the commercial banks as financial intermediary institutions, deposits and interest expenses were applied as input variables while loan advances and interest income were as the output variables. Actually, the DEA model is a non statistical method and the input-oriented DEA model mainly focuses on the input minimization to get the efficiencies keeping the output variables at their current levels. All the input and output variables were measured in Nepalese Rupees. In order to further investigate the effects of risk management factors on the technical, pure technical and scale efficiencies, this study followed with a Tobit model. The determinants of commercial banking efficiency were investigated based on Panel data with 108 observations. The technical, pure technical and scale efficiency scores obtained from DEA evaluations were used as the dependent variables. The Return on Assets (ROA), Return on Equity (ROE), Capital Adequacy Ratio (CAR), Credit to Deposit Ratio (CDR), Non-Performing Loan Ratio (NPL) and Size were used as independent variables. All the variables were measured in percentage except size, which was considered in Nepalese Rupees. The required data were mainly obtained from the Nepal Rastra Bank Bulletin (published by the Central Bank of Nepal), annual audited financial statements of the commercial banks (published by the respective banks).

The CCR and BCC models: The research applied the two-stage DEA technique based on CCR (named after Charnes *et al.*, 1978) and BCC (named after Banker *et al.*, 1984) models to obtain efficiency measures under CRS (constant return on scale) and VRS (variable return on scale) assumptions. All the estimations for DEA analysis have been performed in the MATLAB R2010a program whereas the ordinary calculations were done in Excel. The Technical Efficiency (TE) and Pure Technical Efficiency (PTE) were determined by CCR (CRS) model and BCC (VRS) model, respectively. The scale efficiency was found by TE/PTE.

The CCR model can be defined as follows: Consider a set of Decision Making Units (DMUs) to be evaluated, DMU_j ($j = 1, 2, \dots, n$) that consumes the

amounts $X_j = \{x_{ij}\}$ of m different inputs ($i = 1, \dots, m$) and produces the amounts $Y_j = \{y_{rj}\}$ of r outputs ($r = 1, \dots, s$). The technical efficiency of a particular DMU₀ under the assumption of constant returns to scale (CRS) can be obtained from the following linear programs:

$$\begin{aligned} & \max \sum_{i=1}^m u_i y_{i0} / \sum_{i=1}^m v_i x_{i0} \\ & \text{s.t. } \sum_{i=1}^m u_i y_{ij} / \sum_{i=1}^m v_i x_{ij} \leq 1, j=1, \dots, n \\ & u_i, v_i \geq \varepsilon; r=1, \dots, s; i=1, \dots, m \end{aligned} \tag{1}$$

Its dual program is as follows:

$$\begin{aligned} & \min \theta - \varepsilon (\sum_{i=1}^m s_i^- + \sum_{i=1}^m s_i^+) \\ & \text{s.t. } \sum_{j=1}^n \lambda_j x_{ij} + s_i^- = \theta x_{i0}, i=1, \dots, m \\ & \sum_{j=1}^n \lambda_j y_{rj} - s_r^+ = y_{r0}, r=1, \dots, s \\ & \lambda_j, s_i^-, s_r^+ \geq 0, j=1, \dots, n \end{aligned} \tag{2}$$

BCC model can be defined as follows: The BCC model allows a calculation of pure technical efficiency that is measured without the scale efficiency. The mathematical form of BCC model is as follows:

$$\begin{aligned} & \text{PTE}_0 = \max \left(\sum_{i=1}^s u_i y_{i0} + \mu_0 \right) / \sum_{i=1}^m v_i x_{i0} \\ & \text{s.t. } \sum_{i=1}^s u_i y_{ij} + \mu_0 - \sum_{i=1}^m v_i x_{ij} \leq 0, j=1, \dots, n \\ & u_i, v_i \geq \varepsilon; r=1, \dots, s; i=1, \dots, m \end{aligned} \tag{3}$$

Its dual program is as follows:

$$\begin{aligned} & \min \theta_0^{\text{BCC}} - \varepsilon (\sum_{i=1}^s s_i^+ + \sum_{i=1}^m s_i^-) \\ & \text{s.t. } \sum_{j=1}^n \lambda_j x_{ij} + s_i^- = \theta_0^{\text{BCC}} x_{i0}, i=1, \dots, m \\ & \sum_{j=1}^n \lambda_j y_{rj} - s_r^+ = y_{r0}, r=1, \dots, s \\ & \sum_{j=1}^n \lambda_j = 1 \\ & \lambda_j, s_i^-, s_r^+ \geq 0; i=1, \dots, m; r=1, \dots, s; j=1, \dots, n \end{aligned} \tag{4}$$

