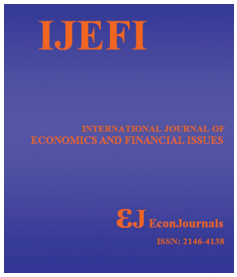

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Investigating the Impact of Firm-specific and Macroeconomic Determinants of Operating Efficiency of Commercial Banks: Panel Evidence from Bangladesh

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ABSTRACT

This paper aims to find out the significant firm-specific and macroeconomic determinants of operating efficiency through covering 360 observations having 30 commercial banks' data from 2009 to 2020. Model specification test along with several diagnostic tests has been done and our investigation reveals that Net interest margin or net investment income ratio, loan loss provision to total loan, debt to total assets and total loan to earning assets are significantly related with operating efficiency ratio (OER) bringing the changes in operating efficiency. In the second model, return on equity, net interest margin or net investment income ratio, equity capital to total assets, loan loss provision to total loan, bank size, total loan to earning assets and total loan to total deposit significantly affect the operating efficiency of commercial banks being measured with cost efficiency ratio (CER). In the subsequent model, net interest margin or net investment income ratio, total loan to earning assets, debt to total assets ratio, and total loan to total deposit have been evidenced to affect the operating efficiency significantly being measured with operating expense to earning assets ratio (OEEAR).

Keywords: Operating Efficiency Ratio, Cost Efficiency Ratio, Operating Expense to Earning Assets Ratio, Fixed Effect, GMM
JEL Classifications: C3, C33

1. INTRODUCTION

Due to the advanced technology, greater competition and customized expectations of customers for bank services, ensuring operating efficiency has been a major issue for banks to remain competitive in the financial sector. Operational efficiency for a bank means how efficient the bank is in managing the firm. Lower overhead expenses compared to the total assets of the banks indicate greater efficiency of the bank. There are four types of scheduled banks in Bangladesh named State-Owned Commercial Banks (6), Specialized Development Banks (3), Private Commercial Banks (43) and Foreign Commercial Banks (9) in total 61 banks currently are operating in the banking industry. Bangladesh Bank is the central bank of Bangladesh, according to Bangladesh Bank Order-1972, performs the function of chief regulatory authority for controlling other banks. Statistics say that though the banking sector is the major financial sector compared to other financial parts in Bangladesh, their share of GDP growth rate is on decreasing trend which remarks inefficiency. In 2019 share of GDP by the financial sector decreased to 3.42% from 3.45% of 2020 through the reduced banking sector's contribution of 2.95% and in 2020 out of the total 3.39% contribution to GDP by the financial sector, banks have contributed by sharing 2.91% of GDP (Source: BBS). 6 state-owned banks share 25.1% of the total assets of the banking sector in 2020 but the loan quality of these government banks is poor. 47.6% of total NPL, a measure of asset quality, is shared by these 6 state-owned banks. Private commercial banks' share of total assets is 67.3% or BDT 12378.7 billion and NPL sharing portion of the total banking sector is 45.5% or BDT 403.6 billion (Source: Bangladesh Bank).

Cost to income ratio is considered an indicator of operating efficiency as it measures how much banks are efficient in controlling the cost of earning a unit of income. The Expenditure-Income ratio of the banks of Bangladesh was 78% in 2019 which stood at 79.2% in 2020 indicating high operating expenses and less operating efficiency. Though the aggregate ROE of the banking sector is positive, 4.28% was in 2020, state-owned commercial banks and specialized banks were bearing negative returns on equity mentioning −29.57% and −13.85% respectively. During the daily operational schedules, capital adequacy works as the protector to absorb possible losses occurring from operational risk. Banks are required to maintain minimum capital of 10% of their risk-weighted assets or BDT 4 billion capitals whichever is higher. Unfortunately, 5 state-owned banks out of 6 have been failing to maintain this (Source: Bangladesh Bank). These poor scenarios regarding profitability, banks' expenditure, capital adequacy, and non-performing loan have emphasized the issue of identifying factors that increase operating efficiency so that these poor statistics are resolved. The principal objective of this paper is to examine the bank-specific and macroeconomic factors that significantly affect the operating efficiency of the commercial banks of Bangladesh. It will deliver a message to the banks of Bangladesh about which factors need to be fostered to achieve operating efficiency and which factors need to be controlled.

2. LITERATURE REVIEW

Ahmed and Liza (2013) defined operational efficiency as the ability of a bank to utilize its resources at the optimal level which will reduce the cost of service production resulting in cost-efficient services delivered to customers. The urge of increasing earnings and controlling costs is further emphasized by the competition coming from non-bank financial institutions. The performance and sustainability of banks can be gauged through the efficiency level of banks.

Akhter (2018) suggested that banks' operational efficiency needs to be competitive enough so that shareholders and depositors have a positive look towards the performance of the banks. The author researched the operational efficiency of commercial banks of Bangladesh over the period 2011 to 2016 using the secondary data of 30 commercial banks with the aid of a fixed-effect regression model, a feasible generalized least square model and a panel correlated standard error model. Bank size (log of total assets), liquidity (loan ratios), and profitability (ROA, ROE, NIM) were used as the proxy variables for liquidity and profitability and the impact was shown on the operating efficiency ratio. The study concludes that increased liquidity has a negative relationship with efficiency. A high-quality loan portfolio needs to be maintained to ensure the operational efficiency of banks. ROE has a positive relationship with efficiency as it indicates banks are working enough to satisfy shareholders.

Amer et al. (2011) researched to find out the determinants of operating efficiency of banks covering the period 2001-2008 investigating 24 commercial banks. The research concludes that asset quality, capital adequacy, credit risk and liquidity of banks significantly affect the operating efficiency of highly competitive banks. A positive relationship has been found between loan loss reserves to impaired loans and the operating efficiency ratio. It illustrates the banks' operating policy of considering a large volume of the reserve as the safeguard for banks which tends to increase the operating efficiency of banks. The capital adequacy ratio is negatively related to operating efficiency and equity to total assets shows a positive relationship indicating that efficient use of core capital will increase the operating efficiency of banks. Kwan (2003) surveyed Asian economies for investigating the operating performance of banks through a fixed effect regression model. For dependent variable total operating costs to total earning assets along with independent determinants of loan quality, liquidity, and capitalization, the model provides a 45% adjusted R square. Significance levels 1%, 5% and 10% were used for the model. The research concludes that when problem loan increases, operating efficiency declines.

