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Full Length Research Paper

A stochastic frontier model on measuring online bank deposits efficiency

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An attempt has been made to investigate the online bank specific deposits efficiency using stochastic frontier technique and it intends to determine various factors affecting the efficiency level of banks for the period 2001 - 2007. We used a panel of 20 banks divided into four groups namely, NBs (National Banks), ISBs (Islamic Banks), FBs (Foreign Banks), and PBs (Private Banks) in Bangladesh. In this study, a comparison was made with the efficiency scores of banks group-wise, year-wise and individually. This study showed that the estimated year-wise average online banks deposits efficiency was 0.738 while group-wise average deposits efficiency was 0.777. At the bank group level, Nationalized Commercial Banks (NBs) and Islamic Banks (ISBS) were more efficient by 90.9 and 86.8% respectively, followed by Private Banks (PBs) which had 63.4% and Foreign Banks (FBs), 62.7%. We observed that the foreign banks were less efficient in producing deposits. However, the overall deposits efficiency of all bank groups steadily increased over time except in 2007. The most efficient bank was found to be Islami Bank Ltd. and the most inefficient bank was Pubali Bank with efficiency scores of 0.96 and 0.52, respectively.

Key words: Deposits efficiency, stochastic frontier analysis, banking industry.

INTRODUCTION

Banking efficiency has long been a subject of many studies and most of the studies have focused on industrial countries like US and Europe. Research on developing countries is a recent phenomenon. Commercial banks, which are the main component of the banking system, have to be efficient; otherwise they will create maladjustments and impediments in the process of development in any economy. Efficiency measurement has been of concern to researchers with an aim to look into the efficiency levels of different commercial banks engaged in various production activities. Identifying determinants of efficiency levels is a major concern in efficiency analysis. The studies of efficiency using stochastic frontier approaches on banking did not start until Sherman and Gold (1985) initiated their own. They applied the frontier approach to the banking industry by focusing on the operating efficiency of the branches of a savings bank. Since then, numerous studies have been conducted using frontier approaches to measure banking efficiency. There have been extensive studies on bank efficiency done in the US and European countries on conventional banking (Berger and Humphrey, 1997; Goddard et al., 2001). No attempt has been made to check the performance and efficiency measure of the commercial banks with loan default; however, some work has been done for Bangladesh banking sector (Raihan, 1998; Choudhury et al., 2000; Choudhury, 2002; Dilruba and Khandoker, 2005). Bangladesh banking industry is an interesting topic for our study for two reasons. First, no earlier studies have been intended to estimate the bank deposits efficiency in Bangladesh. Second, Bangladesh banking sector is one of the most booming industries in this sub-continent, and foreign investors are increasingly trying to grasp this healthy sector.

Past studies on bank efficiency and other financial institutions have focused mainly on the USA (Aly et al., 1990; Elyasiani and Mehdian, 1990; Kwan and Eisenbeis, 1996) and other developed countries (Worthington, 1998), for example Australian (Koetter, 2005) and German banking. In countries like Australia (Sturn and Williams, 2004), Spain (Lozano-Vivas, 1997), Turkey (Isik

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and Hasan, 2003) and Norway (Berger et al., 1992) financial liberalization has positively affected the efficiency and productivity of commercial banks; for Italy (Boscia, 1999), US (Bauer et al., 1993) and other banking efficiency was relatively unchanged after regulation. Surprisingly, in Korea, productivity of the banking sector has declined after deregulation (Mahadevan, 2004). Banks have been faced with growing competition, both from themselves and from firms and markets outside the industry (Wheelock, 1993) and presumably banks will be more successful in maintaining their business if they operate efficiently. Berger and Humphrey (1992) found that during the 1980s high- cost banks experienced higher rates of failure than more efficient banks. Similarly, in a study of bank failures during the 1920s, Wheelock and Wilson (1995) found that the less technically efficient a bank was, the greater its likelihood of failure. There has been a widespread discussion on lack of adequate technical efficiency of banks in developing countries (Das, 1997; Shanmugan and Lakshmanasamy, 2001; Kumar and Verma, 2003; Mohan and Ray, 2004; Das et. al., 2005; Kumbhakara and Sarkar, 2003; De, 2004; Sensarma, 2005; Mahesh et al., 2006).

This type of investigation into bank efficiency is quite important from the viewpoint of macroeconomics as well, since the adequate development of financial markets is essential for stabilizing the macro-economy and accelerating economic growth. In addition, efficiency measure of commercial banks is important for at least two reasons. First, efficiency measures are indicators of success, by which the performance of individual banks, and the industry as a whole, can be gauged. The second reason to investigate the efficiency of commercial banks is the potential impact of government policies on efficiency. Therefore this study intends to reveal the overall performance of commercial banks with loan default and measuring bank deposits efficiency in Bangladesh. In an economy where resources are scarce and opportunities for new technologies are lacking in efficiency, studies will be able to raise productivity by improving efficiency without the resource base or developing new technology. Therefore, it is essential to determine the status of productivity growth which is being decomposed with efficiency and technical change. This is because determining the efficiency status of Bangladesh banks is very important for policy purpose. To the researchers' best knowledge, this is the first time the stochastic frontier approach is being used to analyze the bank deposits efficiency in Bangladesh.