The tobit model: The tobit regression analysis was performed using E-views 7 software program in this study. The estimations were presented under different significant levels (1, 5 and 10%). The tobit model can be defined as follows:

$$\text{TE}_x = C + \beta_1 \text{ROA}_x + \beta_2 \text{ROE}_x + \beta_3 \text{CAR}_x + \beta_4 \text{NPL}_x + \beta_5 \text{CDR}_x + \beta_6 \text{SIZE}_x + \beta_7 \text{OWN}_x + \mu_x \tag{5}$$

$$\text{PTE}_x = C + \beta_1 \text{ROA}_x + \beta_2 \text{ROE}_x + \beta_3 \text{CAR}_x + \beta_4 \text{NPL}_x + \beta_5 \text{CDR}_x + \beta_6 \text{SIZE}_x + \beta_7 \text{OWN}_x + \mu_x \tag{6}$$

$$\text{SE}_x = C + \beta_1 \text{ROA}_x + \beta_2 \text{ROE}_x + \beta_3 \text{CAR}_x + \beta_4 \text{NPL}_x + \beta_5 \text{CDR}_x + \beta_6 \text{SIZE}_x + \beta_7 \text{OWN}_x + \mu_x \tag{7}$$

Where:

Te_{it} = Technical efficiency score obtained by i th bank in time period t under CRS

PTE_{it} = Pure technical efficiency score obtained by i th bank in time period t under VRS

Se_{it} = Scale efficiency score obtained by i th bank in time period t

ROA_{it} and $\text{ROE}_{it}-\text{ROA}_{it}$ represents the Return on Assets for bank i in year t while ROE_{it} represents the return on equity for bank i in year t . They are used to measure the profitability and indicate the earning performance within CAMEL model.

CAR_{it} -(Tier 1 Capital+Tier 2 Capital/Risk Weighted Assets)- CAR_{it} represents the Capital Adequacy Ratio for bank i in year t . This variable evaluates the capital adequacy within the CAMEL framework and helps for evaluating capital risk.

NPL_{it} -(Non-performing Loans/Total Loans)- NPL_{it} represents the non performing loan ratio for bank i in year t . It is used to measure the asset quality within the CAMEL framework. It helps to indicate credit risk.

CDR_{it} - CDR_{it} represents the Credit to Deposit Ratio for bank i in year t . It helps in evaluating bank liquidity risk in the CAMEL framework.

Own_{it} -Dummy variable-0 if i th bank in time period t is owned by Public sector banks otherwise 1.

SIZE_{it} - SIZE which i th bank have time period t . It measures the size effect of firm. Size is measured in total assets. An asset is the natural logarithm of the value of total assets.

$C, \beta_1, \beta_2, \dots, \beta_7$ are the set of parameters to be estimated. μ denotes the error term.

In this model, the ROA, ROE, CAR, CDR and SIZE are predicated to have a positive impact on the efficiency of the commercial banks while NPL is expected to have negative impact on the efficiency. In addition, the dummy for the public sector bank has positive impact on the efficiency.

RESULTS AND DISCUSSION

Input-oriented technical efficiency of the Nepalese commercial banks: The technical efficiency scores of the sampled commercial banks are presented in Table 1. The average annual score for the commercial banks from

Table 1: Input-oriented technical efficiency (constant return to scale)

