**Investigating the Role of ICT Determinants of Private Commercial Banks with Stochastic Frontier models in Bangladesh**

**Abstract**

ICT has now become the engine block of banking institutions worldwide and the Bangladesh banking industry is no exception. This study measures the impact of ICT determinants on 17 private commercial banks (PCBs) in Bangladesh employing Stochastic Cobb-Douglas and Trans-log cost and profit efficiency models considering a panel data set during 2007-2018. The average cost efficiency score was 65.8% and the average profit efficiency score was 50.5% for PCBs for Cobb-Douglas cost and profit frontier analysis models while in Translog stochastic cost and profit frontier analysis models, the average cost efficiency score was 66.3% and the average profit efficiency score was 53.9% for PCBs. The Translog Stochastic Frontier model was more preferable than the Cobb-Douglas Stochastic Frontier model. The IT personnel expenses (0.0018) and Credit Card Transaction (0.0013) were positively significant for the profit efficiency of Stochastic Cobb-Douglas profit frontier model while the IT personnel expenses (0.0006) and credit card transaction (0.000006) were positively significant for PCBs in cost efficiency of Stochastic Translog frontier Model. The IT factors had a positive impact on private commercial banks so we conclude that the Private commercial banking system was technologically more advanced.

**Keywords:** ICT, Stochastic frontier model, Private Commercial Banks, Bangladesh.

**Introduction**

The information technology environment changes rapidly and the number of internet users is increased in Bangladesh. Most of the transactions are conducting via e-banking channels, online internet bank, and m-banking services due to a decrease in the physical branches of banking. So, the customer demands are fulfilled easily in banking activities electronically. Some researchers asserted that ICT investments can really promote the enterprises' operational performance by reducing costs, raising profit margin, upgrading production levels, increasing service quality, advancing customer satisfaction and improving overall operations. In contrast, other researchers do not demonstrate the positive effect of ICT investments and concluded that ICT spending brought no significant contributions to the enterprises' operations, and so the ICT has been an issue of continuous debate for decades. The differences among research objects, methodologies and performance indices result in consistent conclusions obtained in the literature. In this respect, (Rai & Patnayakuni;1997, S.T.Surulivel, et al; 2013 & M.R Safari & L.Z.Yu; 2014) used parametric method (SFA) for estimating the banking efficiency and showed that one or two of the component of ICT had a great impact on the bank efficiency but they did not use gigantic variables related to ICT. Similarly, (S. B. Rom; 2013 & Lee & Menon; 2000) used both SFA & DEA method to analyze the impact on cost & profit efficiency but unable to measure the impact of ICT variables. Furthermore, one researcher (Chu-Fen li; 2007) estimated the technical efficiency of individual banks and group banks by using whole ICT oriented variables on analyzed DEA and SFA method and also measured the correlation and regression analysis among the IT variables in terms of pre-tax profit and total IT expenses. He showed that IT investment can improve profit significantly but could neither reduced operating cost nor enhances operational efficiency significantly but he did not work the exact cost and profit efficiency. The financial institutions in Bangladesh seem to increasingly adopt ICT banking and improving banking capabilities. However, increasing competition among the banks leading to losing their customers, but information and technology by facilitating, service definition and new product (diversity) and increasing efficiency at all levels of banking industry value chain, both reduce the risk and create quality competitive advantages. In Bangladesh, some studies are available solely on the cost and profit efficiency of banking in Bangladesh by using Stochastic frontier analysis and data envelopment analysis (Hasib & Mahmud; 2018, Ara; 2016 & Baten 2015) and there have been some empirical studies about the impact of ICT on banking in Bangladesh (Haque & Reza;2009, Sadekin & Sheik; 2016, Alam; 2017) asserted that ICT investments are becoming an important factor in the future development of Bangladesh banking industry. The rapid growth of e-banking is expected and foreign commercial banks (FCBs) played a pioneering role in adopting modern technology. Several private commercial banks (PCBs) and also state-owned commercial banks (SCBs) offer limited services of telebanking, internet banking and, e-banking facilities within the branches of an individual bank in a closed network environment. There have been no studies available about the impact of ICT in the banking sector on the cost and profit efficiency. This study undertakes to investigate the use and development of some classes of ICT applications (e.g., ATM, Credit cards, IT personnel Expenses and IT investment) from selected 17 PCBs and analyses the impact of ICT factors on the efficiency of PCBs in Bangladesh Banking industry along with the present status of cost and profit efficiency score.