Previous research that has focused on developing countries like Bangladesh is still considered small. This motivates us to undertake this study to fill the gap and add to the existing literature. As a means of addressing this issue within a unified and consistent framework, we propose a variant of the increasingly popular Battese and Coelli (1995) model to examine the bank deposits efficiency level in Bangladesh. The main focus of our study is to measure the bank deposits technical efficiency in accordance with four groups namely NBs (Nationalized Commercial Banks), IBs (Islamic Banks), and PBs (Private Banks) of Bangladesh. The considered model is also used to determine the important factors causing efficiency differential on Bangladesh banking industry.

Given this background, the paper is organized as follows: in the next section we discuss briefly the Bangladesh banking system. Third section contains discussion about the methodology used for measuring deposits efficiency; and various approaches of deposits (output) measurement in the banking sector and details about the data used for this study are presented; and the estimated results are presented in the penultimate section. The concluding section sums up the findings.

Bangladesh banking industry and its importance

The banking industries are the leaders of the financial-services industry. They are the place where we often wind up when we are seeking a loan to purchase a new automobile, tuition for college or a professional school, financial advice on how to invest our savings, credit to begin a new business, a safe deposit box to protect our most valuable documents, a checking account to pay for purchases of goods and services, or a credit or debit card so we can conveniently keep track of when and where we spend our money. Financial firms other than banks are selling us these same services, but banks still head the list of financial service providers in many markets. The banking industries dominate Bangladesh's financial sector. Bangladesh bank is the Central Bank of Bangladesh and the chief regulatory authority in this financial sector. The banking system consists of four nationalized commercial banks, about forty private commercial banks, nine foreign multinational banks and some specialized banks. The Nobel-prize winning Grameen Bank is a specialized micro- finance institution, which revolutionized the concept of micro-credit and contributed greatly towards poverty reduction and the empowerment of women in Bangladesh. The banking industry of Bangladesh is a mixed one comprising nationalized, private and foreign commercial banks. These banks are the main vehicles for mobilizing invisible funds and channeling those funds to fasten the growth of the productive sectors of the economy. Banks in Bangladesh have been operating under both public and private sectors for about two decades. The question arises on how successfully the nationalized private commercial banks are serving the country, and how far they have achieved their desired goals. It is commonly believed that the nationalized commercial banks overcome the vicious problem of corruption, inefficiency, loan default etc. although the private commercial banks are efficient in their commercial activities and solving the problem of loan default.

The banking system of Bangladesh is dominated by the 4 nationalized commercial banks, which together controlled more than 54% of deposits and operated 3388 branches (54% of the total) as of December 31, 2004. Private banks belong to the highest growth sector due to the dismal performances of national/government banks. Foreign banks are also among the growth sector due to the performances of national commercial banks. They tend to offer services by providing disbursed loan and defaulted loan as well as playing a pioneer role in introducing modern financial products and services. Out of the specialized banks, two (Bangladesh Krishi Bank and Rajshahi Krishi Unnayan Bank) were created to meet the credit needs of the agricultural sector while the other two (Bangladesh Shilpa Bank (BSB) and Bangladesh Shilpa Rin Sangtha (BSRS)) are for extending term loans to the industrial sector. The Bangladesh banking sector relative to the size of its economy is comparatively larger than many economies of similar level of development and per capita income. The total size of the sector at 26.54% of GDP dominates the financial system, which is proportionately large for a country with a per capita income of only about US$540. The non-banking financial sector, including capital market institutions is only 3.22% of GDP, which is much smaller than the banking sector. Access to banking services for the population has improved during the last three decades. While population per branch was 57,700 in 1972, it was 19,800 in 1991. In 2001 it again rose to 21,300, due to winding up of a number of branches and growth in population. Compared to India's 15,000 persons per branch in 2000, this indicates that the banking system in Bangladesh is a significant problem. The list of online banks considered in this study with serial number is presented in Table 1.

METHODOLOGY

A theoretical stochastic frontier model

Technical efficiency measurement by frontier method is based on the assumption that a gap normally exists between a firm's actual and potential levels of technical performance. Thus the technical efficiency is measured as the ratio between actual output and the potential output. While there are various methods of measuring technical efficiency (see Lovell 1993, Coelli et al., 1998, and Kumbhakar and Lovell 2000), in the present study we use the approach proposed by Battese and Coellli (1995) which explicitly accounts for statistical noise. The specification of the model may be expressed as:

$$Y_{it} = \beta X_{it} + (V_{it} - U_{it}),\ i = 1,2,\ldots\ldots\ldots,N;\quad t = 1,2,\ldots\ldots,T \qquad \ldots\ldots\ldots\ldots(1)$$

where Y_{it} is the logarithm of output of the i^{th} bank in t^{th} period; X_{it} is a vector of input quantities; β_i 's are unknown parameters to be estimated; V_{it} 's random variables which are assumed to be i.i.d., $N(0, \sigma_v^2)$ and independent of U_{it}; U_{it} 's are non-negative non-negative random variables which are assumed to account for technical inefficiency in output and to be independently distributed as truncations at zero of the $N(\mu, \sigma_u^2)$ distribution; where $U_{it} = Z_{it}\delta$; Z_{it} is a $(1 \times p)$ vector of variables which may influence the inefficiency of bank industry and δ is a $(p \times 1)$ vector of parameters to be estimated. The parameterization from Battese and Corra (1977) are used replacing σ_u^2 and σ_v^2 with $\sigma^2 = \sigma_v^2 + \sigma_u^2$.

