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The Impact of Bank-Specific Factors on the Efficiency of Pakistan's Commercial Banks: Data Envelopment Analysis and Tobit Regression Model Framework

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Abstract

This study aims to measure the effects of bank-specific factors on the efficiency of Pakistan's twenty-seven (27) commercial banks. Efficiency was computed by input-oriented data envelopment analysis approach under CRS (constant return to scale) and VRS (variable return to scale) assumptions. The results revealed that overall inefficiency in commercial banks was to tune of 10 percent and was caused by both managerial incompetence and uneconomical bank's size. However, the uneconomic scale size remained the dominant source of inefficiency at individual banks level, and most of the banks exhibited a decreasing return to scale (DRS) behaviour. Furthermore, efficiency scores were regressed by bank-specific factors using the Tobit regression model. Among the bank-specific factors, Profitability, liquidity, bank size had a significant and positive impact, while market share and Asset quality had a negative and substantial effect on all the efficiency parameters.

Key Words: ideology, textbooks, critical discourse

Introduction

The globalization of financial systems has led the monetary institutions to technological advancement, innovation, globalization, and deregulation (Khan, Ali, & Khan, 2018). These changes empower financial institutions to operate effectively. Effective operations lead to economic stability through the maximum allocation of economic resources, which ultimately acts as a catalyst for economic growth (Abbas, Azid, & Besar, 2016). The strength and stability of a financial sector, therefore, depends on the maximum distribution of financial resources. As an essential fragment of the financial system, the banking sector performs a dominant role between depositors and investors. The sector provides investors with funding for ongoing and new projects, as well as for investors who could make a profit by sacrificing existing savings. In meeting the vital needs of the modern financial system, banking institutions face a variety of challenges (Stewart, Matousek, & Nguyen, 2016). This advancement has changed the customary role of banking organizations in managing the risks of banks, raising funds, and combating their survival (Banya & Biekpe, 2018).

The current situation raises the need to understand the performance of the bank in more detail. Efficiency is considered as one of the main ingredients for business firms. It is the capability of a business firm to make output (s) by using the least input resources (Khan et al., 2018). The efficiency helps to increase profits, manage risks, ensure efficient usage of the monetary resources, and promote the delivery of reasonable services. It is seen as a measurement stick to move towards diverse tactics (such as reformation, integration, and acquisition) if the bank or a particular group, in general, fails to perform consistently (Stewart et al., 2016). Under the highly competitive environment in the financial services sector, banks are required to operate more efficiently. The chances of survival are more in banks operating at a high level of efficiency. High efficiency satisfies all stakeholders, while poor efficiency can lead to many undesirable results. This necessitates bank owners, consumers, regulators and investors to monitor the performance of banks (Tamatam, Dutta, Dutta, & Lessmann, 2019). There are many techniques for measuring performance, such as ratio and regression analysis. These are

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Conventional methods that have certain limits. These methods evaluate the efficiency based on average instead of best practices (Cooper, Seiford, Tone, & Zhu, 2007).

These methods require a predefined function to be specified and do not get the actual function. In the case of ratio analysis, a single index to classify and rate decision-making units based on multiple ratios is unlikely to be set objectively(Cooper, Seiford, Tone, & Zhu, 2007).

The frontier efficiency models emerged as an alternative to measure relative efficiency as well as to cope with the shortcomings of regression and ratio analysis. It includes DEA (Data Envelopment Analysis) and the Stochastic Frontier Method (SFA). However, as demonstrated by Kumbhakar et al. (2001) and Ruggiero (2007), the DEA approach produces better outcomes than SFA. The current study uses DEA as an analysis tool since it focuses on the individual performances and produces a single aggregated index for each DMU as opposed to the average population. The manifold inputs and outputs can be incorporated simultaneously to obtain an aggregate performance index under DEA. It also does not require predefined weights or prices on inputs and outputs. It does not require the production function to be defined in advance. It assigns each bank a defined scope for improvement.