**Data Sources**

The data set used in this study obtained from the annual reports of banks for the period of 2008-2017. The 17 private commercial banks are analyzed which are advanced on the operating system of the ICT sector.

**Methodology**

The methodology of this study is discussed by considering two important issues. The first issue is to measure the efficiency of PCBs using a parametric SFA approach. The second issue is the Tobit regression analysis used to measure the impact of ICT factors on the cost and profit efficiency of PCBs.

**Empirical Stochastic Cobb-Douglas Cost Frontier Model**

The specification of the Cobb-Douglas stochastic frontier cost model (Battese and Coelli, 1995) is defined as:

(1)

where, ln is natural logarithm (that is the log to base e, where e = 2.718). Yit represent the total cost of ith bank in period t LOAit is the loan of bank i in period t; OBSit is the off-balance sheet items of bank i in period t; POFit is the price of fund of bank i in period t; POFAit is the price of fixed assets of bank i in period t; POLit is the price of labor of bank i in period t; v is a two-sided error term assumed to be identically and independently distributed, u is a non-negative technical inefficiency component of the error term and β’s are unknown parameters to be estimated. Having obtained the parameters for each variable by banks using equation (1), the technical efficiency level for PCBs is predicted with equation (2).(2)

**Empirical Stochastic Cobb-Douglas Cost Frontier Inefficiency Effects Model**

The empirical cost inefficiency effects model can be written as:



where uit is defined as the inefficiency term in the cost function; NIIit is the non- interest income of bank i in period t; NPLit is the non-performing loan of bank i in period t; ROAit is the return on assets of bank i in period t; ROEit is the return on equity of bank i in period t; CARit is the capital adequacy ratio of bank i in period t; ωit is the error term.

**Empirical Stochastic Cobb-Douglas Profit Frontier Model**

The specification of the Cobb-Douglas stochastic frontier profit model (Battese and Coelli, 1995) is defined as:



Where *ln* is natural logarithm (that is the log to base *e*, where e = 2.718). Where is the profit after tax of ith bank in period t measured by revenues minus costs;

is a constant to ensure the natural log of profits to be positive. All the independent variables are the same line as described in equation (1). Having obtained the parameters for each variable by banks using equation (5), the technical efficiency level for firms is predicted as like as the equation (2). The profit inefficiency effects model can be estimated as the same line as the equation (3) with the exception of the dependent variable of profit inefficiency.

**Empirical Stochastic Translog Cost Frontier Analysis Model**

The specification of the Stochastic Translog Cost frontier model is defined by



where Cit is defined as the total cost. All the independent variables are the same line as described in equation (1). The empirical cost inefficiency effects model can be estimated as the same line as the equation (3) except the dependent variable of cost inefficiency in the Tanslog case.

**Empirical Stochastic Translog Profit Frontier Model**

The specification form for stochastic Translog profit frontier model can be written as:



Where  is the profit after tax of ith bank in period t measured by revenues minus costs; is a constant to ensure the natural log of profits to be positive. All the independent variables are the same line as described in equation (5). The empirical profit inefficiency effects model can be estimated as the same line as the equation (3) except the dependent variable of profit efficiency in the Translog case.

**Empirical Tobit Regression Model**

The specification of the Tobit regression model can be written as:



where Eit is defined as the Stochastic Cobb-Douglas and Translog cost and profit efficiency scores of the i-th bank in period t; ITEit is the IT expanse of bank i in period t; ITIit is the IT income of bank i in period t; ITINit is the IT investment of bank i in period t; ITPit is the IT personnel of bank i in period t; ITPEit is the IT personnel expenses of bank i in period t; ATMTit is the ATM transaction of bank i in period t; ATMEit is the ATM expenses of bank i in period t; CCT is the Credit Card Transaction of bank i in period t; CCE is the credit card expenses of bank i in period t. ξit is the error term.