The technical inefficiency effect U_{it} in the stochastic frontier model is specified as follows:

$$U_{it} = Z_{it}\delta + W_{it} \qquad \ldots\ldots\ldots\ldots(2),$$

where the random variable, W_{it} follows truncated normal distribution with mean zero and variance σ^2, such that the point of truncation is $-Z_{it}\delta$. Parameters of the stochastic frontier given by equation (1) and inefficiency model given by equation (2) are simultaneously estimated by using maximum likelihood estimation (Battese and Coelli, 1993). After obtaining the estimates of U_{it} the technical efficiency of the i-th bank industry at t-th time period is given by:

$$TE_{it} = \exp(-U_{it}) = \exp(-Z_{it}\delta - W_{it}) \qquad \ldots\ldots\ldots\ldots\ldots \qquad (3).$$

A stochastic frontier model for deposits (in) efficiency

The functional form of the deposit translog stochastic frontier production model is defined as:

$$\begin{aligned}\ln(Y_{it}) = {} & \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln M_{it} + \beta_3 \ln L_{it} + \beta_4 T \\ & + \tfrac{1}{2}\left(\beta_{11}\ln K_{it}^2 + \beta_{22}\ln M_{it}^2 + \beta_{33}\ln L_{it}^2 + \beta_{44}T^2\right) \\ & + \beta_{12}\ln K_{it} * \ln M_{it} + \beta_{13}\ln K_{it} * \ln L_{it} + \beta_{14}\ln K_{it} * T + \beta_{23}\ln M_{it} \\ & * \ln L_{it} + \beta_{24}\ln M_{it} * T + \beta_{34}\ln L_{it} * T + V_{it} - U_{it} \ldots\ldots\ldots\ldots(4),\end{aligned}$$

where, the subscripts i and t represent the i-th bank industry and the t-th year of observation, respectively; $i = 1, 2, \ldots, 20$; $t = 1, 2, \ldots, 7$; Y_{it} denotes the output variables (deposits) of the ith bank industry in the t-th period in values (taka); K_{it} denotes capital (fixed assets of a bank in a year which also adds premises, furniture and fixture) of i-th bank industry in the t-th period; M_{it} represents materials (the sum of expenditure on printing and stationeries and postage, telegrams and telephones etc) of i-th bank industry in the t-th period; L_{it} represents labor (the total number of employees which include officers, sub-ordinates and clerks) of i-th bank industry in the t-th period; T represents year of observation; "ln" refers to the natural logarithm.

Identifying sources of technical inefficiency effects and hypothesis tests

The bank industry specific inefficiency is considered as a function of some explanatory variables and the inefficiency effects model is defined as:

$$U_{it} = \delta_0 + \delta_1 T + \delta_2 TA + \delta_3 HI + \delta_4 NB + \delta_5 ISB + \delta_6 FB + \delta_7 PB + W_{it} \quad .....(5),$$

where δ_0 is the intercept term and $\delta_j \ (j = 1, 2, 3, 4, 5, 6, 7)$ is the parameter for the j-th explanatory variable, T=Year of observation, TA=Total Assets, HI=Herfindahl Index, NB is the dummy variable for Nationalized Commercial Banks: NB=1 if an observation involves a Nationalized Commercial Bank, zero otherwise; ISB is the dummy variable for Islamic banks: ISB=1 if an observation involves an Islamic bank, zero otherwise; FB is dummy variable for Foreign Banks: FB=1 if an observation involves a Foreign Bank, zero otherwise; PB is dummy variable for Private Banks: PB=1 if an observation involves a Private Bank, zero otherwise.

Likelihood ratio tests and hypothesis

The following hypotheses that require testing with the generalized likelihood ratio test statistic are defined by

$$\lambda = -2\left\{\ln L(H_0)/L(H_1)\right\} = -2\{\ln L(H_0) - \ln L(H_1)\} \quad (6)$$

where $L(H_0)$ and $L(H_1)$ are the value of the likelihood function for the deposits frontier model under the null and alternative hypotheses. Under the null hypothesis , this test statistic is assumed to be asymptotically distributed as mixture of chi-square distribution with degree of freedom equal to the number of restrictions involved. The restrictions imposed by the null hypothesis are rejected when λ exceeds the critical value (Taymaz and Saatci 1997). These are obtained by using the values of the log–likelihood functions for the banking industries and the stochastic frontier production function.

The following null hypotheses will be tested:

$H_0 : \beta_{ij} = 0,$ the null hypothesis that identifies an appropriate functional form either the restrictive Cobb-Douglas or Translog production function. It specifies that the second-order coefficients of the stochastic frontier production function are simultaneously zero.

$H_0 : \gamma = 0,$ the null hypothesis specifies that the technical inefficiency effects in banks are zero. This is rejected in favor of the presence of inefficiency effects. Here γ is the variance ratio, explaining the total variation in output from the frontier level of output attributed to technical efficiency and defined by $\gamma = \sigma_u^2 / \left(\sigma_u^2 + \sigma_v^2\right)$. This is done with the calculation of the maximum likelihood estimates for the parameters of the stochastic frontier models by using the computer program frontier version 4.1 developed by Coelli (1996). If the null hypothesis is accepted this would indicate that σ_u^2 is zero and hence that the U_{it} term should be removed from the model, leaving a specification with parameters that can be consistently estimated using ordinary least square (OLS).