Bitar et al. (2018) examined 1992 banks from 39 countries covering the period 1999-2013 to find out whether imposing higher capital ratios resulted in better operating efficiency of banking institutions. To measure operating efficiency, the authors use the cost to income ratio to represent the cost efficiency of the banks. For determinants of operating efficiency, capital adequacy ratio, equity capital to total assets, loan loss provision to total loans, and the logarithm of total assets as a proxy of bank size were used. The study found out that higher capital ratios improve bank efficiency because by reducing agency problems, higher capital reflects the interest of shareholders. Mathuva (2009) attempted to see whether the raising capital level ensures the operating efficiency of the commercial banks in Kenya. This study found that core capital protect bank from financial distress, thus the possibility of bankruptcy is reduced.

Ayadi et al. (2016) examined the efficiency of banks through annual growth of GDP and the annual rate of inflation as the macroeconomic drivers. Firm-specific drivers were the log of total assets, loans to assets ratio, book value equity to assets and bank size as the determinants of efficiency. Barth et al. (2013) evidenced that inflation in the country is negatively related to bank efficiency but equity to asset ratio is positively related to bank efficiency. Another macroeconomic determinant, GDP growth, is positively related to bank efficiency. According to this study, Bank size has a positive impact on bank efficiency due to the economies of scale and scope and portfolio diversification strategy.

Pancheva (2013) investigated the determinants of operating efficiency by defining total operating cost to total operating income ratio as the operating efficiency for banks. As the determinants of operating efficiency, the study used interest rate spreads, capital adequacy, bank liquidity, total assets, and economic growth. The study also proposed that one can use ROE, ROA as the determinant as better exploiting the resources indicates greater operating efficiency for the banks. Liquidity has a negative relationship with efficiency as greater liquidity means idle money kept in the bank to meet the demands of customers. A high-interest rate spread positively affects operating efficiency.

Based on different studies studied above, it has been found that operating efficiency as the dependent variable has been

Table 1: Variable measurement

Factors/Indicators	Variables (Ratio)	Notation	Measurement
Dependent variable: Operating efficiency	Operating efficiency ratio	OER	(interest income+non-interest income+securities gains (or losses))/ (interest expense+non-interest expense+provisions for loan losses+taxes)
	Cost efficiency ratio	CER	Operating expenses/Operating Income
	Operating expense to earning assets ratio	OEEAR	Total operating expenses/Total Earnings Assets
Independent variables			
Capital adequacy	Capital adequacy ratio	CAR	(Tier 1+tier 2)/risk weighted assets
	Equity capital to total assets ratio	ECTA	Equity/total assets
Profitability	Return on Equity	ROE	Net profit after tax/total shareholders' equity
	Net interest margin or net investment income ratio	NIM/NIIR	Net interest income/earning assets or net investment income/earning assets
Credit risk	Loan loss provision to total loans and advances	LLPTLO	Loan loss provision/total loans and advances
	Debt to total assets	DBTA	Total liabilities/Total assets
Asset quality	Loan loss provision to net interest income or net investment income	LLPNII	Loan loss provision/net interest income or net investment income
	Non-performing loan to total loan	NPLTLO	Non-performing loan/total loan
	Bank Size	LNTA	LN of total assets
Liquidity	Total loans to total deposits	TLOTD	Loans and advances/total deposits
	Total loans to earning assets	TLOEA	Total loan to earning assets
Macroeconomic determinants	GDP growth rate	GDPG	(current year GDP – previous year)/previous year's GDP level
	Inflation rate	IR	[{(Later price-starting price)/starting price} *100]
	Interest rate spreads		IR of loan-IR of deposit

Source: Authors' contribution based on the review of literatures, OER: Operating efficiency ratio, CER: Cost efficiency ratio, OEEAR: Operating expense to earning assets ratio

Table 2: Model specification

Estimation Methods	Equations
Pooled OLS, Fixed Effect, and GLS	$OER_{it}=\beta_{1i}+\sum\beta_{it}$ (Bank-specific factors)$+\sum\gamma_{it}$ (Macro-economic factors)$+u_{it}$ (1)
	$CER_{it}=\beta_{1i}+\sum\beta_{it}$ (Bank-specific factors)$+\sum\gamma_{it}$ (Macro-economic factors)$+u_{it}$ (2)
	$OEEAR_{it}=\beta_{1i}+\sum\beta_{it}$ (Bank-specific factors)$+\sum\gamma_{it}$ (Macro-economic factors)$+u_{it}$ (3)
Random Effect Method	$OER_{it}=\beta_{1}+\sum\beta_{it}$ (Bank-specific factors)$+\sum\gamma_{it}$ (Macro-economic factors)$+\varepsilon_{it}+u_{it}$ (4)
	$CER_{it}=\beta_{1}+\sum\beta_{it}$ (Bank-specific factors)$+\sum\gamma_{it}$ (Macro-economic factors)$+\varepsilon_{it}+u_{i}$ (5)
	$OEEAR_{it}=\beta_{1}+\sum\beta_{it}$ (Bank-specific factors)$+\sum\gamma_{it}$ (Macro-economic factors)$+\varepsilon_{it}+u_{i}$ (6)
GMM method	$OER_{it}=\beta_{1i}+\beta_{2i}OER_{(t-1)}+\sum\beta_{it}$ (Bank-specific factors)$+\sum\gamma_{it}$ (Macro-economic factors)$+u_{it}$ (7)

Source: Authors' contribution based on the review of literatures, OER: Operating efficiency ratio, OEEAR: Operating expense to earning assets ratio, CER: Cost efficiency ratio

investigated mostly with one category of operating efficiency ratio. To deliver a clear message to the banking industry of Bangladesh from all possible perspectives, this study will use three categories of operating efficiency ratios based on the updated data covering 2009-2020 to see which firm-specific and macroeconomic determinants affect which category of operating efficiency. Considering the literature discussed above, this research estimates the following hypotheses for the three dependent variables measuring banks' operating efficiency:

H_1: OER (Operating efficiency ratio) being the operating efficiency of commercial banks is significantly affected by several firm-specific and macroeconomic factors such as ROE, NIM/NIIR, CAR, LNTA, DBTA, LLPTLO, NPLTLO, ECTA, TLOTD, TLOEA, LLPNII, GDPG, IR and IRS.