**Results and Discussion**

Both the year wise and bank-wise cost and profit efficiencies of PCBs are measured by Cobb-Douglas and Translog stochastic frontier models and the impact of ICT factors is evaluated by the Tobit regression model.

**Cost and Profit Efficiency Results Based on Cobb-Douglas and Translog Stochastic Frontier Models**

The results of maximum likelihood estimates using stochastic Cobb-Douglas and Translog cost and profit frontier models of the PCBs are given in Table-1. In the Cobb-Douglas cost frontier model, the loan with β1 (0.554) and the input price of fixed assets β4 (0.09) were positively significant implying that they had been a positive influence on the bank’s cost model. On the other hand, only the output variable off-balance sheet items were negatively significant with β2 (-2.767) implies that the off-balance sheet items had not a great influence on the bank’s Translog cost frontier model. The square of inputs, the price of fund β33 (-0.106) was negatively significant and the price of fixed assets β44 (0.623) was positively significant. The interaction term of input price and outputs, loan & off-balance sheet items β12 (0.284), loan & price of fixed assets β14 (0.244), loan &price of labor β15 (0.619) were positively significant where Off-balance sheet item & price of labor β25 (-0.753), price of fund & price of labor β35 (-0.152) and price of fixed assets & price of labor β45 (-0.442) found negatively significant for the cost model. In the Cobb-Douglas cost frontier model, the input price variable, price of the fund was negative but significant with β3 (-0.149) seems to suggest that the price of the fund is impacted negatively to total operating cost. In the Cobb-Douglas profit frontier model, only the price of labor was negatively significant with β5 (-0.153) suggest that the price of labor is impacted negatively. In the Translog Stochasticprofit frontier model, the variableoff-balance sheet items β2(-1.156) was negatively significant and theinputs, the price of fund β3 (2.295) was positively significant. The square input price of labor β55 (-0.325) shown highly negatively significant and also the mixed product, off-balance sheet items & price of fund β23 (-0.212), off-balance sheet items & price of fixed assets β24 (-0.237) were negatively significant and loan & off-balance sheet items β12 (0.148) and the Price of fixed assets & price of labor β45 (0.449) were found positively significant. These results were supported by (Kosak et al., 2009; Christopoulos and Tsionas, 2001).

**Table 1. Results of both Cost and Profit Efficiencies with Cobb-Douglas and Translog Stochastic Frontier Models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Model | | Cobb-Douglas | | Translog | Cobb-Douglas | Translog |
| Variable | Parameter | Coefficient of Cost | | | Coefficient of Profit | |
| Constant |  | 2.66\*\*\* | 15.18\* | | 5.21\*\*\* | 18.42\*\*\* |
| LOA |  | 0.554\*\*\* | 0.666 | | -0.008 | -1.03 |
| OBS |  | -0.042 | -2.767\*\* | | -0.004 | -1.156\*\* |
| POF |  | -0.149\*\*\* | 0.299 | | -0.021 | 2.295\* |
| POFA |  | 0.09\* | -1.368 | | 0.043 | 1.301 |
| POL |  | -0.063 | -0.489 | | -0.153\* | -0.908 |
| (LOA)2 |  |  | -0.230 | |  | -0.152 |
| LOA \* OBS |  |  | 0.284\* | |  | 0.148\* |
| LOA \* POF |  |  | -0.092 | |  | 0.019 |
| LOA \* POFA |  |  | 0.244\* | |  | -0.006 |
| Loan \*POL |  |  | 0.619\*\*\* | |  | 0.057 |
| (OBS)2 |  |  | -0.060 | |  | -0.050 |
| OBS \* POF |  |  | 0.037 | |  | -0.212\* |
| OBS \*POFA |  |  | -0.021 | |  | -0.237\* |
| OBS\*POL |  |  | -0.753\*\*\* | |  | 0.177 |
| (POF)2 |  |  | -0.106\* | |  | 0.124 |
| POF \* POFA |  |  | -0.049 | |  | -0.115 |
| POF \*POL |  |  | -0.152\* | |  | 0.183 |
| (POFA)2 |  |  | 0.623\*\*\* | |  | -0.503 |
| POFA \*POL |  |  | -0.442\*\*\* | |  | 0.449\*\* |
| (POL)2 |  |  | -0.076 | |  | -0.325\*\*\* |