Further $H_0 : \eta = 0,$ the null hypothesis that the technical inefficiency effects are time invariant that is, there is no change in the technical inefficiency effects over time. If the null hypothesis is true, the generalized likelihood ratio statistic λ is asymptotically distributed as a chi-square (or mixed chi-square) random variable.

Measurement of variables

One of the crucial debated issues in the banking literature is output measurement. Though there are a number of alternative approaches of measuring output, they can be grouped into two broad categories (a) Production approach and (b) Intermediation approach. Under this approach output is measured by the number and type of transactions or accounts (both deposit and loan) and inputs used are only physical units such as labour and capital, since, only physical inputs are needed to provide financial services. Under intermediation approach, financial institutions are thought of as primarily intermediating funds between savers and investors. Under this approach, the inputs of the bank are essentially financial capital, and outputs are measured by the volume of loans and investments outstanding. The present study adopts production approach to specify outputs and inputs of commercial banks. Accordingly, deposits are defined as the outputs of commercial banks which are produced by using inputs like labour, capital and materials. All nominal values are converted to real by deflating with GDP deflator and all values are in their natural logarithms.

Data set

We have used data for the period of 2001-2007 from 20 commercial banks of Bangladesh. Banks are grouped into four categories (i) National Banks (NBs), (ii) Islamic Banks (ISBs), (iii) Foreign Banks (FBs), (iv) Private Banks (PBs). Most of the data are collected from the annual reports of the specific banks of Bangladesh and rest of them are collected from annual accounts of Scheduled Commercial Banks published by Bangladesh Bank, the Central Bank of Bangladesh. Deposits are measured as total deposits. Capital is measured as fixed assets (which includes premises, furniture and other fixed assets). Number of employees is measured as the total number of employees. Material is measured as the sum of expenditure on printing and stationeries, postage, telegrams and telephone etc. All nominal values are converted on real by deflating with GDP deflator and all values are in their natural logarithms.

Dependent variables

Deposit (Y)

A bank acquires funds by issuing (selling) liabilities, which are consequently referred to as sources of funds and deposit is one of the significant sources to increase funds. In this study deposit figures are used to represent the dependent variable and equal to total deposits including checkable, non transaction deposit such as savings accounts, time deposits etc. These figures are then deflated by the relevant consumer price index.

Independent variables

Capital (X_1)

Capital is the input variable representing the fixed assets of a bank

in a year which also adds premises, furniture and fixture. Capital figures are deflated by capital price index.

Labour (X_2)

Labour is one of the most important inputs to measure the productivity of a firm. Here labour means number of employee and is measured as the total number of employees which includes officers, sub-ordinates and clerks.

Material (X_3)

For the banking sector, materials have been used as the sum of expenditure on printing and stationeries and postage, telegrams and telephones etc. Material prices are deflated by non-food price index.

Time (X_4)

To find the productive efficiency of a bank over time we have used time as the input variable. In this study we have collected data of seven years from 2001 to 2007 and used 1 for year 2001, 2 for 2002 and so on.

Explanatory variables

Time (Z_1)

Time is also used in this study as influencing variable.

Total asset (Z_2)

Total asset is used as the influencing variable and is the sum of all assets and their book value.

Herfindahl index (Z_3)

The Herfindahl-Hirschman index takes into accounts both the relative size and number of banks in the banking sector. Mathematically, HHI is described as follows: $HHI = \sum_{i=1}^{N} S_i^2$ where N is the number of banks and S_i is share of the i^{th} bank. HHI is known as measure of competition which is measured as the sum of squared of the output share of each bank in the output of considered total banks in Bangladesh.

NB, ISB, FB, and PB are bank group specific dummies for National, Islamic, Foreign and Private Banks, respectively. The dummy variables can take either 1 or 0 depending on whether data are available or not.

RESULTS AND DISCUSSION

In this section, the bank deposits efficiency estimates were measured using a stochastic Translog Production Frontier model proposed by Battese and Coelli (1995) applied to panel data. The parameters of Ordinary Least Square Estimates (OLS) and Maximum Likelihood Estimates (MLE) were reported on measuring bank deposits efficiency in Bangladesh. A two step process was used to find out the technical efficiency using maximum likelihood method. In the first step using frontier 4.1 by grid search the ordinary least square esti-mates of parameters were obtained and these estimates were used to estimate the maximum likelihood estimates of the parameters using the Translog Frontier Production function. This section was devoted to examine the overall performance of banks in Bangladesh.