H_2: CER (Cost Efficiency Ratio) being operating efficiency of commercial banks is significantly affected by several firm-specific and macroeconomic factors as stated under hypothesis 01.

H_3: OEEAR (operating expense to earning assets ratio) being operating efficiency of commercial banks is significantly affected by several firm-specific and macroeconomic factors as mentioned under hypothesis 01.

3. DATA AND METHODS

This paper conveys estimating causation between operating efficiency measured with operating efficiency ratio, cost efficiency ratio and operating expense to earning assets ratio and several explanatory variables of operating efficiency like return on equity, net interest margin or net investment income ratio, capital adequacy ratio, bank size, debt to total assets ratio, loan loss provision to total loans and advances ratio, NPL to total loan ratio, equity capital to total assets ratio, total loans to total deposits ratio, total loan to earning assets, loan loss provision to net interest income ratio, GDP Growth, inflation and interest rate spread. This is an explanatory research investigating the impact of firm-specific and macroeconomic drivers on the operating efficiency of commercial banks through panel data analysis. Panel data will be used for 30 commercial banks covering the period 2009-2020 with 12 years of data for each bank, in a total of 360 years of data.

Secondary data will be used collected from the annual reports of the 30 commercial banks covering the period 2009-2020. Selected

banks include AB Bank Limited, Bank Asia Limited, IFIC Bank Limited, Premier Bank Limited, Pubali Bank, City Bank Limited, UCBL, Uttara Bank, Dhaka Bank, DBBL, Eastern Bank Limited, Prime Bank Limited, NCC Bank, Mercantile Bank Limited, One Bank limited, Jamuna Bank, Standard Bank, National Bank, Trust Bank, Sonali Bank, Janata Bank, Agrani Bank, Rupali Bank, BRAC Bank Ltd., Exim Bank, Islami Bank Bangladesh Limited, Shahjalal Islami Bank Limited, Al-Arafah Islami Bank Limited, First Security Islami Bank Limited and Mutual Trust Bank. Table 1 has summarized the details of variables included in the model.

Econometric models have been developed here under Pooled Ordinary Least Square, Fixed Effect, Generalized Least Square, Random Effect and Generalized Method of Moments as mentioned in Table 2.

4. EMPIRICAL RESULTS AND DISCUSSION

Table 3 represents the summary statistics of the observed variables of scheduled commercial banks of Bangladesh. For all the variables there is a very lower standard deviation and the gap between maximum and minimum values also shows a lower range signifying the dataset as a consistent one.

According to the output given in the Table 4, ROE and Loan loss provision to total loans and advances ratio are found statistically significant at a 0.1% significant level under all four methods. ROE has a negative relationship with operational efficiency. Although high profitability is expected to cause better operating efficiency but the operating expenditure of the selected banks were increasing from year to year. When profitability (ROE) was high for banks, banks were moving for aggressive expansion of branches and operating activities and then the operating expense such as salaries, rent, interest expense and other expenses were also increasing. Again for government banks average ROE value is negative. The negative relationship between loan loss provision to total loans and advances ratio and operating efficiency ratio outlines that as Loan loss provision is an expense item in the income statement which is kept as an allowance for uncollected loans; it decreases operating efficiency, further supported by (Amer et al., 2011). Along with ROE and LLPTLO, NIM/NIIR and TLOEA are found statistically significant under fixed effect method in explaining the changes in operational efficiency. A positive relationship exists between NIM/NIIR and operational efficiency which indicates that commercial banks are operating profitably and banks are capable of bearing interest expenses through returns produced by loan investments, supported by Akhter (2018). The negative relationship between total loan to earnings assets and operating efficiency ratio divulges that those loans are more costly to produce. Under random effect method, ROE, NIM/NIIR, LLPTLO, DBTA, LLPNII, TLOEA and IRS are significantly measuring changes of operating efficiency ratio. The negative association of Debt to total assets ratio means that banks have to spend more for processing liabilities than income generated from assets. Loan loss provision to net interest income ratio has a positive relationship with the operating efficiency ratio indicating that banks are efficient enough to cover the expenses of provisions from the interest income.

Positive relationship of interest rate spread exists as interest rate spread has a direct relation to the net income of banks' business as the greater the interest rate spread, the bigger the net income for banks also supported by Pancheva (2013) and Barth et al. (2013). ROE, NIM/NIIR, DBTA, LLPTLO, TLOEA, LLPNII and IRS are found statistically significant in explaining the changes in operating efficiency under pooled OLS. All the significant explanatory variables mentioned under pooled OLS are also showing significant identity under GLS method. R square value of 0.4035 and 0.4481 under FE and OLS divulge that 40.35% and 44.81% variation of the OER has been explained by fitted models. The F value of 19.770663 and 20.00799 calculated under FE and OLS at a 0.1% significance level reflect that jointly all the regressors are statistically significant in affecting the dependent variable OER. The Chi-square value of 287.24506 and 292.29064 found under FE and GLS reveal the joint significance of all explanatories in explaining the changes in OER of banks at a 0.1% significance. Sigma_u means the standard error of the residual within the entity which is 0.11952157 and 0.08572903 under FE and RE. Sigma_e is the standard error of the residual

Table 3: Summary statistics of all the variables

Variables	Observations	Mean	SD	Minimum	Maximum
OER	360	1.158178	0.3138964	0.2725415	5.234196
CER	360	0.4858025	0.1203042	0.1591707	1.140068
OEEAR	360	0.0433487	0.0648765	0.0058502	0.5236345
ROE	360	0.1196862	0.1857313	−2.5994	0.5375
NIM/NIIR	360	0.0315032	0.0459782	−0.0785646	0.5560042
CAR	360	0.1189292	0.0239927	−0.0867929	0.1793
ECTA	360	0.0332762	0.0128244	0.0058935	0.0710191
LLPTLO	360	0.0092109	0.0112241	−0.0978898	0.1170303
DBTA	360	0.9228452	0.0228465	0.8142568	1.06358
LLPNII	360	0.534086	2.62922	−4.845117	44.07278
NPLTLO	360	0.0633468	0.0593295	0.0094	0.3528
LNTA	360	26.08556	0.7162446	24.53355	28.09553
TLOTD	360	0.8063231	0.1053611	0.3728	1.072412
TLOEA	360	1.236565	1.576321	0.4826352	9.131758
GDPG	360	0.0625	0.0145065	0.0238	0.0815
IR	360	0.0665917	0.0166139	0.0542	0.114
IRS	360	0.0361333	0.0104389	0.0187	0.0551

Source: Authors' contribution based on the output developed by Stata 16.0, OER: Operating efficiency ratio, OEEAR: Operating expense to earning assets ratio, CER: Cost efficiency ratio

of the overall model which is 0.22704353 and 0.22704353 under FE and RE. The rho value of 0.21699075 and 0.12478246 under the FE and RE reveal that 21.69% and 12.47% variability in the OER are explained by the differences across panels.

