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Research Article

Stochastic Frontier Model for Measuring Investment Efficiency of Banks

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Abstract: The study attempts to evaluate the investment efficiency level of online banks and to make a comparison of the investment efficiency scores of banks according to group-wise, year-wise and individually. We used a panel of 20 banks dividing them into four groups namely NBs (National Banks), ISBs (Islamic Banks), FBs (Foreign Banks) and PBs (Private Banks) in Bangladesh. Using Translog stochastic frontier technique we estimated investment efficiencies of those four groups of banks. We observed that there are significant variations of efficiencies across different banks in different time periods. ISBs, FBs and PBs are found inefficient in producing investments. The estimated year wise average efficiency of the sample banks is recorded 0.431 while group wise average efficiency is 0.517. Islamic Banks are observed best performing banks in investment sector. The most investment efficient bank is Islami Bank and the least investment efficient bank is City Bank with efficiency score 0.97 and 0.11, respectively.

Keywords: Efficiency, investment, online banks, performance, stochastic frontier analysis

INTRODUCTION

In general, bank efficiency studies, which are of interest not only to academics, but also to policymakers, bank creditors, owners and managers. The entry of investments (institutional and private) into the banking sector is a subject of public interest. Investment banking industry has gone through unbelievable transformation in global context due to crossing international borders and consolidation. Evaluating investment efficiency of banks is important for several reasons. First, investment bank engage in public and private market transaction for corporations, governments and investors and is making benefits for all the participants. Second, efficiency of these institutions affect the financial markets and the ability of investment banks to minimize costs or maximizes profits is important both for them and for their clients. Third, by exercising their powers and by improving their efficiency, these institutions can improve certain industry segments.

There has been a widespread discussion about efficiency of banks in developing countries compared to their counterparts in the developing world (Das, 1997; Raihan, 1998; Choudhury and Moral, 1999; Choudhury, 2002; Shanmugam and Lakshmanasamy, 2001; Kumar and Verma, 2003; Mohan and Ray, 2004; Das *et al*., 2005; Kumbhakara and Sarkar, 2003; De, 2004; Sensarma, 2005; Baten and Kamil, 2010, 2011; Baten and Begum, 2014). No literature is available on measuring investment efficiency of banks in Bangladesh using stochastic frontier models (Battese and Coelli, 1995). This study contributes to the existing literature because no studies explored on investment banks (Berger and Humphrey, 1997) and we will estimate the efficiency through introduction of the appropriate variables in the investment frontier estimations. To measure investment efficiency of commercial and private banks are 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 judged. Second, efficiency investigation of commercial banks is the potential impact of government policies.

Investments might have a significant role in the development of the banking system but there is no study that explicitly explores the impact of investments in the Bangladesh banking system. No attempt has been made to check the performance and investment efficiency measure of private banks and the commercial banks with loan default. In Bangladesh that banks are operating under both public and private sector and addresses two major questions. Question arises how successfully the nationalized private commercial banks are serving the country, how far they have achieved their desired goals? The goal of this study is to obtain a proper comparison of banking investment efficiency by using a global best practice econometric frontier

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whereby the banks can be compared against the same standard.

This study intends to reveal the overall performance measuring of NBs (Nationalized Commercial Banks), IBs (Islamic Banks), FBs (Foreign Banks) and PBs (Private Banks) banks in Bangladesh in the context of investment sector. To determine the important factors and identify the determinants causing investment efficiency differential on banking industry in Bangladesh is of interest. Comparisons are taken consideration lastly to be made on efficiency scores of banks according to group-wise, year-wise and individually.

BACKGROUND OF BANGLADESH BANKING INDUSTRY

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, around thirty private commercial banks, nine foreign multinational banks and four 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.

Bangladesh Bank (Central Bank): Pursuant to Bangladesh Bank Order, 1972 the Government of Bangladesh reorganized the Dhaka branch of the State Bank of Pakistan as the central bank of the country and named it Bangladesh Bank with retrospective effect from 16th December, 1971.

Nationalized commercial banks: 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. Total branches of banks in Bangladesh are 8322, among them the branches of nationalized banks is increased towards 3478 as of 2013. The nationalized commercial banks are: Sonali Bank, Janata Bank, Agrani Bank, Rupali Bank.