The DEA has also been broadly applied in a wide variety of sectors, in addition to finance, such as health care, agriculture, transport, education, and many more. There is an extraordinary increase in the number of publications involving DEA as a performance measure in various sectors (Emrouznejad, Parker, & Tavares, 2008). While there is a significant insight into literature about the banking sector performance around the world, there are few studies that analyzed the performance of the Pakistani banking sector. Actually, many existing studies are based upon the traditional analysis ratio. Although some (Ahmad, Mujaddad, & Nadeem, 2015; Ahmad & Burki, 2015; Chaudhary & Arshad, 2016; Khan & Khattak, 2016) have applied modern boundary approximation techniques such as Data Envelopment Analysis (DEA). In addition, few studies have attempted to quantify the outcome of bank-specific factors on banks' efficiency. This study is exclusive in nature as it only not calculates the efficiency by DEA frontier approach as a performance indicator but also finds its main bank-specific determinants causing a change in efficiency using Tobit regression in a developing country like Pakistan.

Literature Review

The efficiency analysis is thought to be an important issue for the performance of any sector. Efficiency as a performance parameter has been used in several studies from diverse fields. Similarly, numerous techniques have been adopted, ranging from simple ratios to more sophisticated measurement techniques. Kirigia and Asbu (2013) used DEA to measure technical and scale efficiencies while Tobit regression to assess the influence of efficiency determinants on the Community Hospital in Eritrea. Likewise, Valdmanis, Rosko, Leleu, and Mukamel (2017) evaluated the technical and scale efficiencies of home health care facilities of the United States using DEA and Ordinary least square regression to measure the impact of environmental factors on its efficiency. Grmanová and Strunz (2017) studied the association between efficiency and profitability in terms of ROA and ROE for insurance firms in Slovakia.

The efficiency was measured by DEA models. The impact of profitability on the efficiency was then assessed by the Tobit regression model and found statistically significant results. Singh and Bajpai (2013) analyzed the efficiency of a Coal power plant in the energy sector by DEA and then regressed the efficiency determinants through the Tobit regression model.

They concluded that the quality and size of the plant had shown a significant effect on the technical efficiency of power plants. Hong and Fang (2015) explored the efficiency of Chinese energy policy in thirty provinces using DEA based Malmquist productivity index and Tobit regression. Monkam (2014) “studied the efficiency” of domestic municipalities of South Africa by means of DEA approach while Tobit regression to gauge the impact of efficiency determinants. Kumar (2011) analyzed the efficacy of Government transportation firms of India applying DEA and Tobit regression models. Nowak, Kijek, and Domańska (2015) applied a similar methodology for assessing the efficiency of the agriculture sector across twenty-seven European countries. Fethi, Jackson, and Weyman-Jones (2000) used the same methodological style to assess the efficiency and its determinants in the European’s Airlines industry. Yahia and Essid (2019) have used a similar approach to observe efficiency and its determining factors in education sector of Tunisia. The extensive research has been undertaken in the banking sector relating to efficiency and its determinants. The evidence relating to efficiency and its determinants have been found in single country as well as cross country experiences.

Banya and Biekpe (2018) studied the efficiency of banking institutions in the 10 frontier African countries. They employed DEA for efficiency measurement with Deposits and Labour as inputs while total assets as outputs in the first stage. The truncated regression was applied to check the efficiency effect on bank-specific variables. The study found that the size of the bank and the risk of liquidity had a statistically negligible and negative effect on the performance. The loan risk, financial leverage, and bank's diversification had a positive but statistically insignificant impact on the efficiency. However, the fixed assets to total assets had a positive and statistically significant effect. Similarly, Banna, Shah, Noman, Ahmad, and Masud (2019) examined the performance of banking companies of the Sino ASEAN countries. The study used the DEA methodology to compute efficiency using 4 inputs and three (3) outputs. The efficiency scores thus obtained were regressed by the bank-specific and country-specific determinants through Tobit regression. The results indicated that the bank specific variables of size, profitability (ROAA) and capital adequacy had statistically significant and positive effect.

Likewise, the country-specific variables of GDP (growth) had a positive and significant impact on efficiency, whereas inflation and interest had a negative bearing on the bank's efficiency. There are numerous studies that focused on efficiency and its determinants of financial institutions at the country level. Batir, Volkman and Gungor (2017) explored the efficiency of Turkish banks through DEA. The labour, capital and deposits were used as input variables, whereas total loans and off-balance sheet were taken as output variable for efficiency computations. The efficiency scores were then regressed by internal (bank-specific) determinants of Profitability (ROA), capital adequacy (Equity), Expense ratio, Deposits, Loans ratio, non-performing loans, Size, and external factors of GDP and inflation. The results disclosed that profitability had a positive and insignificant impact on technical efficiency while an insignificant negative impact on cost and allocative efficiencies. Similarly, loans had a significant and positive effect on all efficiency parameters. On the contrary, Equity, expense ratio, deposit, Loan quality, size, GDP and inflation had a negative influence on the efficiency of banks. Kar and Deb (2017) examined the technical capabilities of selected microfinance institutions in India and the factors affecting them. This study used Tobit regression to measure factors affecting technical efficiency computed by DEA models.