**Results of Cost and Profit Inefficiency Effects for Private Commercial Banks in Cobb-Douglas and Translog Stochastic Frontier Models**

The cost and profit inefficiency estimates of PCBs for both the stochastic Cobb-Douglas and Translog cost and profit frontier model are given in Table-2. The variable of non-interest income and return on equity were found significant from the cost inefficiency of the Cobb-Douglas cost inefficiency model. The negative coefficient of non-performing loan δ1 (-0.32) indicates a negative impact on bank inefficiency and therefore a positive effect on cost efficiency. The highly positive coefficient of return on equity δ4 (0.871) increased bank cost inefficiency. In the Translog cost inefficiency model, the coefficient of return on equity δ4 (0.341) and capital adequacy ratio δ5 (0.961) were found highly significant with a positive value that means they could not contribute to the bank’s cost efficiency. On the other hand, the coefficient of non-interest income δ1 (-0.305) was negatively significant. In the profit inefficiency Cobb-Douglas model, the coefficient of return on equity δ4 (2.38) was a highly positive significant indication that the banks were not profitable on the shareholder investment. The coefficient of non-performing loan δ2 (-0.572), return on assets δ3 (-1.704) and capital adequacy ratio δ5 (-1.75) was negatively significant implies that they could be a positive impact to maximize profit. In the profit inefficiency Translog model, the coefficient of return on assets δ3 (-2.513) and capital adequacy ratio δ5 (-2.806) were negatively significant so, therefore, a positive effect on profit efficiency. The coefficient of return on equity δ4 (2.868) was positively significant. These results were supported by (Ngan, 2014).

**Table-2: Cost and Profit Inefficiency Estimates for Private Commercial Banks of Cobb-Douglas Stochastic Frontier Model**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Model | | Cobb-Douglas | | Translog | Cobb-Douglas | Translog | |
| Variable | Parameter | Coefficient of cost | | | Coefficient of Profit | | |
| NII | δ1 | -0.32\*\*\* | -0.305\*\*\* | | -0.244 | | 0.058 |
| NPL | δ2 | -0.039 | -0.045 | | -0.572\* | | -0.467 |
| ROA | δ3 | -0.344 | -0.229 | | -1.704\* | | -2.513\*\* |
| ROE | δ4 | 0.871\*\* | 0.341\* | | 2.38\*\*\* | | 2.868\*\*\* |
| CAR | δ5 | 0.356 | 0.961\*\*\* | | -1.75\* | | -2.806\*\* |
| Sigma Sq | б2 | 0.26\*\*\* | 0.121\*\*\* | | 3.41\*\*\* | | 2.704\*\*\* |
| Gamma | γ | 0.862\*\*\* | 0.669\*\*\* | | 1.00\* | | 0.999\*\*\* |

**Result of Test of Hypothesis for Stochastic Cost and Profit Frontier Model**

Table-3 reports the results of hypothesis tests conducted on the cost and profit frontier models. The hypothesis tests were obtained using the generalized likelihood-ratio statistic.

The 1st null hypothesis is  which specifies that the Cobb-Douglas stochastic frontier model is more preferable than the Translog stochastic frontier model for cost and profit efficiency model of PCBs. It was observed that the null hypothesis is rejected in both cases of cost and profit efficiency models. So, the Translog model was more preferable than the Cobb-Douglas for both cost and profit efficiency models of PCBs.