Results of stochastic frontier model for deposits inefficiency

Bank deposits efficiency over time was estimated as the ratio between actual deposits and the maximum possible deposits. The ordinary least square estimates of the parameters which showed the average performance of the sample banks were presented in Table 2. From the analysis we observed that all the coefficients, except the interaction between capital and labor, squared of time are statistically significant in the deposit production process. The maximum likelihood estimates of parameters of deposits Translog stochastic frontier production model are presented in Table 3. From the maximum likelihood estimates of the deposits model we observed that the coefficients of capital, the squared of time, the interaction between capital and material, and the interaction between capital and time are insignificant. The coefficient of capital is 0.050 which indicated that bank deposits (output) are explained only by 5% capital. So from this result we concluded that the capital has low output elas-ticity. The coefficient of material input variable showed a negative sign, indicating that banks which use less material (Stationary, postage, and other materials) are more productive. The linear inefficiency model consisted of eight explanatory variables. The coefficients of HHI, NB, ISB, and PB dummies were found interestingly insignificant. The important variable which has significant impact an efficiency measure is the 'Competition', which was measured by HHI. Its positive sign showed that efficiency increases when competition increases. Though the coefficients of dummies were observed insignificant in efficiency measures except Foreign Bank (FB) dummy, their signs differ across different services. In deposits inefficiency model we observed that the coefficient of total assets contains negative sign which indicated that the more the total asset the more the bank efficient. From the coefficient of FB dummies it appeared to be the same and it showed positive sign. This suggested that the foreign banks were not in the race to increase their depo-sits level which we easily understood from the coefficient of HHI that was found to be statistically insignificant.

The year- wise average bank deposits efficiency is illustrated in Table 4 and Figure 1. The average deposit efficiency estimates for the total banking industry (for the entire study period) are 0.738, which suggested that on an average, banks were 73.8% efficient in producing deposit

Table 1. List of online banks considered in this study.

List of online bank's name	Serial number
Sonali Bank	1
Janata Bank	2
Islami Bank	3
Shahajal Islami Bank	4
Al Arafah Bank	5
Bank Asia	6
The City Bank	7
National Bank	8
Prime Bank	9
Uttara Bank	10
One Bank	11
UCB Bank	12
Pubali Bank	13
Priemer Bank	14
Mutual Bank	15
South East Bank	16
Eastern Bank	17
AB Bank	18
Dhaka Bank	19
DBBl	20

Table 2. OLS estimates of translog stochastic frontier production function: Deposits frontier estimates.

Variable	Parameter	Coefficient	S.E	t-value
Constant	$_0$	9.829*	0.736	13.358
Capital	$_1$	-0.461**	0.268	-1.720
Material	$_2$	0.923*	0.380	2.432
Labour	$_3$	-0.960*	0.203	-4.733
Time	$_4$	0.349*	0.078	4.486
Capital*Capital	$_{11}$	0.218*	0.092	2.361
Material*Material	$_{22}$	-0.432*	0.154	-2.804
Labour*Labour	$_{33}$	0.059*	0.022	2.739
Time*Time	$_{44}$	-0.012@	0.010	-1.201
Capital*Material	$_{12}$	-0.144***	0.092	-1.566
Capital*Labour	$_{13}$	-0.011@	0.047	-0.235
Capital*Time	$_{14}$	-0.235***	0.019	-1.293
Material*Labour	$_{23}$	0.269*	0.065	4.150
Material*Time	$_{24}$	0.036***	0.028	1.292
Labour*Time	$_{34}$	-0.028**	0.013	-2.200
Sigma-squared		0.048		
Log likelihood function		21.949		

*, **, *** Significance level at 1, 5 and 10% consecutively; @ means insignificant S.E = standard error.

Table 3. Maximum-likelihood estimates of bank deposits Translog Stochastic Frontier Production Function and Inefficiency Effects model.

Maximum-likelihood estimates				
Variable	**Parameter**	**Coefficient**	**S.E**	**t-value**
Constant	$_0$	8.525*	0.676	12.615
Capital	$_1$	0.050@	0.200	0.249
Labour	$_2$	1.851*	0.244	7.588
Material	$_3$	-1.266*	0.210	-6.023
Time	$_4$	0.161**	0.094	1.708
Capital*Capital	$_{11}$	0.072***	0.055	1.326
Labour*Labour	$_{22}$	-0.757*	0.134	-5.643
Material*Material	$_{33}$	0.056*	0.014	3.944
Time*Time	$_{44}$	-0.010@	0.011	-0.921
Capital*Labour	$_{12}$	-0.158**	0.077	-2.047
Capital*Material	$_{13}$	0.033@	0.028	1.187
Capital*Time	$_{14}$	0.007@	0.009	0.774
Labour*Material	$_{23}$	0.295*	0.049	6.005
Labour*Time	$_{24}$	0.077*	0.023	3.299
Material*Time	$_{34}$	-0.048*	0.008	-5.476
Inefficiency model estimates				
Constant	$_0$	0.727@	0.784	0.928
Time	$_1$	0.062*	0.027	2.333
Total assets	$_2$	-0.120**	0.072	-1.664
Herfindahl index	$_3$	0.005@	0.047	0.107
NB dummy	$_4$	-0.363@	0.603	-0.602
ISB dummy	$_6$	-0.066@	0.486	-0.135
FB dummy	$_7$	0.643***	0.495	1.299
PB dummy	$_8$	0.512@	0.473	1.083
Sigma-squared (σ_2)		0.073*	0.014	5.070
Gamma (γ)		0.999*	0.000003	3.111

*, **, *** Significance level at 1, 5 and 10% consecutively; @ means insignificant, S.E = standard error.

Table 4. Year-wise average deposits efficiency of banks in Bangladesh.