Martins (2018) studied the performance of large banks operating in Portugal based DEA. The efficiency scores were then tested by Tobit regression to evaluate the effect of factors causing changes in efficiency. Samad (2019) followed the process of performance analysis for Islamic banks in Bangladesh through the DEA methodology. In the second phase, Tobit regression was applied to assess the effects of various factors affecting performance. The findings of the study indicated that a number of branches and capital adequacy had a positive effect on the performance, while credit quality, liquidity, and bank size had a negative effect. The use of DEA and panel regression to examine the effect of different factors on the performance of Islamic banks and Islamic business units in Indonesia was considered by Hidayati, Siregar, and Pasaribu (2017). The results showed that capital adequacy ratio and funding were significantly positive, while deposits had a negative and important effect on the competitiveness of Islamic banks. Fernandes, Stasinakis, and Bardarova (2018) used the truncated regression model to analyze efficiency determinants calculated for European domestic banks over bootstrapped DEA model.

There are, however, limited studies in Pakistan that have measured performance using DEA and Tobit regression to predict performance factors. Working capital policies and productivity of Pakistan's manufacturing sector were analyzed by Ahmad, Ishtiaq, Hamid, Usman Khurram, and Nawaz (2017). The efficiency scores were further regressed by factors influencing efficiency using Tobit regression. Gishkori and Ullah (2013) analyzed the performance of Pakistan conventional and Islamic banks using an input-based DEA model. In the second phase, Tobit regression was applied to predict the properties of qualitative and quantitative variables on the performance level of banks. The Size, investments, advances, total liabilities, interest or mark-up earned, non-interest or non-mark-up revenue, interest and non-interest expenses, number of employees were used as quantitative determinants of efficiency under the study.

The ownership structure of the banks has been used as a qualitative variable to distinguish between foreign and domestic owned banks. The results showed that traditional banks were technically more efficient than banks (Islamic) under the DEA analysis. The regression results showed that bank size, number of employees, mark-up expenses, ownership structure, mark-up (profit), and advances have a significantly positive impact on efficiency while the remaining variables had an insignificant effect.

Abbas et al. (2016) evaluated the performance of the Pakistani banks via efficiency and effectiveness through DEA. The efficiency was computed through DEA by using a number of employees, fixed assets, deposits, and equity as contributions while Advances & Loans and investments as yields. The effectiveness was measured by taking loans and investments as inputs, whereas mark-up income and non-mark-up income as outputs. The performance was taken as a product of both efficiency and effectiveness scores. The performance, efficiency and effectiveness scores were then regressed by bank-specific, market-specific and macroeconomic variables using Tobit regression. The DEA results indicated that Conventional banks performed far better than Islamic banks on effectiveness and efficiency measures. The Tobit regression consequences showed that age, capitalization, and "loan ratio had a positive" influence on efficiency, whereas profitability and other operating income had a negative relationship with efficiency. The market "specific and macroeconomic" factor did not indicate any significant effect on efficiency.

Methodology

DEA (Data Envelopment Analysis) is the non-parametric linear optimization technique. It is applied to calculate performance by optimizing weighted input in proportion to weighted output. This is a relative efficiency approach for determining performance by considering multiple inputs and outputs. This method was first conceived by Charnes, Cooper and Rhodes (1978) to review the performance of non-profit firms. This form of performance is called technical efficiency and also referred to as CRS (constant return to scale) efficiency. Another variant of DEA computed under VRS (variable return to scale) assumption was first presented by Banker, Charnes and Cooper (1984). They suggested that the use of the VRS assumption can provide the basis for computing managerial efficiency devoid of scale effect and is generally termed as "Pure-technical efficiency".