Bank's name	Input-oriented technical efficiency (CRS)						Average
	2005	2006	2007	2008	2009	2010	
Public Sector Bank							
Nepal Bank Ltd.	0.564	0.706	0.639	0.796	0.702	1.000	0.734
Rastriya Banijya Bank Ltd.	1.000	0.693	0.665	0.617	0.563	0.588	0.688
Agriculture Development Bank Ltd.	0.829	1.000	1.000	1.000	1.000	1.000	0.971
Average	0.799	0.800	0.768	0.805	0.755	0.863	0.798
Joint Venture Bank							
Nabil Bank Ltd.	1.000	1.000	1.000	0.977	0.822	0.691	0.915
Standard Chartered Bank Ltd.	0.890	1.000	1.000	1.000	0.757	0.882	0.921
Himalayan Bank Ltd.	0.662	0.830	0.825	0.894	0.874	0.755	0.806
Nepal SBI Bank Ltd.	0.782	0.878	0.965	1.000	0.627	0.513	0.794
Nepal Bangladesh Bank Ltd.	0.579	0.575	0.768	0.796	1.000	0.744	0.744
Everest Bank Ltd.	0.825	1.000	0.972	0.982	0.807	0.743	0.888
Average	0.790	0.881	0.922	0.941	0.814	0.721	0.845
Domestic Private Sector Bank							
Nepal Investment Bank Ltd.	0.834	0.965	0.935	0.954	0.821	0.751	0.877
Bank of Kathmandu Ltd.	0.761	0.895	1.000	1.000	0.909	0.805	0.895
Nepal Credit and Commerce Bank Ltd.	0.705	0.768	0.665	0.808	0.809	0.705	0.743
Lumbini Bank Ltd.	0.691	0.674	0.725	0.860	0.833	0.844	0.771
Nepal Industrial and Commercial Bank Ltd.	0.752	0.795	0.950	0.949	0.940	0.759	0.857
Machhapuchhre Bank Ltd.	0.920	0.323	0.832	0.874	0.859	0.728	0.756
Kumari Bank Ltd.	0.856	0.913	0.968	0.977	0.994	0.804	0.919
Laxmi Bank Ltd.	0.821	0.973	0.957	0.975	0.887	0.764	0.897
Siddhartha Bank Ltd.	1.000	1.000	1.000	1.000	0.899	0.766	0.944
Average	0.812	0.892	0.933	0.883	0.770	0.851	0.851
Overall average	0.804	0.833	0.881	0.914	0.839	0.769	0.804

2005-2010 were determined 80.39, 83.27, 88.14, 91.43, 83.89 and 76.90%, respectively. It indicates that there was a fluctuating trend in their mean of yearly technical efficiency measures of the commercial banks of Nepal over the study period. These increases (decreases) in the efficiency could be due to the fact that the commercial banks were becoming more (less) efficient but the ranged values for the technical efficiency of the Nepalese commercial banks were similar to other developing countries around the world (Chen, 2009; Hassan and Sanchez, 2007; Mostafa, 2007).

When turn the analysis to the commercial banks with different ownership structure. The average technical efficiency of JVB (84.48%) was found higher than that of DPB (81.55%) and PSB (79.70%). It shows that the resource employment procedure in JVB banks is working well than PSB and DPB. The same result has also been presented by Ismail (2004). He found that joint venture banks are more efficient than the public sector banks for the Malaysian banks. On the other hand, it contradicts the finding of Yildirim (2002) which stated that the public sector banks are more efficient than the joint venture and domestic private bank for the Turkish banks.

Among the public sector banks, only ADBL showed the consistency at its efficiency scores i.e., 1 for each year from 2006-2010 because the ADBL concerns with the movements of households' deposits. It made ADBL to be safe. In DEA terminology, such type of the bank is called peer and set an example of good operating practices for

inefficient banks to emulate. However, RBBL and NBL had score 1 in 2005-2010, respectively, they were treated as inefficient banks because their scores were less than 1 in the rest of the years. Instead of the NBL and RBBL have a large volume of operations and resources in Nepal did not consistent in their performances. This transition can be observed with the fact that, heavy accumulated loss.

As like public sector banks, the technical efficiency scores for the joint venture banks were also found in an inconsistency trend. Although, the average technical efficiency of the joint venture banks was higher than the public sector banks, no any joint venture banks had 100% efficiency from 2005-2010. NABIL bank in the year from 2005-2007 and SCBL bank from 2006-2008 showed 100% technical efficiency level among the joint venture banks. It means the production method of the NABIL and SCBL among joint venture banks is relatively adequate with less misuse of the inputs. The analysis of technical efficiency scores demonstrates that the domestic private banks had also the fluctuating trend for their technical efficiencies during the study period. Among the domestic private banks, SBL bank in the year 2005-2008 showed 100% technical efficiency level. The average technical efficiency was 81.55%. This means that if the average sampled banks were to achieve the technical efficiency level of its most efficient counterpart, then the average banks could realize about 18.45% saving in their inputs.