The coefficients estimated in Table 5 shows a positive relationship of TLOEA with CER indicating costly processing of loans of the scheduled commercial banks of Bangladesh which has brought operating inefficiency supported by Kwan (2003). Significant positive direction of bank size in explaining the changes in CER means that larger banks of Bangladesh are unable to take the advantage of economies of scale and portfolio diversification further supported by Bitar et al. (2018). LLPTLO, ECTA, TLOTD, IR and IRS are found statistically significant in explaining the changes of cost-efficiency. LLPTLO has a negative relationship with CER illustrating that although banks' operating policy of

Table 4: Output of the coefficients in the model with the FE, RE, Pooled OLS, and GLS methods

Dependent variable- OER	Estimations of the models			
	FE	RE	Pooled OLS	GLS
ROE	−0.61665815***	−0.61756921***	−0.62244928***	−0.62244928***
NIM/NIIR	0.9112682*	0.95013213**	0.98311216**	0.98311216**
CAR	−1.1014436	−1.4938819	−1.4603567	−1.4603567
ECTA	2.234133	0.88470354	0.27028378	0.27028378
LLPTLO	−18.218648***	−17.744199***	−17.256184***	−17.256184***
DBTA	−0.39361498	−2.0041938*	−2.9910115***	−2.9910115***
LLPNII	0.00971807	0.01025897*	0.01051951*	0.01051951*
NPLTLO	0.17397897	0.32043082	0.31800647	0.31800647
LNTA	−0.04242899	−0.00100311	0.01263298	0.01263298
TLOTD	0.19063027	0.07298906	0.07102728	0.07102728
TLOEA	−0.04788412*	−0.03564197*	−0.03136119**	−0.03136119**
GDPG	−0.05721128	−0.32372584	−0.41945397	−0.41945397
IR	1.1616735	1.2364775	1.1048728	1.1048728
IRS	2.5300542	3.6086266*	3.8659964*	3.8659964**
Constant	2.6218556	3.1564999*	3.7247331***	3.7247331***
N	360	360	360	360
Chi-square		287.24506		292.29064
R square	0.4035		0.4481	
F	19.770663		20.00799	
Sigma_u	0.11952157	0.08572903		
Sigma_e	0.22704353	0.22704353		
Rho	0.21699075	0.12478246		

Source: Authors' contribution based on the output developed by Stata 16.0. *,**,*** indicates of significance level at 5%, 1% and 0.1%, FE: Fixed effect, RE: Random effect, GLS: Generalized least square, OER: Operating efficiency ratio

Table 5: Output of the coefficients in the model with the FE, RE, Pooled OLS, and GLS

Dependent variable-CER	Estimations of the Models			
	FE	RE	Pooled OLS	GLS
ROE	−0.04429998	−0.0453739	−0.0510532	−0.0510532
NIM/NIIR	−0.66533291***	−0.62226986***	−0.56741002***	−0.56741002***
CAR	0.34360114	0.51855577	0.46126035	0.46126035
ECTA	−0.0901173	−1.5601092*	−2.524629***	−2.524629***
LLPTLO	−0.80140181	−0.9564947*	−1.3077171*	−1.3077171**
DBTA	0.16166106	0.04264297	−0.15597475	−0.15597475
LLPNII	−0.0006034	−0.00017569	0.00002815	0.00002815
NPLTLO	0.12295333	0.11108651	0.09035229	0.09035229
LNTA	0.05096713**	0.01543832	−0.01028022	−0.01028022
TLOTD	−0.07045777	−0.16627087*	−0.28842009***	−0.28842009***
TLOEA	0.03623747***	0.02325927***	0.0165502***	0.0165502***
GDPG	−0.26525052	0.07874752	0.35113469	0.35113469
IR	−0.66935754	−0.88058079**	−1.1088488**	−1.1088488**
IRS	0.15917186	−0.82909315	−1.5619365*	−1.5619365**
Constant	−0.93717749	0.2498587	1.2777799**	1.2777799**
N	360	360	360	360
Chi-square		164.44146		218.55383
R square	0.2583		0.3778	
F	10.964162		14.96053	
Sigma_u	0.07188569	0.03761934		
Sigma_e	0.08460025	0.08460025		
Rho	0.41928236	0.16508931		

Source: Authors' contribution based on the output developed by Stata 16.0. *,**,*** indicates of significance level at 5%, 1% and 0.1%, FE: Fixed effect, RE: Random effect, GLS: Generalized least square

keeping allowances for uncollected loans is a cost item, it is also used to safeguard the bank to decrease unexpected costs, for example-raising funds suddenly at a high cost to cover loans losses amount, which has ensured controlled cost, also evidenced by Amer et al. (2011). The underlying reason behind the negative relationship of ECTA with CER is that higher equity capital reduces agency problems, also supported by Bitar et al. (2018). The TLOTD have a negative relationship with CER as income from loans surpasses the cost of deposits which ensures controlled cost. Inflation has a significant negative direction with cost efficiency because the higher but moderate level of inflation increases the incentive for the investment of the private sector which increases demand for banks' loans. The coefficient of IRS has a significant negative relationship with cost-efficiency. The interest income that banks can generate over the interest cost reflects those banks can control their interest cost and utilizes the opportunity of interest earnings indicating cost efficiency for banks which was also supported by Pancheva (2013).