The DEA efficiency can be assessed either by Input-based or output-based models. The former model focuses on the proportional reduction in input resources while keeping the outputs constant. Whereas the latter approach of DEA aims at expanding outputs while keeping the current inputs intact. Under CRS, input-based and output-based assumption measures always provide the same value, but VRS does not generate equivalent values. The DEA assigns different weights to the inputs and outputs to the compute efficiency scores of the firm under investigation. The efficiency scores range from zero to one. The most efficient firm will get a score of one, and the inefficient firm will get less than one score. Since these scores are not absolute, rather, they are relative. The status of a highly efficient firm can change with a change in the sample.

Mathematical Model of Data Envelopment Analysis

Suppose that we need to analyze the k number of Decision-making units (DMUs). These DMUs use a varying amount of "x" inputs to produce "y" outputs. It means that DMU_p uses x_{ap} (a = input 1 to input n and p is the DMU i.e., a^{th} inputs of DMU "p") quantities of input to get y_{bp} (b outputs of DMU p). These inputs and outputs are assumed to be positive or at least one output, and input needs to have a positive value. The mathematical model to compute the efficiency of a firm under analysis is provided below:

Min θ_p (The efficiency of DMU "p") .... (i)

Subject to

$\theta_p x_{ap} - \sum_{k=1}^{n} \lambda k\ x_{ap} \geq 0,\ a = 1,2, \dots \dots \dots .., m;$............ (ii)

$\sum_{k=1}^{n} \lambda k\ y_{bk} \geq y_{bp}$, $b = 1,2, \dots \dots \dots .., s;$ ...... (iii)

$\lambda k \geq 0$ $k = 1,2, \dots \dots \dots .., n;$ .... (iv)

The above model can be changed to VRS, IRS, and DRS models by adding constraints (a to c) given below distinctly.

Constraints

a) Add: $\sum_{k=1}^{n} \lambda k = 1$ for Barnes, Charnes and Cooper (1984) Variable return to scale (VRS) model.

b) Add: $\sum_{k=1}^{n} \lambda k \geq 1$ for Increasing Return to scale assumption (IRS)

c) Add: $\sum_{k=1}^{n} \lambda k \leq 1$ for decreasing return to scale (DRS) assumption

Tobit Regression Model

The influence of internal and external factors on efficiency can be accommodated in DEA analysis. As discussed in the earlier section, the DEA scores range between zero and one, which makes the dependent variable a limited or censored variable. The Tobit model was developed by James Tobin in 1958 as an extension of the Probit model. It is a typical regression model where the data on the dependent variable is censored, or the data is limited by some threshold value. The limit for threshold value is fixed below or above a certain value. The value below a certain level is either not observable or not required for the purpose of analysis. Such a limit on data is called censoring from below or left censoring. Similarly, the threshold value may be fixed at the upper level of data, and beyond that limit, the observations are not considered. This type of limit is known as censoring from above or right censoring. The sampled data could be censored by either or both limits at the same time. Therefore, the Tobit is also called the limited or censored dependent variable regression model.

The data on the dependent variable sometimes cannot be obtained fully, and only a fraction of data is available. In such cases, the data cannot represent the entire population, and the estimate of the Least square (LS) for such models is incorrect or unexplained results of data are obtained from disconnected or censored data. Limited dependent variable or latent variable models have been developed to analyze dependent or censored data. The efficiency scores obtained through DEA analysis are bounded between zero and one. It can neither fall below zero nor exceed one. It implies that a firm under investigation in DEA can take a maximum of one or minimum value of zero or between these two values. Therefore, the efficiency score of a firm is censored from below at zero and from above at one.

The standard Tobit model can be defined as follows for observation (bank) i:

$yi^* = \beta\text{-}\ xi + \varepsilon i$; $yi =$ yi^*, if $yi^* \geq 0$ otherwise $yi = 0$, and if $yi^* \leq 1$ otherwise $yi = 1$

where

yi^* is a latent variable (and is equal to or greater than zero) and is conditioned to be greater than or equal to 1.

x_i represents the independent variable for bank "i".

β shows the coefficient of independent variable xi.

ε_i is the error term having zero mean with normal distribution and fixed or constant variance and is expressed as $\varepsilon_i \sim N(0, \sigma 2.)$.

y_i is the efficiency score computed through DEA.