Private commercial banks: Private Banks are the highest growth sector due to the dismal performances of national/government banks and consisted of 30 Banks, which together controlled more than 62.57% of deposits and operated 3339 branches as of 2012-2013. They tend to offer better service and products and private commercial banks: AB Bank Limited, BRAC Bank Limited, Eastern Bank Limited, Dutch Bangla Bank Limited, Dhaka Bank Limited, Islami Bank Bangladesh Ltd, Pubali Bank Limited, Uttara Bank Limited, IFIC Bank Limited, National Bank Limited, The City Bank Limited, United Commercial Bank Limited, NCC Bank Limited, Prime Bank Limited, SouthEast Bank Limited, Al-Arafah Islami Bank Limited, Social Investment Bank Limited, Standard Bank Limited, One Bank Limited, Exim Bank Limited, Mercantile Bank Limited, Bangladesh Commerce Bank Limited, Mutual Trust Bank Limited, First Security Bank Limited, The Premier Bank Limited, Bank Asia Limited, Trust Bank Limited, Shahjalal Bank Limited, Jamuna Bank Limited.

Foreign banks: Foreign Banks are also the growth sector due to the performances of national commercial banks and consisted of 9 Banks, which together controlled more than 6.06% of deposits and operated 65 branches as of 2012-2013. They tend to offer services providing disbursed loan and defaulted loan as well as are playing a pioneer role in introducing modern financial products and services. Foreign banks are: Citigroup, HSBC, Standard Chartered Bank, Commercial Bank of Ceylon, State Bank of India, Habib Bank, National Bank of Pakistan, Woori Bank, Bank Alfalah, ICB Islami Bank.

Specialized banks: 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. They are consisted of 4 Banks, which together controlled more than 4.83% of deposits and operated 1440 branches as of 2012-2013. The Specialized banks are: Grameen Bank, Bangladesh Krishi Bank, Bangladesh Shilpa Bank, Rajshahi Krishi Unnayan Bank, Bangladesh Shilpa Rin Sangstha, Basic Bank Ltd (Bank of Small Industries and Commerce), Bangladesh Somobay Bank Limited (Cooperative Bank), The Dhaka Mercantile Co-operative Bank Limited (DMCBL).

Why Bangladesh banking industry? Bank efficiency has been an important issue in transition. All transition countries have been faced with at least one banking crisis and many with more. In most of the transition countries, the relative comparison of banks by size, type of ownership or date of appearance has at some point been an issue. How good it is to let new banks enter the market? Should the domestic banking sector be sold to foreigners? Do small banks have a future in the era of globalization and banking market consolidation? These and other questions, continue to dominate discussions in many transition countries. Therefore, an understanding of a bank's relative performance compared to the market, or over a period of time, is

important for analysts, practitioners and policymakers alike.

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 overall GDP in Bangladesh is 6.3%, as December 31, 2012. In banking sector GDP is 1.59% as constant price, 1.46% as current price.

The non-bank 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 rose to 21,300, in 2012-2013 it again rose to 44163 per nationalized banks due to winding up of a number of branches and growth in population. Out of total population in Bangladesh, irrespective to any branch, total person per branch is 18457. However, compared to India's 15,000 persons per branch in 2000, this indicates that the banking system of our country is a significant problem. Therefore, Bangladesh banking industry is an interesting topic for our study for two reasons. First no earlier studies have been intended to estimate the productive and investment efficiency on banks 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. Thus it is very important to look into Bangladesh banking sector.

METHODOLOGY

This section devotes the formulation of the investment stochastic frontier model followed by the theoretical stochastic frontier model. Data description and a brief explanation of the variables from the data set and Likelihood Ratio Tests for hypotheses are illustrated.

Theoretical stochastic frontier model: The stochastic frontier production model approach is considered to be most suitable for the panel data of 20 sample banks of Bangladesh covering 7 years followed by Battese and Coelli (1995), which is expressed as:

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

where, Y_{it} is the logarithm of output of the the i^{th} bank in t^{th} period, X_{it} is a vector of input quantities, V_{it} are random variables which are assumed to be iid, $N(0, \sigma_v^2)$ and independent of U_{it}. And, U_{it} are non-negative random variables which are assumed to account for technical inefficiency in output production 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 a firm and δ is a $1\times p$ vector of parameters to be estimated. The parameterization from Battese and Corra (1977) are used replacing σ_u^2 and σ_v^2 with $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and the parameters are estimated by Maximum Likelihood Estimation approach.