The 2nd null hypothesis is , which specifies that there is no technical inefficiency effect in the Cost-efficiency model. The hypothesis is accepted for the PCBs. So, there is no technical inefficiency effect in the cost model. In the profit model, the hypothesis is rejected for PCBs, which imply that there is a technical inefficiency effect in PCBs.

The 3rd null hypothesis is which specifies that there is an interaction effect on the Translog Stochastic cost and profit frontier model. It is observed that the null hypothesis is rejected for both cost and profit efficiency, which implies that there is an interaction effect in both Translog Stochastic Cost and profit frontier models for the PCBs. This result was supported by (Baten; 2013 and Ngan; 2014).

**Table 3: Results of Likelihood-Ratio Test of Stochastic Cost and Profit Frontier Models for Private Commercial Banks**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | Null Hypothesis | Log-Likelihood Function | Test Statistics λ | Critical Value | Decision |
| Cost |  |  | -54.96 | 38.301 | Reject |
| Cobb-douglas | -65.61 |
| Translog | -38.13 |
|  | -33.64 | 1.3172 | 35.827 | Accept |
|  | -64.82 | 48.9 | 5.138 | Reject |
| Profit |  |  | 16.31 | 35.83 | Reject |
| Cobb-douglas | -165.32 |
| Translog | -157.17 |
|  | -165.93 | 88.654 | 35.827 | Reject |
|  | -165.32 | 112.54 | 5.138 | Reject |

Note: all critical values are at a 5% level of significance and the critical values are obtained from a table of kodde and palm (1986)

**Year-wise Average Cost and Profit Efficiency Scores of Stochastic Cobb-Douglas and Translog Frontier Models**

The year-wise average cost and profit efficiency scores for PCBs are illustrated in Figure-1. It is observed that the average cost efficiency was 65.8% in Stochastic Cobb-Douglas cost frontier model and 66.3%was in Stochastic Translog cost frontier model greater than the average profit efficiency was 50.5% in Stochastic Cobb-Douglas profit frontier model and 53.9% in Stochastic Translog profit frontier model respectively. The efficiencies were varied year by year in both cases of cost and profit. In the Stochastic Cobb-Douglas Cost frontier model, the cost efficiencies were around 49.9 %-74.4% from 2008-2014, and it attained the peak percentage amount of 74.8% in 2013. After that, it has been a little drop of 71.5% in 2015 and 2016. In the last year of the study period, it has been slightly increased by 73.1%. Conversely, in Stochastic Translog cost Frontier Model, the cost efficiencies were around 51.1 % to 72.1% from 2008-2013, and then it has been slightly decreased by 71.2 %. It remained steady at 70.1% in 2015 and 2016. In the last year of the study period, it was a little drop of 69.8%. On the other hand, in Stochastic Cobb-Douglas profit frontier model, the profit efficiency of PCBs was recorded 40% in the year of 2008, and then slightly decreased at 31.7% in the next year. It remained constant at 47% in 2011 and 2012. Again, it declined slowly and after 2014 it was gradually increasing and reached the highest value at 66.7% in the year of 2017. Moreover, in the Stochastic Translog profit frontier model, the profit efficiency score of PCBs was 50% in 2008, then it decreased moderately at 32.8% in the following year. It remained at 50% in 2011 and 2012. Again, it declined slowly at 40.7% and finally, it was an upward trend and reached the highest value at 66.7% in the last year of 2017. This result was supported by (Casu and Girardone, 2004; Baten, 2003; Ara, 2016; and Hasan & Hasan, 2018) who measured the PCBs were the most cost-efficient rather than profit efficiency.