Variables and Data

Various DEA models have been used in the literature on the efficiency of banks. The literature, however, is dominated by the two basic DEA models, namely BCC and CCR, developed by Banker, Charnes and Cooper (1984) and Charnes, Cooper and Rhodes (1978). These models are applied to measure, respectively, pure technical efficiency and technical efficiency. Moreover, by enveloping multiple inputs and outputs at a time, these models have the capacity to quantify performance. As with a production process, the inputs are converted into outputs to assess the relative efficiencies of a business. The company or decision-making unit (DMU) can receive a score between 0 and 1. The DMU is defined as efficient with a score of 1, and a DMU with a score of less than 1 is called inefficient. The relative efficiency can be determined by DEA models, either input-oriented or output-oriented. The input-oriented model assumes how much reduction in inputs will be needed to achieve current output levels while keeping the outputs constant. Whereas the output-oriented model assumes how much enhancement from the specified or set inputs is possible in outputs. Input or output-oriented model selection

Depends on the discretion or control of a DMU or company over the inputs or outputs in the transformation process.

If the company can exercise more control over inputs, then the best choice is an input-oriented model; otherwise, the output-oriented model is more appropriate. Because banking companies have more or more direct control over the inputs of banks. Therefore, a better option is to use an input-oriented model for computing efficiency. Thus, the study adopted this efficiency calculation approach. Similarly, there are two widely used methods in the literature for input and output selection under the DEA approach. One such strategy is known as the production approach. Banks are considered to be production unit that can use land, labor and capital to generate loans, reserves and other banking facilities as inputs. The second approach, commonly referred to as the intermediate approach, assumes banks as a mediator that raises additional funds to deficit units from suppliers (depositors) (or lenders). In the banking literature, both methods have been applied. However, because of the availability of data or information about input and output, the intermediation approach is mostly used. For the "selection of input and output variables, the present study" used an intermediation strategy. Table 1. provides the inputs and outputs used in the study.

For the year 2015, the data on these variables were obtained from the banks' financial statements included in the study sample. To retrieve data or information on some variables, the official web page of the State Bank of Pakistan (www.sbp.gov.pk) was accessed. Similarly, a survey published by KPMG Pakistan was also available for the purpose of obtaining information on the number of bank staff to be studied.

Table 1. Input and Output Variables for DEA.

Input Variable	Description
Labour	Includes number of full-time employees of the bank.
Fixed Assets	Includes tangible and intangible fixed assets measured in Pakistani Rupees.
Deposits	Consists of current, demand and other deposits of a bank measured in Pakistani Rupees.
Total Expenses	These include interest and non-interest expenses incurred by a bank measured in Pakistani Rupees.
Output variables	
Loans and Advances	Involves Loans and advances made by a bank net of provisions for non-performing loans and others expressed in Pak Rupee.
Investments	Comprises of investments in Pakistani rupee made by a bank.
Total Income	Includes income earned from interest and non-interest activities of a bank measured in Pak Rupee.

The variables used "to study the impact of bank-specific" variables are provided in table 2. The data on these variables for the year 2015 has been obtained "from financial statements" of individual banks and from the analysis of financial statements published by the state bank of Pakistan (i.e., www.sbp.gov.pk).

Table 2. Bank Specific Determinants of efficiency.

Variables	Description
Profitability	Measured by Return on Assets (ROA) = after-tax profit / Total Assets
Market Share	Measured by natural deposit logarithm measurement
Size	Natural Total Assets Logarithm
Liquidity	Loans and Advances ratio to Total Assets
Asset Quality	The ratio between non-performing loans and net borrowings and advances

Results and Discussion

Technical Efficiency

Technical efficiency (TE) scores have been computed using the input-oriented "Charnes, Cooper, and Rhodes

(1978) model of Data envelopment analysis" for the year 2015. The descriptive statistics and DEA results have been provided in table 3 and 4, respectively. The mean TE score is noticed at 0.90 or 90%. It implies that the actual output or outcome attained by sampled banks could be possible with 10% fewer input resources. In other words, the current inputs applied could produce 1.11 (1/0.90 or 1/TE) times more output than the actual output produced. The minimum score (TE = 0.79) has been observed for the bank of Khyber (BOK). Six banks (DB, CITIBANK, ICBC, DIB, NIB, and UBL) achieved the maximum score (TE = 1). these banks form efficiency frontier and are termed as benchmark performers. The remaining twenty-one banks have been declared as inefficient since their TE score is less than unity. The inefficiency ranged from 2% to 21% during the study period**.**