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

$$U_{it} = \delta Z_{it} + W_{it} \quad (2)$$

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

$$TE_{it} = \exp(-U_{it}) = \exp(-Z_{it} - W_{it}) \quad (3)$$

Data description and the variables: We used data for the period of 2001-2007 from 20 selected banks of Bangladesh. Banks are grouped into four categories:

- National Banks (NBs)
- Islamic Banks (ISBs)
- Foreign Banks (FBs)
- 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. All nominal values of dependent, independent and explanatory variables are converted on real by deflating with GDP deflator and all values are in their natural logarithms.

Dependent variable:

Investment (Y_1): We used investment as a dependent variable in this study and this amount is equal to the total investment which is made up by treasury bills, prize bonds, zero coupon bonds, shares/sponsor shares of financial institutions and other companies. It includes investment in Government securities, other approved securities and other investments A bank normally tries to invest its money in various productive sectors so that it can earn optimal profits. This output value is deflated by respective consumer price index.

Independent variables:

Capital (X_1): Capital is the first input variable in this very study and is used to represent the fixed assets of a bank in a year which also adds premises, furniture, fixture and other fixed assets. Capital figures are deflated by capital price index.

Number of employee (X_2): Number of employee is one of the most important inputs to measure the productivity of a firm. Here number of employee is measured as the total number of employees which include officers, sub-ordinates and clerks.

Material (X_3): For the banking sector, material 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 forth 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 used as the first influencing variable and it is the sum of all assets and their book value.

Herfindahl index (Z_3): Herfindahl index is also known as measure of competition which is measured as the sum of squared of the output share of each of bank in the output of considered total banks in Bangladesh.

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

Formulation of investment stochastic frontier model: The functional form for the investment stochastic frontier model is considered as translog and it can be written as follows:

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

where, output variable is bank investment, K is the capital, M is the material, L is the labour, T is the time.

Further the technical inefficiency effects are defined as follows:

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

where, TA is the Total Assets, HI is the Herfindahl Index, NB, ISB, FB and PB are bank dummy variables.

Likelihood ratio tests: The following hypotheses requires testing with the generalized likelihood ratio test:

$$\lambda_{LR} = -2\{\ln[L(H_0)] - \ln[L(H_1)]\}$$

where, $L(H_0)$ and $L(H_1)$ are the maximum values of the log likelihood functions for the investment stochastic frontier model under the null and alternative hypothesis respectively. The following hypotheses will be tested:

$H_0 = \beta_{ij} = 0$: The null hypothesis that identifies an appropriate function form between the restrictive Cobb-Douglas and the translog production function.

$H_0 = \gamma = 0$: The null hypothesis specifies that the technical inefficiency effects in banks are zero.

$H_0 = \eta = 0$: The null hypothesis means that there is no change in the technical inefficiency effects over time.

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 $\lambda_{LR} > \chi_c^2$, i.e., 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 investment stochastic frontier model.

RESULTS AND DISCUSSION

Results of hypothesis tests: The results of various hypothesis tests of the investment stochastic frontier model are presented in Table 1.

Since the first null hypothesis H_0: $\gamma = 0$, is rejected so we concluded that there is a technical inefficiency effect in the model.

Table 1: Generalized likelihood-ratio test of hypothesis of the investment stochastic frontier model

Null hypothesis	Log-likelihood function	Test statistic λ	Critical value*	Decision
H_0: $\gamma = 0$	-86.55	197.93	3.38	Reject H_0
H_0: $\beta_{ij} = 0$	-107.98	215.96	19.35	Reject H_0
H_0: $\eta = 0$	-79.46	158.92	3.38	Reject H_0

All critical values are at 5% level of significance; *The critical values are obtained from table of Kodde and Palm (1986); The null hypothesis which includes the restriction that γ is zero does not have a chi-square distribution, because the restriction defines a point on the boundary of parameter space

Table 2: OLS estimates of translog stochastic frontier production function: Investments frontier estimates