Table 2 presents the degree of efficiencies for the commercial banks in Nepal. It was shown that no any

Table 2: Distribution of average DEA scores of technical, pure technical and scale efficiencies

Degree of efficiency	No. of Banks											
	Technical efficiency				Pure technical efficiency				Scale efficiency			
	PSB	JVB	DPB	Total	PSB	JVB	DPB	Total	PSB	JVB	DPB	Total
Equal to 100	-	-	-	-	1	-	-	1	-	-	-	-
90-99.9	1	2	2	5	-	3	6	9	3	6	7	16
80-89.9	-	2	5	7	-	3	3	6	-	-	2	2
70-79.9	1	2	2	5	1	-	-	1	-	-	-	-
60-69.9	1	-	-	1	1	-	-	1	-	-	-	-

PSB: Public Sector Bank, JV: Joint Venture Bank, DPB: Domestic Private Sector Bank

Table 3: Input-oriented pure technical efficiency (variable return to scale)

Bank's name	Input-Oriented Technical Efficiency (BCC)							Average
	2005	2006	2007	2008	2009	2010		
Public Sector Bank								
Nepal Bank Ltd.	0.676	0.722	0.684	0.805	0.731	1.000	0.770	
Rastriya Banijya Bank Ltd.	1.000	0.699	0.666	0.624	0.573	0.593	0.692	
Agriculture Development Bank Ltd.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Average	0.8919	0.892	0.807	0.783	0.810	0.768	0.864	
Joint Venture Bank								
Nabil Bank Ltd.	1.000	1.000	1.000	1.000	0.832	0.693	0.921	
Standard Chartered Bank Ltd.	0.891	1.000	1.000	1.000	0.835	0.970	0.949	
Himalayan Bank Ltd.	0.747	0.939	0.859	0.903	0.894	0.766	0.851	
Nepal SBI Bank Ltd.	0.792	0.881	0.989	1.000	0.683	0.849	0.866	
Nepal Bangladesh Bank Ltd.	0.584	0.588	0.972	0.878	1.000	1.000	0.837	
Everest Bank Ltd.	0.839	1.000	1.000	1.000	0.828	0.755	0.921	
Average	0.789	0.790	0.881	0.922	0.941	0.814	0.721	
Domestic Private Sector Bank								
Nepal Investment Bank Ltd.	0.852	1.000	1.000	1.000	1.000	1.000	0.877	
Bank of Kathmandu Ltd.	0.768	0.908	1.000	1.000	0.999	0.866	0.895	
Nepal Credit and Commerce Bank Ltd.	0.715	0.850	0.948	0.955	0.922	0.847	0.743	
Lumbini Bank Ltd.	0.800	0.862	1.000	1.000	1.000	1.000	0.771	
Nepal Industrial and Commercial Bank Ltd.	0.757	0.796	1.000	0.950	0.957	0.817	0.857	
Machhapuchhre Bank Ltd.	0.944	0.493	0.850	0.913	0.906	0.764	0.756	
Kumari Bank Ltd.	0.874	0.915	0.990	0.977	1.000	0.840	0.919	
Laxmi Bank Ltd.	0.825	0.977	0.981	0.977	0.915	0.800	0.896	
Siddhartha Bank Ltd.	1.000	1.000	1.000	1.000	0.914	0.795	0.944	
Average	0.837	0.866	0.974	0.974	0.957	0.858	0.911	
Overall average	0.836	0.868	0.940	0.943	0.888	0.853	0.888	

Nepalese commercial banks obtained 100% technical efficiency during the study period but one PSB (ADBL), two JVBs (NABIL and SCBL) and two DPBs (KBL and SBL) have been categorized as marginal inefficient banks because they have attained TE score above the 90% but less than 100%. It means these banks are functioning at a high level of operating efficiency even though they are not fully efficient. Furthermore, these banks might achieve the status of efficient banks with minute improvements in the resource utilization process. Therefore, the regulators must pay special attention to enhance their efficiency. Among the inefficient banks, RBBL was the most inefficient banks which scored less than 70% which is a public sector bank. As the performance of this bank was the worst among the sampled banks, it can be treated as a target bank. It is significant to note that this bank lacked vitality in terms of the efficiency of resource utilization.