Pure Technical Efficiency

"technical efficiency" is further split into two components to trace the sources of inefficiency. The first component deals with managerial aspects of technical inefficacy and is called Pure Technical Efficiency (PTE). It is computed through the Banker, Charnes and Cooper (1984) model of DEA. It tells us about the competency of management in transforming the inputs into outputs of the firm under review. The firm with a PTE score of one (1) is called PTE efficient, while a firm scoring below one is termed PTE-inefficient. By examining the PTE scores, it is evident that about 48% (13 out of 27) banks have a PTE score of 1. Among these, only six banks are efficient under both TE and PTE measures (TE = PTE = 1). Whereas the rest of seven (7 out of 13) banks are efficient under PTE but inefficient under TE measure. Moreover, there are 52% (14 out of 27) banks that are inefficient under PTE as well as TE measures. The inefficiency in these banks ranged from 1% (in the case of Faysal Bank;1-0.99 =0.01) to 21% for the Bank of Khyber (BOK).

Scale Efficiency

The second component of TE is called scale efficiency (SE) and is obtained by the ratio of TE to PTE. It tells us about the effect of bank size on efficiency. The score of 1 shows that the firm is operating at the optimum scale of operations while the score less than unity implies that the bank is operating either below or above the economic size of operations. The results show that banks operated at a mean SE score of 0.95 (95%). It means that the banks transformed their inputs to outputs by using 95% of their available capacity. There are about 30% (8 out of 27) banks that have used their capacity at optimum level and thus declared as Scale Efficient (SE score = 1). The minimum score of 0.83 has been noticed for NBP and Meezan bank. The scale inefficiency (SIE) ranged from 1% to 17%. To find out the main source behind technical inefficiency (TIE), the PTE scores of banks are compared with SE scores. The mean scores for PTE and SE are approximately equal under both efficiency measures. It can, thus, be inferred that both measures have caused technical inefficiency (TIE) at an approximately equal magnitude.

This finding is similar to the study of Yilmaz and Güneş (2015) undertaken for Turkish banks and Banya and Biekpe (2018) in cross countries comparison of ten African countries. From the individual bank's point of view, HBL, NBP, MCB, BAF, Meezan, HMB, and BOT are efficient on PTE measure but found inefficient on SE measure. Similarly, summit and BOK are observed as efficient on SE but inefficient under PTE criteria. So, it is quite clear that seven banks are efficient under PTE, and only two banks are efficient under SE. Therefore, it can be inferred that Scale inefficiency remained a major cause behind technical inefficiency during the study period. This finding of the study is line with Yilmaz and Güneş (2015), Said, Hasnan, Ismail, Majid, and Rahim (2013). It is "evident from the above results that" the majority of banks suffered due to operating at an inappropriate scale size or economies of scale. The scale inefficiency could be associated with either operating above or below the economic scale size. So, the bank operating below the economic size needs to increase the scale of operations to catch the efficiency frontier. While the bank operating at above the optimum size requires to reduce their size of operations to reach the efficiency frontier. The Data envelopment analysis provides information regarding the sources of scale inefficiency under return to scale variants.

The results on RTS are provided in the last column of Table 4. There are five banks (Silk, Albaraka, Samba, FWB, and BOT) that can improve their efficiency by increasing their scale of operations (Bank size) or expanding their branch network to cater to customer needs. Apart from these banks, there are sixteen (16) representing

59% of the study sample which are facing inefficiency due to operating at above the economic or optimum level of operations. These banks can improve their deficiency by reducing (decreasing) their current level of operations and can achieve the benefits of economies of scale. This implies that the majority of banks operated in the Decreasing return to scale (DRS) zone. Similar results were obtained by Yilmaz and Güneş (2015) in the case of Turkish banks and D. Singh and Fida (2015) for the banking sector of Oman. However, six banks, namely DB, CITIBANK, ICBC, DIB, NIB, and UBL, operated at the economic size (Constant) and thus are declared as leaders of the banks in the study sample. The study took a step further to find out the most efficient bank among the top-performing banks. It has been done by looking at the number of times the efficient bank has been "quoted as a benchmark" for technically inefficient banks in the study sample.