Variables	Parameters	Coefficients	S.E.	t-value
Constant	β_0	13.155*	1.910	6.887
Capital	β_1	-3.677*	0.695	-5.293
Material	β_2	-2.982*	1.009	-2.955
Labour	β_3	1.544*	0.528	2.926
Time	β_4	1.508*	0.207	7.296
Capital*Capital	β_{11}	0.937*	0.273	3.436
Material*Material	β_{22}	1.295*	0.411	3.147
Labour*Labour	β_{33}	0.747*	0.193	3.879
Time*Time	β_{44}	-0.008@	0.030	-0.265
Capital*Material	β_{12}	0.955*	0.250	3.826
Capital*Labour	β_{13}	-0.619*	0.176	-3.518
Capital*Time	β_{14}	-0.217*	0.055	-3.940
Material*Labour	β_{23}	-0.871*	0.227	-3.847
Material*Time	β_{24}	-0.263*	0.073	-3.610
Labour*Time	β_{34}	0.126*	0.041	3.055
Sigma-squared		0.322		
Log likelihood function		-111.382		

*, **, *** Significance level at 1, 5, 10%, consecutively @ means insignificant; S.E. = Standard Error

Table 3: Maximum-likelihood estimates of translog production function and inefficiency model: Investments stochastic frontier estimates

Variables	Parameters	Coefficients	S.E.	t-value
Constant	β_0	4.158*	0.909	4.575
Capital	β_1	0.126@	0.313	0.404
Material	β_2	0.834**	0.486	1.717
Labour	β_3	0.265@	0.295	0.898
Time	β_4	0.373*	0.088	4.246
Capital*Capital	β_{11}	0.106@	0.163	0.652
Material*Material	β_{22}	-0.591*	0.196	-3.017
Labour*Labour	β_{33}	-0.094@	0.124	-0.760
Time*Time	β_{44}	-0.019**	0.012	-1.679
Capital*Material	β_{12}	0.007@	0.124	0.054
Capital*Labour	β_{13}	-0.068@	0.102	-0.671
Capital*Time	β_{14}	-0.013@	0.029	-0.444
Material*Labour	β_{23}	0.264**	0.128	2.055
Material*Time	β_{24}	0.030@	0.032	0.922
Labour*Time	β_{34}	-0.031**	0.017	-1.759
Inefficiency effects model estimates				
Variables	Parameters	Coefficients	S.E.	t-value
Constant	δ_0	0.296@	0.498	0.595
Time	δ_1	0.072*	0.016	4.587
Total Assets	δ_2	-0.001@	0.019	-0.051
Herpindahl Index	δ_3	-0.029@	0.042	-0.693
NB Dummy	δ_4	0.177@	0.500	0.354
ISB Dummy	δ_6	-2.955*	0.465	-6.360
FB Dummy	δ_7	1.526*	0.465	3.283
PB Dummy	δ_8	1.548*	0.454	3.408
Sigma-squared		0.113*	0.011	9.990
Gamma		0.964*	0.018	52.213

*, **, *** Significance level at 1, 5, 10% consecutively; @ means insignificant, S.E. = Standard Error

From the second null hypothesis H_0: $\beta_{ij} = 0$, it is observed that the null hypothesis is rejected and Translog production function is found more appropriate than Cobb-Douglas.

The third null hypothesis H_0: $\eta = 0$, is rejected indicating that the technical inefficiency effect fluctuates remarkably.

Results of stochastic frontier investment model: In this subsection, investment efficiency on banks in Bangladesh, ordinary least square estimates, as well as maximum likelihood estimates of the parameters have been reported. The efficiency estimates have been measured using the translog stochastic frontier production function proposed by Battese and Coelli (1995) applied to panel data. A two-step process is used to find out the investment efficiency using maximum likelihood method. In the first step using frontier 4.1 by grid search the ordinary least square estimates of parameters are obtained and these estimates are used to estimate the maximum likelihood estimates of the parameters of the translog stochastic frontier production model. In the second step efficiencies of banks are obtained automatically. The section also devotes to examine the overall performance of online banks in Bangladesh.

We obtained the ordinary least squared estimates of investment stochastic frontier model which are tabulated in the Table 2. All the coefficients of the parameters of investment model are statistically significant in case of OLS estimation at 1% level of significance apart from second order variable time (β_{44}).

In order to investigate the significant contribution of various input variables on investment frontier, we estimated the maximum likelihood estimates of the parameters of investment stochastic frontier model along with inefficiency effects model. The estimated results are reported in the Table 3. From the study we perceived that almost all variables are insignificant in producing investment over the sample period apart from material and some second order variables. Capital is found insignificant and the value of the coefficient is 0.126 which shows a positive sign and from this result we may infer that time variable is significant issue to increase investment productivity.