Input-oriented pure technical efficiency of the Nepalese commercial banks:

The data envelopment analysis based on the BCC Model was used to account for variable return to scale to analyze the pure technical efficiency of the commercial banks of the Nepal for the period of 2005-2010 reported in Table 3. In VRS, there was an increase in number of the commercial banks which shows the consistency in their performance for each year with the score 1. The average score of the pure technical efficiency of the commercial banks of Nepal varied from 0.83 (FY 2005) to 0.94 (FY 2007) during the study period.

The pure technical efficiency analysis of the commercial banks with different ownership structure indicates that it was highest for DPB (91.14%), followed by the JVB banks (88.79%) and the PSB (82.06%). It is clear that DPB exhibited a higher mean pure technical efficiency than JVB and PSB. This suggests that DPBs are managerially efficient in controlling expenses compared to

Table 4: Input-oriented scale efficiency

Bank's name	Input-oriented efficiency (SE)						Average
	2005	2006	2007	2008	2009	2010	
Public Sector Bank							
Nepal Bank Ltd.	0.834	0.978	0.934	0.989	0.960	1.000	0.949
Rastriya Banijya Bank Ltd.	1.000	0.991	0.998	0.989	0.984	0.992	0.992
Agriculture Development Bank Ltd.	0.829	1.000	1.000	1.000	1.000	1.000	0.971
Average	0.888	0.990	0.978	0.993	0.981	0.997	0.971
Joint Venture Bank							
Nabil Bank Ltd.	1.000	1.000	1.000	0.977	0.987	0.997	0.993
Standard Chartered Bank Ltd.	0.998	1.000	1.000	1.000	0.907	0.909	0.969
Himalayan Bank Ltd.	0.886	0.884	0.960	0.989	0.977	0.985	0.947
Nepal SBI Bank Ltd.	0.987	0.997	0.976	1.000	0.919	0.605	0.914
Nepal Bangladesh Bank Ltd.	0.992	0.978	0.791	0.906	1.000	0.744	0.902
Everest Bank Ltd.	0.984	1.000	0.972	0.982	0.974	0.983	0.983
Average	0.975	0.977	0.950	0.976	0.961	0.870	0.951
Domestic Private Sector Bank							
Nepal Investment Bank Ltd.	0.979	0.965	0.935	0.954	0.821	0.751	0.901
Bank of Kathmandu Ltd.	0.992	0.985	1.000	1.000	0.910	0.929	0.969
Nepal Credit and Commerce Bank Ltd.	0.986	0.904	0.702	0.846	0.877	0.833	0.858
Lumbini Bank Ltd.	0.864	0.782	0.725	0.860	0.833	0.844	0.818
Nepal Industrial and Commercial Bank Ltd.	0.994	0.999	0.950	0.999	0.982	0.930	0.976
Machhapuchhre Bank Ltd.	0.975	0.655	0.979	0.957	0.948	0.954	0.911
Kumari Bank Ltd.	0.979	0.999	0.978	0.999	0.994	0.956	0.984
Laxmi Bank Ltd.	0.996	0.997	0.976	0.998	0.969	0.955	0.982
Siddhartha Bank Ltd.	1.000	1.000	1.000	1.000	0.984	0.964	0.991
Average	0.974	0.921	0.916	0.957	0.924	0.902	0.932
Overall average	0.960	0.951	0.938	0.969	0.946	0.907	0.945

JVBs and PSBs. The less efficiency in public sector banks might be the reflective of high government influence, very large branch network and high operating cost and conventional technologies.

As per pure technical efficiency, ADBL was running as fully efficient units in every year among PSBs. NABIL bank in year 2005-2008, SCBL bank in 2006-2008 and EBL bank in 2006-2008 were performing efficiently among joint venture banks. Among DPBs, NIBL bank in year 2006-2010, LBL bank in 2007-2010 and SBL bank in 2005-2008 were functioning efficiently.

As per Table 2, however the ADBL is a public sector bank, it was the most efficient bank with pure technical efficiency of 100%. The three JVBs (NABIL, SCBL and EBL) and two DPBs (KBL and SBL) have been found marginal inefficient banks due to the higher efficiency scores in between 90-99.9%. The three JVBs (HBL, NSBI and NBBL) and four DPBs (NIBL, NIC, BOK and LXBL) have performed with the technical efficiency of 80-89.9% while 70-79.9% was the score range for one PSB (NBL), three DPBs (NCCBL, LBL and MPBL). As like the technical efficiency, the pure technical efficiency score of the RBBL (PSB) was also the least (<70%) among all the selected commercial banks.