Year	**Mean**
2001	0.765
2002	0.793
2003	0.736
2004	0.766
2005	0.702
2006	0.731
2007	0.675
Mean	0.738

services compared to the best practicing bank operating in the same environment. The highest deposits efficiency was in 2002 and it was near to 80% which was 3.66% higher than previous year. The average deposits efficiency in 2007 was 67.5% which was 7.66% lower than 2006. Year wise average deposits efficiency seemed to be unstable during the study period.

As shown in Table 5 and Figure 2, while the deposits efficiency of Nationalized Commercial Banks (NBs) and Islamic Banks (ISBs) increased over the time period, for

Table 5. Year-wise bank group level efficiency in deposits.

Year	NB	ISB	FB	PB
2001	0.892	0.919	0.562	0.741
2002	0.976	0.890	0.671	0.761
2003	0.830	0.882	0.722	0.690
2004	0.857	0.851	0.690	0.745
2005	0.863	0.853	0.669	0.647
2006	0.960	0.906	0.606	0.675
2007	0.988	0.776	0.518	0.627
Mean	0.909	0.868	0.634	0.698

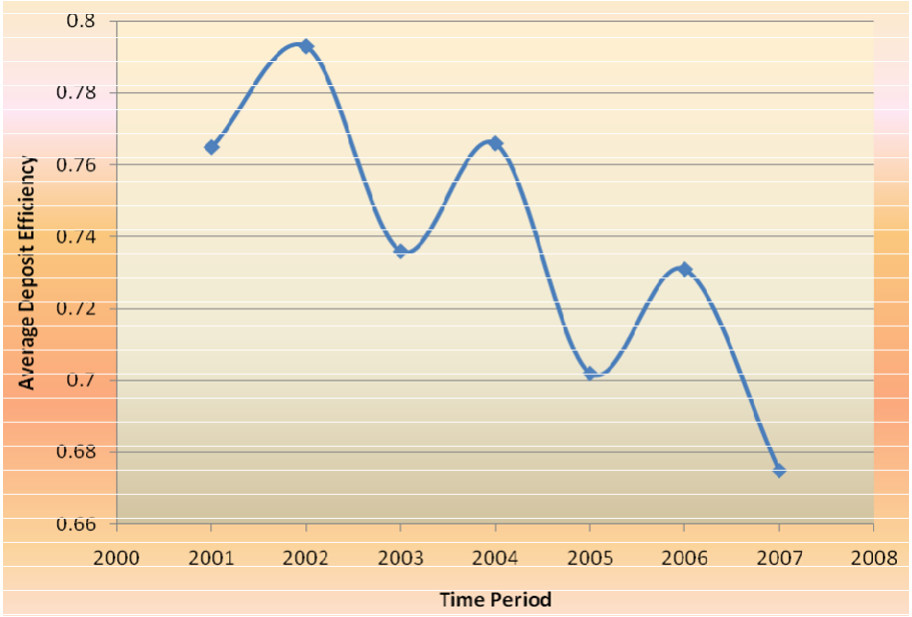

Figure 1. Year-wise average bank deposits efficiency in Bangladesh.

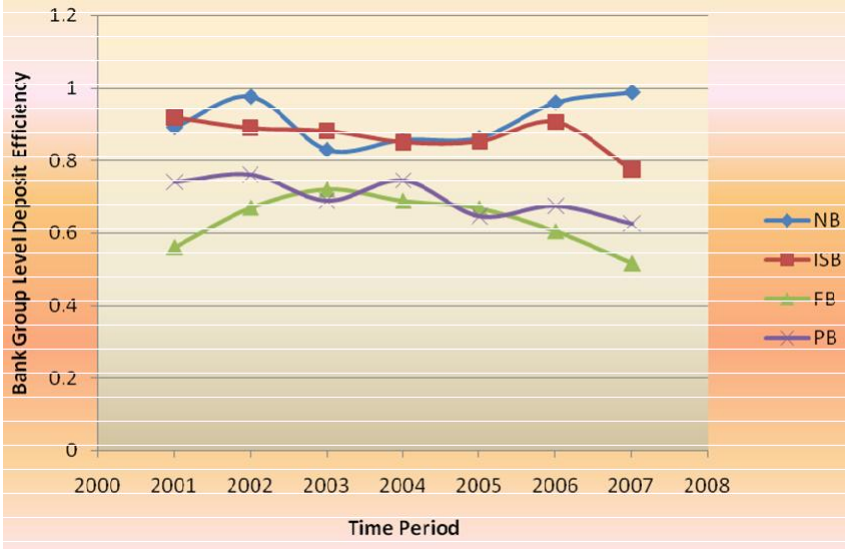

Figure 2. Bank group level average deposits efficiency in Bangladesh.

Table 6. Deposits efficiency of banks in Bangladesh.