From the inefficiency effects model, it is investigated that time is significant and positive signed. The coefficients of total assets and Herfindahl index demonstrate negative sign signifying that inefficiency level declines when competition increases. Another explanatory variable in inefficiency effects model is ISB dummy which is highly significant and contains negative sign and the value is -2.955.

The investment efficiency is regressed on three explanatory variables namely time, total assets, Herfindahl index and four ownership dummy variables. The time variable and all dummy variables excluding NB, recorded a positive impact on inefficiencies. Again, total assets and Herfindahl Index have negative signs suggesting that these two significantly decrease the inefficiency of a bank. This result indicates that ownership dummy plays an important role in investment efficiency.

The group wise bank efficiency of investment stochastic frontier model is depicted in the Fig. 1. From the analysis it is observed that Islamic Banks in group are best performing banks in investment sector and it seems to be very surprising result to other researchers. The average investment efficiency of Islamic bank is 97%. On the contrary Foreign Banks are significantly inefficient in this regard and they are on an average 79% inefficient. The reason for foreign banks being lowest efficient in investing could be that majority of them depend mainly on borrowed funds and investment purpose. On an average NB is second best performing bank in investment sector with 57% efficiency, followed by PB (32%) and FB (21%). Hence huge gap was observed between ISBs and others that support the findings of Mahesh and Rajeev (2006). But it is a matter of hope that the investment efficiency levels are almost stable for ISBs over the sample. Moreover, Private Banks are not interested in investment sector rather they are highly concentrated on standard services.

The year wise average investment efficiency of 20 Bangladeshi Commercial banks from 2001 to 2007 is revealed in the Fig. 2. It is found that on an average, Bangladeshi banks are 43.1% efficient in engaging in investment relative to best practicing bank during the

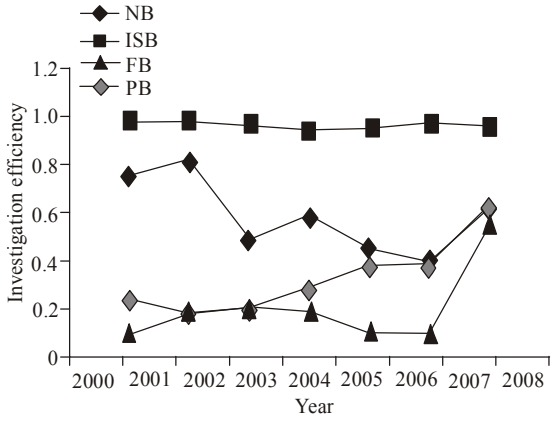

Fig. 1: Group-wise bank's investment efficiency over time in Bangladesh

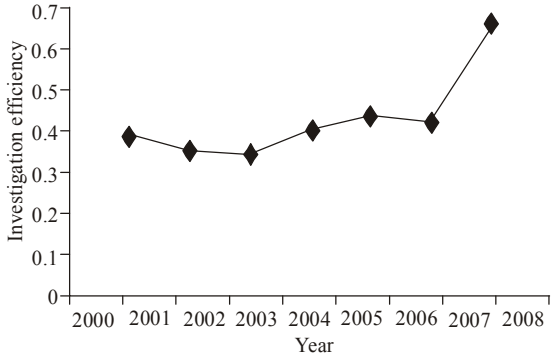

Fig. 2: Year-wise average investment efficiency of banks in Bangladesh

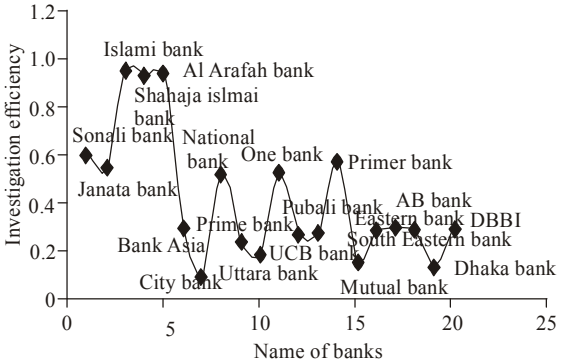

Fig. 3: Bank-wise average investment efficiency of banks in Bangladesh

study period. Though the efficiency scores are not satisfactory but it is a matter of hope that there has been occurred a gradual improvement over the sample period. In 2001 the investment efficiency was found only 38.6%. Remarkable change has been occurred in 2007. In 2007 the investment efficiency was recorded 65.8%. Investment efficiency shows a gradual improvement over the time period.