Input-oriented scale efficiency of the Nepalese commercial banks: Table 4 shows the mean efficiency each year by decomposing technical efficiency into pure technical efficiency and scale efficiency to gain insight

into the main sources of the inefficiencies. Scale efficiency varied in between 0.90-0.97. The average scale efficiency of the commercial banks was 94.50%. This shows that the actual scale of production has differed from the most productive scale size by about 5.50%.

According to Hassan and Sanchez (2007) if scale inefficiency is greater than pure technical efficiency, it means wrong mix of inputs and outputs for the reasons beyond their control inefficiency. Here, scale inefficiency was 5.50% whereas pure technical inefficiency was 11.16%, suggesting bank executives are using bank resources efficiently and choosing proper mix of inputs and outputs. The similar result was found by Drake and Hall (2003) for the Japanese banks and Miller and Noulas (1996) for the US banks.

When the scale efficiency of the individual bank was examined, ADBL, one of the public sector banks was found operating efficiently with the efficiency score of 1 during the study period. Among JVBs, NABIL from 2005-2007 and SCBL from 2006-2008 were determined as competent banks while the scale efficiency score of BOK from 2007-2008 and of SBL from 2005-2008 showed 100% efficient. It was shown in Table 2 that all the sampled commercial banks have obtained higher scores for scale technical efficiency (90-99.9%) except two DPBs namely NCCBL and LBL which ranged in between 80-89.9%

Ranks of commercial banks: Different commercial banks had different ranking based on efficiency related to TE,

Table 5: Ranks of the selected commercial banks in Nepal

Name of bank	Indication		
	Technical efficiency	Pure technical efficiency	Scale efficiency
Public Sector Bank			
Nepal Bank Ltd.	17	17	11
Rastriya Banijya Bank Ltd.	18	18	2
Agriculture Development Bank Ltd.	1	1	8
Joint Venture Bank			
Nabil Bank Ltd.	5	8	1
Standard Chartered Bank Ltd.	3	4	10
Himalayan Bank Ltd.	11	14	12
Nepal SBI Bank Ltd.	12	13	13
Nepal Bangladesh Bank Ltd.	15	15	15
Everest Bank Ltd.	8	10	5
Domestic Private Sector Bank			
Nepal Investment Bank Ltd.	9	2	16
Bank of Kathmandu Ltd.	7	7	9
Nepal Credit and Commerce Bank Ltd.	16	12	17
Lumbini Bank Ltd.	13	5	18
Nepal Industrial and Commercial Bank Ltd.	10	11	7
Machhapuchhre Bank Ltd.	14	16	14
Kumari Bank Ltd.	4	6	4
Laxmi Bank Ltd.	6	9	6
Siddhartha Bank Ltd.	2	3	3

Table 6: Determinants of risk management factors on technical, pure technical and scale efficiencies

Variables	Technical efficiency	Pure technical efficiency	Scale efficiency
Constant	0.922839 (2.274224)**	0.780045 (2.192381)**	1.055104 (4.000074)*
Return on assets	0.588897 (1.676242)***	0.590982 (1.918496)***	0.041740 (0.182773)
Return on equity	0.060499 (2.461532)**	0.061838 (2.869484)*	-0.000181 (-0.011349)
Capital adequacy ratio	0.307717 (1.906066)***	0.334950 (2.366223)**	-0.054151 (-0.516007)
Non-performing loan	-0.193982 (-1.122523)	0.130012 (0.858041)	-0.362861 (-3.230277)*
Credit to deposit ratio	0.190374 (2.311159)**	0.192389 (2.663731)*	0.025552 (0.477215)
Size	-0.021525 (-0.448241) ^{ns}	-0.007674 (-0.182251) ^{ns}	-0.072117 (-0.177290) ^{ns}
Ownership	-0.111123 (-2.070225)**	-0.035038 (-0.744457)	-0.005534 (-2.066894)**

*, **, ***Significant at 1, 5 and 10%, respectively, ns: Not significant

PTE and SE (Table 5). Based on the TE, the highest rank was for ADBL, which is a public sector bank, SBL Bank, was the second, which is a domestic private bank and the last position belonged to RBBL, a public sector bank. Based on PTE, the first position was for ADBL while NIBL was occupied the second position which is a domestic private bank and RBBL was in the last position. Based on SE, NABIL was considered to be first position which is a joint venture bank, RBBL was second position and LBL was last position. Based on the reported ranking, it was concluded that the bank with higher technical efficiency does not always mean that it has also higher pure technical efficiency and scale efficiency.