**Fig. 1. Year-wise Average Cost and Profit Efficiency Scores of Stochastic Cobb-Douglas and Translog Frontier Models**

**Bank-wise Average Cost and Profit Efficiency Scores of Stochastic Cobb-Douglas and Translog Frontier Models**

The average cost and profit efficiency scores of individual commercial banks from 2008-2017 are reported in Figure 2. As presented the result, the BRAC bank was the most cost-efficient bank with an average efficiency score of 89.3% and DBBL was the less cost-efficient (34.1%) among the other banks in Stochastic Cobb-Douglas cost frontier model and IBBL was the most cost-efficient with an average efficiency score of 82.4% and Exim bank was the less cost-efficient (31.1%) bank in Stochastic Translog cost frontier model. On the other hand, IBBL was the most profit efficient with an average efficiency score of 73.8% and Al- Arafah was the less profit efficient (37%) bank in Stochastic Cobb-Douglas profit frontier model and the Southeast and Eastern banks were the most profit efficient bank with an average efficiency score of 68% and Mercantile was the less profit efficient (33.3%) banks in Stochastic Translog profit frontier model. Furthermore, in Stochastic Cobb-Douglas cost and profit frontier model, Southeast, Al-Arafah, BRAC, and Prime bank had 60% above profit efficiency scores and Mercantile, One Southeast, Eastern, IBBL had cost efficiency scores more 70%. This result confirms that the majority of the PCBs are around 40% to 50% regarding profit efficiency and around 60% to 70% in terms of cost-efficiency. Conversely, in Stochastic Translog cost and profit frontier models, the IBBL and Prime bank had 60% above profit efficiency scores and the BRAC, Mercantile, One, Prime, Premium, and Shahjalal banks had cost efficiency scores more than 70%. This result confirms that the majority of the PCBs were around 40% to 50% regarding profit efficiency and around 60% to 70% in terms of cost-efficiency. These results were supported by (Ara, 2016).

**Fig. 2. Bank-wise Average Cost and Profit Efficiency Scores of Stochastic Cobb-Douglas and Translog Frontier Models**

**Results of IT Determinants with Cost and Profit Efficiency Estimates using Tobit Regression Model**

Table-4 represents the results of IT determinants of cost and profit efficiency of Stochastic Cobb-Douglas and Translog cost and profit frontier models for PCBs. As can be seen that the IT income ɸ2 (-0.00018) and credit card expanses ɸ9 (-0.00013) were negatively significant and the IT personnel expanses ɸ5 (0.00087), ATM Expenses ɸ7 (0.00306) and credit card transaction ɸ8 (0.00008) had a positive impact on the cost-efficiency of Stochastic Cobb-Douglas cost frontier model whereas in Translog cost frontier model, the IT personnel expenses ɸ5 (0.0006) and credit card transaction ɸ8 (0.000006) were positively significant but IT income ɸ2 (-0.0002) and credit card expenses ɸ9 (-0.0001) are negatively significant for the cost efficiency of PCBs. Also, IT expenses ɸ1 (-0.00003) and IT investment ɸ3 (-0.000002) were insignificant but had a negative impact on the cost efficiency of PCBs. On the contrary, in IT determinant profit efficiency of Stochastic Cobb-Douglas profit frontier model, the IT investment ɸ3 (-0.0003), IT income ɸ2 (-0.0032), IT personnel ɸ4 (-0.004), and ATM transaction ɸ6 (-0.0008) were found negatively significant but the IT personnel expenses ɸ5 (0.0018) and Credit Card Transaction ɸ8 (0.0013) were positively significant of PCBs. Also, the ATM expenses ɸ7 (-0.009) and credit card expense ɸ9 (-0.0012) were an insignificant but negative impact on the cost efficiency for PCBs. Besides, in IT determinants with profit efficiency of Stochastic Translog profit frontier model, the IT investment ɸ3 (-0.000008), and credit card expenses ɸ9 (-0.0000007) were found negatively significant. IT Expenses ɸ1 (-0.000002), Credit Card Transaction ɸ8 (-0.00000007) had a negative impact on the profit efficiency of PCBs which supports the study of (Surulivel et. al., 2013; and Safari & Liu, 2014).