The Chi-square value of 164.44146 and 218.55383 projected under the random effect method and generalized least square method respectively outline the joint significance of all explanatory variables in explaining the changes in cost efficiency of banks at a 0.1% level of significance. R square value of 0.2583 and 0.3778 estimated under fixed effect and OLS method respectively reflects that 25.83% and 37.78% variability in the dependent variable being measured with cost efficiency ratio (CER) has been explained by explanatory variables under fixed effect and OLS method respectively. The F value of 10.964162 and 14.96053 estimated under fixed effect and OLS respectively shows that all explanatory variables of the respective models are jointly statistically significant at a 0.1% level in explaining the changes in cost efficiency ratio measuring the operating efficiency of banks.

According to the output of estimated models in Table 6, NIM/NIIR, TLOTD and TLOEA are statistically significant under all four models. DBTA is statistically significant in inverse direction under random effect, OLS and GLS method as high debt raises good governance issue accelerating bank management to manage liabilities to minimize risk which reduces cost and increases cost efficiency considered with asset approach. Here R square values are 0.9221 and 0.9157 under fixed effect and pooled OLS respectively divulging that 92.21% and 91.57% variation in the dependent variable OEEAR is explained by the regressors of the two methods. The Chi-square value of 4084.421 and 4262.0045 estimated under random effect and GLS methods respectively reveal the joint significance of all regressors in explaining the changes of operating efficiency being measured with operating expense to earning assets ratio (OEEAR) of banks at a 0.1% level of significance. In addition, the F value of 71.995609 and 291.74435 calculated under fixed effect and OLS respectively shows that all independent variables of those models are jointly statistically significant in explaining the changes of operating Expense to Earning Assets Ratio measuring operating efficiency of banks. The rho value of 0.29539222 under the fixed-effect method divulges that 29.53% variability in OEEAR is explained by the differences across panels.

The variance inflation factor test in Table 7 is done to diagnose multicollinearity problems in the regression model. As the name suggests, independent variables must be independent. If independent variables are correlated, then the problem occurs in fitting the model and result interpretation. Here, none of the independent variables has crossed value 5, so none of these variables is causing a multicollinearity problem. And the mean VIF value is 1.76 which is far lower than 5. So, the models are not suffering from multicollinearity problems.

Table 6: Output of the coefficients in the model with the FE, RE, Pooled OLS, and GLS

Dependent variable -OEEAR	Estimations of the models			
	FE	RE	Pooled OLS	GLS
ROE	0.00142645	−0.00171136	−0.00171136	−0.00171136
NIM/NIIR	0.10132967***	0.1746572***	0.1746572***	0.1746572***
CAR	0.00364953	0.07141735	0.07141735	0.07141735
ECTA	−0.07362664	−0.1638593	−0.1638593	−0.1638593
LLPTLO	−0.03468386	−0.01955803	−0.01955803	−0.01955803
DBTA	−0.10647107	−0.19430133**	−0.19430133**	−0.19430133**
LLPNII	0.0003024	0.00025284	0.00025284	0.00025284
NPLTLO	0.01490949	−0.02119744	−0.02119744	−0.02119744
LNTA	−0.00203193	−0.00339169	−0.00339169	−0.00339169
TLOTD	−0.07128402***	−0.08326172***	−0.08326172***	−0.08326172***
TLOEA	0.04063247***	0.03601815***	0.03601815***	0.03601815***
GDPG	0.05625255	0.08324296	0.08324296	0.08324296
IR	−0.0374086	−0.10808081	−0.10808081	−0.10808081
IRS	0.20057538	0.12893219	0.12893219	0.12893219
Constant	0.19143665	0.32411527***	0.32411527***	0.32411527***
N	360	360	360	360
Chi−square		4084.421		4262.0045
R square	0.9221		0.9157	
F	71.995609		291.74435	
Sigma_u	0.01142663	0		
Sigma_e	0.01764788	0.01764788		
Rho	0.29539222	0		

Source: Authors' contribution based on the output developed by Stata 16.0. *,**,*** indicates of significance level at 5%, 1% and 0.1%, FE: Fixed effect, RE: Random effect, GLS: Generalized least square, OEEAR: Operating expense to earning assets ratio

Under modified Wald test in Table 8, none of the P-values is more than 0.05 under all of the three models, so the null hypothesis has been rejected divulging the heteroscedasticity problem and indicating that error variance is not constant across the group or panel under the fixed-effect method. This heteroscedasticity problem under the fixed effect method has been rectified through the generalized least square method where GLS assumes homoscedasticity and no autocorrelation.

B/P LM test is executed and reported in Table 9 through a correlation matrix of residuals from which Pesaran's test of cross-sectional independence value has been estimated where the null hypothesis is residuals across entities are not correlated. Here P-value of cross-sectional independence for Pesaran's test is 0.2298 which is more than 0.05. So we have failed to reject the null hypothesis and conclude that there is a non-presence of cross-sectional dependence for the cost efficiency ratio model.

Here F values for wooldridge test in Table 10 under dependent variables Operating Efficiency Ratio, Cost Efficiency Ratio and Operating Expense to Earning Assets Ratio are 24.112, 17.278 and 35.338 respectively are significant at a 0.1% significance level. So null hypothesis has been rejected and concluded that models are suffering from 1st order autocorrelation problem. These problems have been resolved through the GLS regression method which assumes no autocorrelation problem.

Hausman test is a test that will suggest here between the fixed effect and random effect model to identify which model is better for the panel data set with the dependent variable operating efficiency ratio (OER). Here null hypothesis is that the preferred model is a random effect versus the alternative is a fixed effect. If we look at the Chi-square value at Table 11, the Chi-square value is 8.11 and the P-value of the Chi-square test is 0.8834 which is more than a 5% significance level. So, we have failed to reject the null hypothesis and conclude that random effect is a better method than fixed effect.

For panel data set with dependent variable cost-efficiency ratio in Table 12, here Chi-square value is 16.31 and P-value is more than 0.05. So, we fail to reject the null hypothesis and conclude that for this model, the random effect is preferred.

For panel data set with the dependent variable operating expense to earning assets ratio, the Hausman test reported in Table 13 estimates a Chi-square value of 499.00 and P = 0.0000 which is significant as <0.05. Here null hypothesis is random effect is the preferred method, so we reject the null hypothesis as the P-value is significant and reveal that the fixed effect is a better method than the random effect for the said model.