Determinants of risk management factors on technical, pure technical and scale efficiencies: The results of the Tobit regression analysis are presented in Table 6 and the values of Z-statistics of the coefficients are shown in parentheses. The profitable ratios (ROA and ROE) were positive and significant with regards to TE and PTE but negative and insignificant with respect to SE. It suggests that profitable commercial banks are technically efficient and the commercial banks manager in profitable

commercial banks have more incentive to perform effectively. Negative and insignificant relationship between ROE with SE suggested that profitability was not an influencing factor in determining greater scale efficiency during the period of analysis. With regard to the effect of capital adequacy ratio was positive and had significant effect on TE and PTE but negative and statistically insignificant with SE. The results are consistent with Hassan and Sanchez (2007) and Naceur *et al.* (2009). According to Mester (1996), the positively contributed CAR on efficiency implies that if a bank increases its CAR ratio, then its level of efficiency will increase because higher capital ratios may keep away from ethical risk. Asset quality on efficiency, coefficient for the NPL was negative and insignificant with TE whereas negative but significant with SE. This result suggests that the commercial banks which have higher non-performing loans are less technically efficient. As argued by Berger and Mester (1997) commercial banks that are weak in operation might also be weak in loan management. The result was also consistent with some earlier studies (Delis and Papanikolaou, 2009; Kalluru and Bhat, 2009) From the assets results, suggested that the

Nepalese commercial banks can improve their level of technical efficiency by effective evaluation of credit risk. The coefficient on credit to deposits (CDR) was significantly positive with TE and PTE, suggesting that the Nepalese commercial banks may attempt to utilize the fund it collected; this in turn could increase efficiency level. However, the CDR was determined positive but statistically insignificant with SE.

Regarding the ownership dummy had a negatively significant with in every case efficiency versus private (both domestic and joint venture) ownership. This means public sector bank was also significant contributor in the efficiency of the commercial banks. The relationship between commercial bank size and efficiency in this study was found negative and insignificant. This result is inconsistent with the finding of Pasiouras *et al.* (2007) for Greek cooperative banks. This empirical results suggests that as bank size increases, the level of efficiency decreases. There might be number of possible reasons for this inverse relationship between efficiency and size of banks in case of Nepal. The small banks tend to surpass large banks due to limited market segments with better information access and less agency hitch. Moreover, the lower originating, servicing and monitoring costs per currency of loan for the small banks compared to larger banks assists in achieving higher level of efficiency (Isik and Hassan, 2002).

CONCLUSIONS

The technical inefficiency in the Nepalese commercial banking industry was due to poor inputs utilization. However, the degree of technical efficiency for the commercial banks of Nepal were lower than the degree of scale efficiency, which indicates that a portion of the overall inefficiency was due to producing below the production frontier rather than producing on an inefficient scale. Thus, commercial banks are more successful in choosing optimal levels of outputs than adopting best practice technology and the banks are running at their optimal levels of operations.

Concerning the ownership, it was shown that the public sector banks were less efficient than joint venture banks and domestic private banks during the study period due to the high overhead costs, political interventions and poor managerial management. The efficiencies of the joint venture and domestic private banks of Nepal were also not consistent because the market conditions were not conducive for growth. The political uncertainty, labor problems in industries, long hours of load-shedding, infrastructural bottleness and other factors, national as

well as internationally continued to affect the efficiencies of the Nepalese commercial banks. The Tobit regression results suggest that the efficiency differences were affected by many risk management factors. The main variables increasing commercial bank efficiency are ROA, ROE, CAR and CDR which were positive and significantly related to the technical, pure technical efficiencies. In order to improve the performance of the commercial banks, they need not only to reduce the inputs to achieve the efficiency frontier, but also to consider the effects of risk management factors.

ACKNOWLEDGMENT

The authors would like to thank the National Science Foundation of China (71173060, 70773028 and 71031003) for their support for this study.

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