**Table 4: IT Determinants of Cost and profit Efficiency Scores by Tobit Regression Model**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | | Cobb-Douglas | Translog | Cobb-Douglas | Translog |
| Variable | Parameter | Coefficient of Cost | | Coefficient of Profit | |
| Intercept | ɸ0 | 0.580\*\*\* | 0.619\*\*\* | 0.304\*\*\* | 0.42\*\*\* |
| IT.Expenses | ɸ1 | 0.00002 | -0.00003 | 0.0009 | -0.00002 |
| IT.Income | ɸ2 | -0.00018\* | -0.0002\*\* | -0.0032\*\* | 0.00003 |
| IT.Investment | ɸ3 | -0.0000009 | -0.000002 | -0.0003\* | -0.000008\* |
| IT.personnel | ɸ4 | 0.0002 | 0.0003 | -0.004\*\* | 0.0006 |
| IT personnel expanses | ɸ5 | 0.00087\* | 0.0006\* | 0.0018\*\* | 0.0009 |
| ATM.Transaction | ɸ6 | -0.00004 | -0.00005\* | -0.0008\* | 0.00005 |
| ATM.expeses | ɸ7 | 0.00306\* | 0.0002 | -0.009 | 0.00002 |
| Credit.Card.Transaction | ɸ8 | 0.00005\* | 0.000006\*\* | 0.0013\*\*\* | -0.0000007 |
| Credit.card.expenses | ɸ9 | -0.00013\*\* | -0.0001\* | -0.0012 | -0.0002\*\*\* |

**Conclusion**

The cost and profit efficiency are examined for the 17 PCBs in Bangladesh employing a panel set of data. The stochastic Cobb-Douglas and Translog frontier analysis are used uniquely for estimating cost and profit efficiency. Then the IT components are assessed using a Tobit regression model for both stochastic Cobb-Douglas and Trans-log models. In the Cobb-Douglas stochastic frontier analysis, the average cost efficiency score was 65.8% and the average profit efficiency score was 50.5%. In the PCBs, IBBL was the most profit efficient with an average efficiency score of 73.8% and the BRAC bank was the most cost-efficient bank with an average efficiency score of 89.3%, Al-Arafah was the less cost-efficient (37.4%) and Mercantile bank was the less profit efficient (33.6%) respectively. In the Translog stochastic frontier analysis, the average cost efficiency score was 66.3% and the average profit efficiency score was 53.9%. Social Islami bank was the most cost-efficient with an average efficiency score of 88% and the Southeast and Eastern banks were the most profit efficient bank with an average efficiency score of 68%. Exim bank was less cost-efficient (31.1%) and Mercantile bank was less profit efficient (33.3%) respectively. Translog Stochastic frontier model was more preferable than the Cobb-Douglas Stochastic frontier model.

The ICT factors had a positive impact on the PCBs. In IT determinants with cost and profit efficiency of Stochastic Translog cost and profit frontier model for PCBs, the IT personnel expenses ɸ5 (0.0006) and credit card transaction ɸ8 (0.000006) were positively significant but IT income ɸ2(-0.0002) and credit card expenses ɸ9(-0.0001) are negatively significant for the cost efficiency of PCBs. On the contrary, the IT investment ɸ3 (-0.000008), and credit card expenses ɸ9 (-0.0000007) were found negatively significant for the profit efficiency of Stochastic Translog profit frontier model. The IT income ɸ2 (-0.00018) and credit card expanses ɸ9 (-0.00013) were negatively significant for the cost efficiency of the Stochastic Cobb-Douglas cost frontier model. In IT determinants with profit efficiency of Stochastic Cobb-Douglas profit frontier model, the IT investment ɸ3 (-0.0003), IT income ɸ2 (-0.0032), IT personnel ɸ4(-0.004), and ATM transaction ɸ6 (-0.0008) were negatively significant for the profit efficiency but the IT personnel expenses ɸ5(0.0018) and Credit Card Transaction ɸ8 (0.0013) were positively significant. This study builds a new measure of efficiency because this study employs the huge ICT data for measuring the impact of ICT components on cost and profit efficiency of Bangladesh banking industry using the Tobit regression model which is different from most of the studies. The PCBs system has to be internally efficient and technologically advanced. The information obtained from efficiency studies can be used to help the government, regulators, and investors to remove the hindrance of progress in the Bangladesh economy.

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