Table 7: Output of value VIF

Variables	VIF	1/VIF
NPLTLO	2.84	0.351929
LNTA	2.33	0.428526
CAR	2.15	0.464361
DBTA	2.15	0.466079
TLOEA	1.95	0.513564
ECTA	1.85	0.540580
TLOTD	1.82	0.548318
IRS	1.57	0.638396
ROE	1.56	0.639844
NIM/NIIR	1.53	0.653530
IR	1.32	0.757286
LLPTLO	1.25	0.797120
LLPNII	1.23	0.811370
GDPG	1.10	0.908216
Mean VIF	1.76	

Source: Authors' contribution based on the output developed by Stata 16.0,
VIF: Variance inflation factor

Table 8: Output of modified wald test for heteroskedasticity problem

Modified Wald test for GroupWise heteroskedasticity in the fixed effect regression model		
The null hypothesis, H0: sigma (i)^2=sigma^2 for all i		
Operating efficiency ratio	**Cost efficiency ratio**	**Operating expense to earning assets ratio**
Chi-square (30) =27085.67 Prob>Chi-square=0.0000	Chi-square (30) =3595.41 Prob>Chi-square=0.0000	Chi-square (30) =94779.13 Prob>Chi-square=0.0000

Source: Authors' contribution based on the output developed by Stata 16.0

Table 9: Output of B/P LM Test of independence

Cross-sectional INDEPENDENCE Test (Pesaran's Test)		
Operating efficiency ratio	**Cost efficiency ratio**	**Operating expense to earning assets ratio**
Pesaran's test of cross-sectional independence=3.228 Probability (Pr) =0.0012	Pesaran's test of cross-sectional independence=1.201 Probability (Pr) =0.2298	Pesaran's test of cross-sectional independence=4.498 Probability (Pr) =0.0000

Source: Authors' contribution based on the output developed by Stata 16.0

Table 10: Output of Wooldridge test for 1st order autocorrelation problem

Woolridge test for autocorrelation in Panel data		
The null hypothesis, Ho: There is no 1st order autocorrelation		
Operating Efficiency Ratio	**Cost Efficiency Ratio**	**Operating Expense to Earning Assets Ratio**
F (1, 29) =24.112 Prob > F = 0.0000	F (1, 29) =17.278 Prob > F = 0.0003	F (1, 29) =35.338 Prob > F = 0.0000

Source: Authors' contribution based on the output developed by Stata 16.0

Table 11: Output of hausman test for OER

Variables/Statistic: OER	Coefficients			
	Fe (b)	Re (B)	Difference	S.E.
ROE	0.6166581	−0.6175692	0.0009111	0.016535
NIM/NIIR	0.9112682	0.9501321	−0.0388639	0.1327306
CAR	−1.101444	−1.493882	0.3924383	0.4106462
ECTA	2.234133	0.8847035	1.349429	1.607854
LLPTLO	−18.21865	−17.7442	−0.474449	0.404898
DBTA	−0.393615	−2.004194	1.610579	0.6647167
LLPNII	0.0097181	0.010259	−0.0005409	0.0008018
NPLTLO	0.173979	0.3204308	−0.1464519	0.1989923
LNTA	−0.042429	−0.0010031	−0.0414259	0.0332733
TLOTD	0.1906303	0.0729891	0.1176412	0.1515226
TLOEA	−0.0478841	−0.035642	−0.0122421	0.0159894
GDPG	−0.0572113	−0.3237258	0.2665146	0.245861
IR	1.161673	1.236477	−0.074804	0.3388309
IRS	2.530054	3.608627	−1.078572	1.022448
Chi-square	8.11			
P-value	0.8834			

Source: Authors' contribution based on the output developed by Stata 16.0, OER: Operating efficiency ratio, CER: Cost efficiency ratio

Table 12: Output of Hausman test for CER

Variables/Statistic: CER	Coefficients			
	Fe (b)	Re (B)	Difference	S.E.
ROE	−0.0443	−0.0453739	0.0010739	–
NIM/NIIR	−0.6653329	−0.6222699	−0.043063	0.0291395
CAR	0.3436011	0.5185558	−0.1749546	0.1193278
ECTA	−0.0901173	−1.560109	1.469992	0.5408574
LLPTLO	−0.8014018	−0.9564947	0.1550929	0.0480618
DBTA	0.1616611	0.042643	0.1190181	0.2099827
LLPNII	−0.0006034	−0.0001757	−0.0004277	–
NPLTLO	0.1229533	0.1110865	0.0118668	0.0590914
LNTA	0.0509671	0.0154383	0.0355288	0.0112812
TLOTD	−0.0704578	−0.1662709	0.0958131	0.0506297
TLOEA	0.0362375	0.0232593	0.0129782	0.0054982
GDPG	−0.2652505	0.0787475	−0.343998	–
IR	−0.6693575	−0.8805808	0.2112233	0.0817442
IRS	0.1591719	−0.8290932	0.988265	0.3256891
Chi-square	16.31			
P-value	0.2947			

Source: Authors' contribution based on the output developed by Stata 16.0

Table 13: Output of Hausman Test for OEEAR

Variables/Statistic: OEEAR	Coefficients			
	Fe (b)	Re (B)	Difference	S.E.
ROE	0.0014264	−0.0017114	0.0031378	---
NIM/NIIR	0.1013297	0.1746572	−0.0733275	0.0108674
CAR	0.0036495	0.0714173	−0.0677678	0.0349335
ECTA	−0.0736266	−0.1638593	0.0902327	0.1452141
LLPTLO	−0.0346839	−0.019558	−0.0151258	0.0307546
DBTA	−0.1064711	−0.1943013	0.0878303	0.0627746
LLPNII	0.0003024	0.0002528	0.0000496	---
NPLTLO	0.0149095	−0.0211974	0.0361069	0.0168863
LNTA	−0.0020319	−0.0033917	0.0013598	0.0029682
TLOTD	−0.071284	−0.0832617	0.0119777	0.0132363
TLOEA	0.0406325	0.0360181	0.0046143	0.0013995
GDPG	0.0562525	0.083243	−0.0269904	0.0061479
IR	−0.0374086	−0.1080808	0.0706722	0.0226979
IRS	0.2005754	0.1289322	0.0716432	0.0845837
Chi-square		499.00		
P-value		0.0000		