Bank's name	2001	2002	2003	2004	2005	2006	2007	Mean efficiency
Sonali Bank	0.96	0.99	0.86	0.90	0.95	0.92	0.99	0.94
Janata Bank	0.82	0.96	0.80	0.81	0.77	1.00	0.99	0.88
Islami Bank	0.93	0.99	0.95	0.97	0.96	0.92	1.00	0.96
Shahajal Islami Bank	0.93	0.97	0.86	0.74	0.82	0.92	0.71	0.85
Al Arafah Bank	0.90	0.71	0.83	0.84	0.78	0.88	0.62	0.79
Bank Asia	0.49	0.72	0.85	0.81	0.68	0.64	0.57	0.68
The City Bank	0.63	0.62	0.59	0.57	0.65	0.57	0.46	0.59
National Bank	0.76	0.69	0.59	0.54	0.48	0.49	0.49	0.58
Prime Bank	0.80	0.77	0.75	0.80	0.71	0.92	0.95	0.81
Uttara Bank	0.68	0.61	0.56	0.54	0.51	0.45	0.45	0.54
One Bank	0.69	0.68	0.55	0.89	0.50	0.60	0.49	0.63
UCB Bank	0.62	0.62	0.61	0.81	0.85	0.86	0.92	0.76
Pubali Bank	0.59	0.56	0.53	0.55	0.52	0.43	0.44	0.52
Priemer Bank	0.38	0.72	0.66	0.67	0.61	0.59	0.54	0.60
Mutual Bank	0.67	0.81	0.88	1.00	0.77	0.87	0.66	0.81
South East Bank	0.91	1.00	0.86	0.94	0.88	0.77	0.72	0.87
Eastern Bank	0.88	0.74	0.57	0.60	0.51	0.52	0.49	0.61
AB Bank	0.98	0.99	0.97	0.83	0.65	0.66	0.57	0.80
Dhaka Bank	0.84	0.80	0.68	0.76	0.70	0.80	0.77	0.77
DBBl	0.85	0.90	0.77	0.76	0.72	0.83	0.64	0.78

Foreign Banks (FBs) it declined sharply and for Private Banks (PBs) it remained almost stable. These results were supported by Mahesh and Meenakshi (2006). However, not all banks belonging to FB showed declining trend in deposits efficiency in the time period. At the bank group level, NBs and ISBS were more efficient with 90.9% and 86.8% respectively followed by PBs with 63.4% and FBs with 62.7% in producing deposits services. This study supported the findings of Dilruba and Khandakher (2005) and Hamim et al (2006) in particular for nationalized commercial banks and for Islamic Banks. From our analysis we observed that the foreign banks were less efficient in producing deposits. It was noted that not all foreign banks were less efficient. For example, the year (2003 and 2005) wise group efficiency of foreign bank in deposits efficiency were 0.722 and 0.669, higher than the corresponding deposits efficiency of private banks. These findings are in line with the argument that foreign banks are superior as they normally have advanced technology and skills; sophisticated services and broader international networks (Levine, 1996; Unite and Sullivan, 2003) . The reason for the other years, the foreign banks being less efficiency in producing deposits services could be that majority of them depend mainly on borrowed funds for lending and investment purposes. However, the overall deposits efficiency of all bank groups was steadily increasing over time except in 2007. In 2007 the deposits efficiency remarkably decrease might be due to political unrest, emergency power government and fear of the people to keep their money in the bank. In case of foreign banks, the reason for less efficient was their lower fixed assets compared to other banks. Domestic banks were relatively more efficient than foreign banks. These results are supported by the findings of Iza et al. (2009).

The bank- wise efficiency was reported in Table 6 and in Figure 3. We observed that Islami Bank Bangladesh Ltd and Government Owned Sonali Bank were most efficient in producing deposits with 96 and 94% respectively. This result indicated that big size (measuring their total assets) banks are comparatively more efficient. But this result contradicted with Islamic banks. This might be due to the fact that people have faith on Islamic banks. On the other hand, Pubali Bank and Uttara Bank were far lower efficient comparing with the above two Banks. It could be that these less efficient banks were concentrating in other services rather than deposits. From our study we found that large size banks were less inefficient than small size banks in producing deposits.

Results on hypothesis tests of deposits stochastic frontier model

The results of various hypothesis tests of deposits model were presented in Table 7. All the hypotheses tests are obtained using the generalized likelihood-ratio statistic (7).

The critical values are obtained from table of Kodde and Palm (1986). The null hypothesis included the restriction that $\gamma = 0$ did not have a chi-square distribution , because the restriction defined a point on the boundary of parameter space.

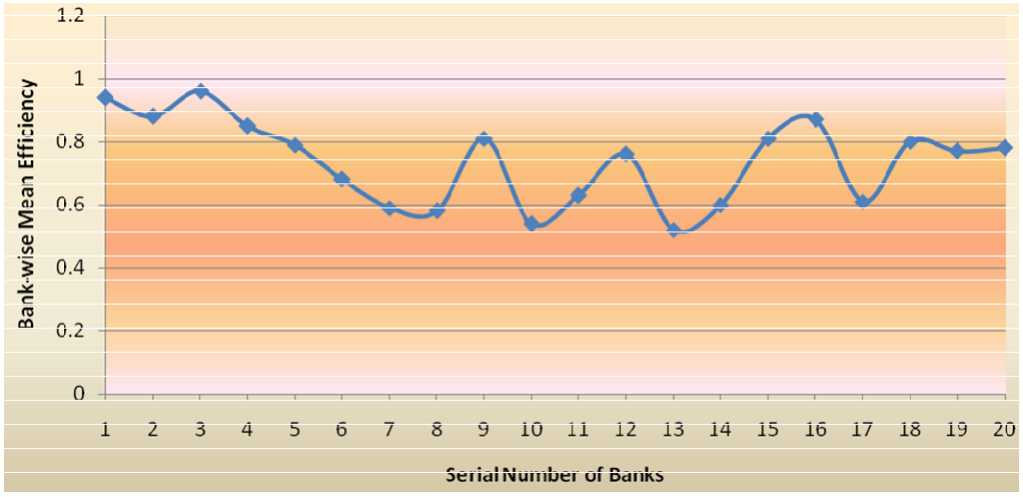

Figure 3. Bank-wise average deposits efficiency in Bangladesh.