Bank wise average investment efficiency has been depicted in the Fig. 3. The most three inefficient banks

are the city bank, Dhaka bank and Mutual Trust bank with 89, 86 and 84% inefficiency scores. Government owned Sonali bank (61%) is slightly better than Janata bank (56%) in producing investment. The best performing bank in the competition is Islamic bank Bangladesh ltd with 3% inefficiency only. National bank, One bank, Priemer bank have roughly the same efficiency scores 54, 55 and 57%, respectively. United Commercial bank, South East bank, Arab Bangladesh bank and Pubali bank have the same inefficiency with 73, 72, 72 and 69%, respectively.

CONCLUSION

A Translog stochastic frontier model as an investment efficiency effect was formulated where the bank's investment efficiency to depend on capital, material and labor, as well as interactions between these variables is situated. From the results it was observed that Translog stochastic frontier model is an appropriate than Cobb-Douglas frontier model. From the results it was recorded that capital is found insignificant with positive value (0.126), raw material and time variable was recorded significant issue to increase investment productivity. The coefficients of total assets and Herfindahl index demonstrated negative sign representing that inefficiency level of a bank decline significantly when competition increases. This result indicated that ownership dummy played an important role in investment efficiency. Another explanatory variable in inefficiency effects model is ISB dummy which is observed highly significant with negative value. The investment efficiency is regressed on time, total assets, Herfindahl index and four ownership dummy variables where the time variable and all dummy variables excluding NB, recorded a positive impact on inefficiencies.

From the analysis results it is also perceived that Islamic Banks in group are best performing banks in investment sector compare to other groups of banks and the average investment efficiency of Islamic bank is 97%. While Foreign Banks are significantly inefficient in this regard and they are on an average 79% inefficient as the reason for foreign banks being lowest efficient in investing could be that majority of them depend mainly on borrowed funds and investment. On an average NB is documented second best performing bank in investment sector with 57% efficiency, monitored by PB (32%) and FB (21%). Enormous gap was observed between ISBs and others that support the findings of Mahesh and Rajeev (2006). But it is a matter of hope that the investment efficiency levels are almost stable for ISBs over the sample. Moreover, Private Banks are not interested in investment sector rather they are highly concentrated on standard services. As an individual, Islamic bank Bangladesh ltd was observed the best performing bank in the competition with all other banks. Besides, the time variable and bank group specific dummies for Islamic Bank, Foreign Bank and Private Bank excluding Nationalized Banks, recorded a positive impact on inefficiencies and indicating that these dummy variables plays an important role in investment efficiency. Among nationalized banks, Sonali bank was found to be slightly better than Janata bank in producing investment.

On an average, it is originated that banks are 43.1% efficient in engaging in investment relative to best committed bank during the study period. There has been ensued a regular development over the sample period even though the efficiency scores was not found satisfactory. Remarkable change was occurred 65.8% in 2007 while the investment efficiency was found only 38.6% in 2001. The most three inefficient banks were recorded for the city bank, Dhaka bank and Mutual Trust bank with inefficiency scores 89, 86 and 84%, respectively. Sonali bank (61%) as government owned bank was detected somewhat better than Janata bank (56%) in producing investment. The best performance bank in the competition was remarked Islamic bank Bangladesh ltd with 3% inefficiency only. National bank, one bank, Priemer bank occurred roughly the nearly same efficiency scores 54, 55 and 57%, respectively. Again United Commercial bank, South East bank, Arab Bangladesh bank and Pubali bank noticed the approximately same efficiency scores with 73, 72, 72 and 69%, respectively.

The efficiency results of banks can help recover their overall investment performance. It is a matter of significant standing to distinguish whether decisions regarding acceptance of the state-of-the-art technology in banking organize in determining banks' performance and growth. The findings of the study initiated important policy implications for efficiently managing the financial institutions, especially the NB, ISB and PB banks. In particular, the NB should take suitable movements for increasing their attention in offering advanced technology driven services with a view to growing their performance and nurturing their market effectiveness. Banks can provide efficient banking services to the nation if they are maintained with suitable banking laws and regulations. It would be better if banks had the opportunity to work as an individual system in an economy that would provide banking system to fully operate its potentials. Studies show that Private Banks are not interested in investment sector rather they are highly concentrated on standard services as they should upsurge their investment.

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