Source: Authors' contribution based on the output developed by Stata 16.0, OEEAR: Operating expense to earning assets ratio, CER: Cost efficiency ratio

Breusch-Pagan Lagrange multiplier test reported in Table 14 identifies the better model between random effect and pooled OLS. Here null hypothesis is random effect is not appropriate compared to pooled OLS. Here for the first two models with dependent

Table 14: Output for B/P LM test for OER, CER, OEEAR

Breusch and pagan lagrangian multiplier test for random effects						
Details	**OER [banks, t] =Xb+u[banks] +e[banks, t]**		**CER [banks, t] =Xb+u[banks] +e[banks, t]**		**OEEAR [banks, t] =Xb+u[banks] +e[banks, t]**	
Estimated results	Var	sd=√(var)	Var	sd=√(var)	Var	sd=√(var)
Dependent variables	0.098531	0.3138964	0.0144731	0.1203042	0.004209	0.0648765
E	0.0515488	0.2270435	0.0071572	0.0846003	0.0003114	0.0176479
U	0.0073495	0.085729	0.0014152	0.0376193	0	0
Test var (u)=0						
Chi-square value	8.87		48.49		0.00	
P-value	0.0014		0.0000		1.0000	

Source: Authors' contribution based on the output developed by Stata 16.0, OER: Operating efficiency ratio, CER: Cost efficiency ratio, OEEAR: Operating expense to earning assets ratio

Table 15: Output for LLC unit root test

Levin-Lin-Chu unit-root test for all Variables				
Null Hypothesis H_0=Panels contain unit roots		**Number of panels=30**		
Number of periods=12				
Asymptotics: N/T -> 0				
H_1: Panels are stationary				
AR parameter: Common				
Panel means: Included				
Time trend: Not included				
ADF regressions: 1 lag				
LR variance: Bartlett kernel, 7.00 lags average (chosen by LLC)				
		Statistic	**P-value**	**Stationary**
OER	Adjusted t*	−38.1010	0.0000	Yes
CER	Adjusted t*	−3.8752	0.0001	Yes
OEEAR	Adjusted t*	−1.7622	0.0390	Yes
ROE	Adjusted t*	−17.2245	0.0000	Yes
NIM/NIIR	Adjusted t*	−4.9058	0.0000	Yes
CAR	Adjusted t*	−2.6712	0.0038	Yes
LNTA	Adjusted t*	−8.0895	0.0000	Yes
DBTA	Adjusted t*	−11.5075	0.0000	Yes
LLPTLO	Adjusted t*	−5.3654	0.0000	Yes
NPLTLO	Adjusted t*	−7.7020	0.0000	Yes
ECTA	Adjusted t*	−3.5065	0.0002	Yes
TLOTD	Adjusted t*	−8.8114	0.0000	Yes
TLOEA	Adjusted t*	−7.6474	0.0000	Yes
LLPNII	Adjusted t*	−5.3645	0.0000	Yes
GDPG	Adjusted t*	4.8977	1.0000	No
IR	Adjusted t*	−3.0763	0.0010	Yes
IRS	Adjusted t*	−7.9232	0.0000	Yes

Source: Authors' contribution based on the output developed by Stata 16.0, OER: Operating efficiency ratio, OEEAR: Operating expense to earning assets ratio, CER: Cost efficiency ratio

Table 16: Output of GMM approach for OER

Dependent Variable- OER	**Coefficients of GMM model 1**
L_1(OER)	0.1703472***
ROE	−0.4127592
NIM/NIIR	1.745859
CAR	−1.476212
ECTA	9.414704*
LLPTLO	−20.39699***
DBTA	2.959766
LLPNII	0.0251619*
NPLTLO	−1.145639
LNTA	−0.0455531
TLOTD	−0.5675023
TLOEA	−0.0384533*
GDPG	−0.7458981
IR	−0.5965476
IRS	5.86356***
Constant	−0.084768
No. of observations (N)	330
Wald Chi-square	11365.01
Prob > Chi-square	0.000
AR (1) P-value	0.006
AR (2) P-value	0.156
Sargan Test of overidentification P-value	0.000
Difference in Sargan Test of exogeneity of Instrument subsets:	
Sargan Test excluding group P-value	0.000
Difference (H0=exogenous) P-value	0.007
Number of instruments	66

Source: Authors' contribution based on the output developed by Stata 16.0. *,**,*** indicates of significance level at 5%, 1% and 0.1%, OER: Operating efficiency ratio

variable operating efficiency ratio and cost-efficiency ratio, the P < 0.05. So it indicated that the random effect is better compared to pooled OLS for the first two models.

For the third model with the dependent variable OEEAR, the P = 1 which is more than 0.05, so it is insignificant. Here we conclude that random effect is not an appropriate method compared to pooled OLS in this model and polled OLS is the better option.

In Levin-Lin-Chu unit-root test executed and reported in Table 15, assumed hypothesis is the series contains the unit root, or the series is non-stationary or it follows a stochastic (random) trend. The data set will be stationary if the null hypothesis is rejected with a P < 0.05.

For all the variables except GDP Growth, adjusted t values are significant. For example, the adjusted t value of the dependent variable Operating Efficiency Ratio is significant at a 0.1% level of significance suggesting the rejection of the null hypothesis and putting comment that the mean, variance and covariance of Operating Efficiency Ratio's data set are constant across the time.

Generalized Methods of Moments are applied to resolve endogeneity problems as outlined in Table 16. Independent variables are expected to be exogenous that are not influenced by outside variables. In our model Chi-square value is 11365.01 and the P = 0.000 which is statistically significant. It reveals that independent variables are jointly statistically significant in measuring the changes in the dependent variables.

Under the Arellano-Bond test for AR(1) or first-order autoregressive scheme null hypothesis assumes the model doesn't follow the first-

order autoregressive scheme. Here P < 0.05 for AR(1) rejecting null hypothesis which means the model follows a first-order autoregressive scheme. This also justifies the new formation of the regression model that we have implemented by taking 1 year lag period of the dependent variable as the independent variable. In AR(2), the null hypothesis says the model doesn't follow AR(2) scheme but here P-value is more than 0.05 in our model. Again it is statistically proved that our model follows a first-order autoregressive scheme. In the Sargan Test of endogeneity, the null hypothesis assumes that independent variables are exogenous which has been rejected in this study as the P = 0.007. By using GMM, endogeneity problem has been resolved.