Table 7. Generalized likelihood-ratio test of hypothesis of the deposits stochastic frontier production model.

Null hypothesis	Log-likelihood function	Test statistic λ	Critical value*	Decision
$H_0 : \gamma = 0$	21.94	68.99	3.38	Reject H_0
$H_0 : \beta_{ij} = 0$	-20.26	166.01	19.35	Reject H_0
$H_0 : \eta = 0$	21.94	126.965	3.38	Reject H_0

*All critical values are at 5% level of significance.

The estimates of variance ratios $\gamma = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2}$ of deposits model was found to be 0.999. The first null hypothesis is $H_0 : \gamma = 0$, which specified that there was no technical inefficiency effect in the deposits model. Since the hypothesis was rejected so we concluded that there was a technical inefficiency effect in the model.

The second null hypothesis is $H_0 : \beta_{ij} = 0$, which indicated that Cobb-Douglas Production Function was preferable to Translog Production Function. From the outcome it was observed that the null hypothesis was strongly rejected and Translog Production Function was statistically more favorable.

The third null hypothesis is $H_0 : \eta = 0$, which specified that the technical inefficiency effect did not vary significantly over time. The null hypothesis was rejected indicating that the technical inefficiency effect varied significantly.

POLICY RECOMMENDATIONS

Bank efficiency studies are of crucial importance for operational and academic proposes (Berger et al., 1997). Efficiency evaluation is useful for individual investment or loan decisions. In addition, creditors and investors use such efficiency evaluations to judge past performance and current position of banks. Second, to judge future potential and the risk connected with that potential. Consequently, drawing efficiency results of banks can help improve their overall investment performance. It is a matter of significant importance to know whether decisions regarding adoption of the innovative technology in banking constitute one of the prime factors in determining banks' performance and growth. The findings of the study have important policy implications for efficiently managing the financial institutions, especially the NB, ISB and PB banks. In particular, the NB should take appropriate actions for increasing their coverage in offering innovative technology driven services with a view to increasing their performance and raising their market competitiveness. Banks can provide efficient banking services to the nation if they are supported with appropriate banking laws, and regulations. It would be better if banks had the opportunity to work as a sole system in an economy. That would provide banking system to fully utilize its potentials. Studies show that Islamic banks cannot operate within their full efficiency level and if they operate under a conventional banking framework, their efficiency goes down in a number of dimensions.

It would be important for financial sector policies to encourage the banks to use any excess liquidity in the banking system for providing credit to productive activities. The Bangladesh Bank, being the regulator of the financial system, can play an important role through taking necessary measures to expedite the initiatives of the traditional banks in adopting such innovative technology driven products and services in their banking activities. On its part, this bank should strengthen its prudential oversight and closely monitor the liquidity situation in the banking system. In addition, it would be important for the Bangladesh Bank to continue its efforts in urging the banks to reduce their lending rates, increase competition among the financial intermediaries, and pursue strong monitoring and supervision measures so that the financial institutions reduce administrative cost by improving efficiency and reducing the burden of nonperforming loans.

Conclusion

This study was set out to provide the estimates of the bank specific deposits efficiency and to compare efficiency estimates for NBs (National Banks), ISBs (Islamic Banks), FBs (Foreign Banks), and PBs (Private Banks) of Bangladesh using stochastic frontier analysis. We compared the efficiencies of 20 Commercial Banks group wise, year wise and specific bank wise for the time period of 2001 to 2007. The most important results were summarized thus:

(1) First, we analyzed the Translog Stochastic Frontier Production Function with distributional assumptions for the measurement of bank specific deposits efficiency and the presence of one-sided error component was justified by the LR test individually, which was highly significant for deposits Translog stochastic frontier model. We found that the technical inefficiency declined over the reference period and Translog Production Function was preferable to Cobb-Douglas Production Function.
(2) From the estimates of deposits model we found that the coefficient of material input variable showed a negative sign, indicating that banks using less material (Stationary, postage, and other materials) were more productive. In deposits inefficiency effects model, the coefficient of total assets contains negative sign, indicating that the more the total asset the more the bank efficiency. The coefficients of NBs and ISBs demonstrate negative sign, implying that inefficiency level declines when competition increases.
(3) The estimated year wise average efficiency of the sample banks from the deposits model was 0.738 while group wise average technical efficiency is 0.777. At the bank group level, Nationalized Commercial Banks (NBs) and Islami Banks (ISBS) were more efficient by 90.9 and 86.8% respectively followed by Private Banks (PBs) 63.4% and Foreign Banks (FBs) with 62.7% in producing deposits services. From our analysis we observed that the foreign banks were less efficient in producing deposits. However, the overall deposits efficiency of all bank groups was steadily increasing over time except in 2007. The most efficient bank was Islami Bank Ltd. and the most inefficient bank was Pubali Bank with efficiency scores of 0.96 and 0.52, respectively.

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