In Table 17, revised output has been shown for operating efficiency ratio model again by excluding data of government banks named Sonali Bank, Janata Bank, Agrani Bank, Rupali Bank and also Pubali bank which have high negative ROE for which profitability has been showing inverse relationship with operating efficiency in the previous described models. Again, GDP growth and loan loss provision to net interest income has been excluded here where GDP growth's data set is non-stationary and loan loss provision to net interest income bears high VIF value. ROE has now insignificant positive relationship with Operating efficiency ratio. Previously positive relationship was missing because government banks carried high negative ROE and as mentioned in introduction chapter, state-owned commercial banks were bearing negative returns on equity mentioning -29.57%. NIM/NIIR is significantly positively related with OER. LLPTLO, DBTA and TLOEA are significantly negatively related with OER.

Table 17: Output of the coefficients in the model with excluded banks and variables

Dependent variable-	Estimations of the models			
OER	FE	RE	Pooled OLS	GLS
ROE	0.38485095	0.35416741	0.32579391	0.32579391
NIM/NIIR	1.9854365*	1.994967*	1.9988779*	1.9988779*
CAR	−1.2008998	−1.2868132	−1.3468703	−1.3468703
ECTA	4.5959942	3.0129701	2.3220757	2.3220757
LLPTLO	−5.9736486*	−5.9855978**	−6.2095014**	−6.2095014**
DBTA	−1.464697	−2.6537939**	−3.1441071***	−3.1441071***
NPLTLO	−0.36398528	−0.53308442	−0.71074122	−0.71074122
LNTA	0.04702683	0.05473722	0.05255614	0.05255614
TLOTD	0.04036012	0.12628898	0.21422251	0.21422251
TLOEA	−0.14743876*	−0.14750483*	−0.14871345*	−0.14871345*
IR	0.75205186	0.6194729	0.46754052	0.46754052
IRS	2.379352	2.158983	1.8062571	1.8062571
Constant	1.1863298	2.1031678	2.6068331*	2.6068331*
n	300	300	300	300
Chi-square		75.763932		90.222422
R square	0.2144		0.2312	
F	4.9944299		7.1927319	
Sigma_u	0.08872899	0.05598753		
Sigma_e	0.20341204	0.20341204		
Rho	0.15985678	0.07042302		

Source: Authors' contribution based on the output developed by Stata 16.0. *,**,*** indicates of significance level at 5%, 1% and 0.1%, OER: Operating efficiency ratio

Table 18: Output of the coefficients in the model with excluded banks and variables

Dependent variable-CER	Estimations of the models			
	FE	RE	Pooled OLS	GLS
ROE	−0.82602359***	−0.79905285***	−0.7756399***	−0.7756399***
NIM/NIIR	−1.0553993**	−0.66553191*	−0.13888783	−0.13888783
CAR	0.29679344	0.36873042	0.27567629	0.27567629
ECTA	−1.5505938	−2.945266***	−3.3122602***	−3.3122602***
LLPTLO	−3.2972483***	−3.5320835***	−4.1348023***	−4.1348023***
DBTA	−0.03808757	−0.33573419	−0.3999652	−0.3999652
NPLTLO	0.09785675	0.25200663	0.40089096	0.40089096
LNTA	0.00417703	−0.01028014	−0.02442015	−0.02442015*
TLOTD	−0.01158921	−0.17937939*	−0.36964796***	−0.36964796***
TLOEA	0.07913534***	0.05277105*	0.01719108	0.01719108
IR	−0.35075434	−0.34474654	−0.49079525	−0.49079525
IRS	0.58354129	0.29121519	0.02283958	0.02283958
Constant	0.53272183	1.3746404**	2.0139947***	2.0139947***
N	300	300	300	300
Chi-square		199.76271		212.56761
R square	0.2592		0.4147	
F	17.84002		16.946362	
Sigma_u	0.067113	0.03271196		
Sigma_e	0.06855969	0.06855969		
Rho	0.48933816	0.18543832		

Source: Authors' contribution based on the output developed by Stata 16.0. *,**,*** indicates of significance level at 5%, 1% and 0.1%, CER: Cost efficiency ratio

Table 19: Test for omitted variable bias

Ramsey RESET test using powers of the fitted values of CER
Ho: model has no omitted variables
F (3, 284) =0.43
Prob>F = 0.7322

Source: Authors' contribution based on the output developed by Stata 16.0, CER: Cost efficiency ratio

In this revised results of CER in Table 18, profitability ratios (ROE and NIM/NIIR) are significantly negatively related with cost efficiency ratio meaning that when profitability increases, operating cost decreases.

LLPTLO, ECTA, TLOTD are significantly negatively related with CER and TLOEA is significantly positively related with CER.

In the revised model of CER, there is no omitted variable bias as observed from Table 19 indicating that all the required independent variables for measuring changes in dependent variable CER has been included in the model.

5. CONCLUSION

Commercial banks are facing greater competition due to increased advancements in technology and also due to an increasing number of banks in Bangladesh. The efficient operation of these banks will enable them to remain competitive and achieve success in this competition. This study has divulged the significant bank-specific and macroeconomic determinants of operating efficiency to give a guideline to the commercial banks of Bangladesh to concentrate on factors that may increase operating efficiency and control factors that decrease operating efficiency. Through financing the economic growth of the country, commercial banks put a significant impact on the GDP of Bangladesh. This study provides an outline to the bank authorities to rectify the problems that decrease the operating efficiency of the state-owned and private commercial banks. Private commercial banks currently are lending effectively collected amounts of deposits. But to reduce non-performing loan, quality loan needs to be ensured to enjoy increased operating efficiency. Core capital in state-owned banks is not satisfactory like private commercial banks which need to be rectified by good governance efficiency. As SCBs have a large bank size compared to PCBs and if large bank sizes of SCBs can be utilized efficiently, banks would be able to enjoy economies of scale generating operating efficiency through cost reduction. Further research can be employed in the operating efficiency sector by integrating foreign commercial banks in the sample size along with some qualitative factors like skills of employees, management, and the role of the supervisory authority.

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