The DEA also provides information on benchmark lambda or the best practice bank (decision-making unit) to be followed by inefficient banks for performance improvement. The benchmark lambda provides that DB, CITIBANK, ICBC, DIB, NIB, and UBL have been quoted 3, 19, 17, 18, 12, and 7 times respectively as best practice banks for inefficient banks. These results indicate that Citibank is quoted a maximum number of times as a benchmark and hence can be ranked as 1st among the efficient banks. Similarly, ICBC, DIB, NIB and DB can be ranked 2nd, 3rd, 4th, 5th, and 6th, respectively. The procedure of ranking other banks in the study is made by their TE scores. The banks with high TE score are ranked higher and vice versa.

Table 3. Descriptive Statistics**.**

Variable	Obs	Mean	Std. Dev.	Min	Max
Technical Efficiency	27	.903	.073	.79	1
Pure Technical Efficiency	27	.949	.066	.79	1
Scale Efficiency	27	.953	.058	.83	1
Profitability	27	.012	.012	-.013	.048
Market Share	27	12.011	1.488	8.561	14.307
Liquidity	27	.346	.114	.05	.668
Bank Size	27	12.418	1.352	9.289	14.612
Asset Quality	27	.094	.067	0	.209

Table 4. DEA efficiency scores, return to scale (RTS), benchmark lambda, and ranking of 27 commercial banks of Pakistan

DMU	TE (CRS)	PTE (VRS)	SE (CRS/VRS)	R.T.S	Times as a benchmark for another DMU	Bank Ranking
HBL	0.98	1.00	0.98	D.R.S	0	7
NBP	0.83	1.00	0.83	D.R.S	0	16
UBL	1.00	1.00	1.00	C.R.S	7	5
MCB	0.98	1.00	0.98	D.R.S	0	7
ABL	0.93	0.98	0.95	D.R.S	0	8
BAF	0.85	1.00	0.85	D.R.S	0	14
BAH	0.82	0.86	0.96	D.R.S	0	17
ASKARI	0.84	0.90	0.93	D.R.S	0	15
MEEZAN	0.83	1.00	0.83	D.R.S	0	16
HMB	0.90	1.00	0.90	D.R.S	0	10
SCB	0.86	0.98	0.88	D.R.S	0	13
FAYSAL	0.85	0.99	0.86	D.R.S	0	14
SONERI	0.91	0.92	0.98	D.R.S	0	9

NIB	1.00	1.00	1.00	C.R.S	12	4
JS	0.86	0.87	0.99	D.R.S	0	13
SUMMIT	0.84	0.84	1.00	D.R.S	0	15
DIB	1.00	1.00	1.00	C.R.S	18	2
BOK	0.79	0.79	1.00	D.R.S	0	19
ICBC	1.00	1.00	1.00	C.R.S	17	3
SILK	0.89	0.90	0.99	I.R.S	0	11
SINDH	0.93	0.96	0.96	D.R.S	0	8
CITIBANK	1.00	1.00	1.00	C.R.S	19	1
ALBARAKA	0.84	0.85	0.99	I.R.S	0	15
SAMBA	0.87	0.88	0.99	I.R.S	0	12
FWB	0.80	0.89	0.89	I.R.S	0	18
DB	1.00	1.00	1.00	C.R.S	3	6
BOT,(MUFG)	0.98	1.00	0.98	I.R.S	0	7

Table 5. Tobit Regression output**.**

	Dependent variables		
	Technical Efficiency Score ,(CRS)	**Pure Technical, Efficiency Score (VRS)**	**Scale ,Efficiency ,Score**
Independent variables			
Profitability	7.328^{**}	7.229^{*}	3.822
	(4.02)	(2.27)	(1.90)
Market ,Share	-0.318^{**}	-0.217	-0.216^{*}
	(-3.56)	(-1.75)	(-2.20)
Liquidity	0.566^{**}	0.401	0.377
	(3.60)	(1.56)	(2.01)
Bank Size	0.326^{**}	0.243	0.207
	(3.44)	(1.83)	(1.98)
Asset Quality	-0.209	-0.175	-0.0344
	(-1.19)	(-0.62)	(-0.17)
Constant	0.434^{*}	0.377	0.826^{**}
	(2.52)	(1.36)	(4.18)
Observations	27	27	27

t,----- - -statistics in parentheses * $p < 0.05$, ** $p < 0.01$,

Results of Tobit Regression

The Tobit regression model was run after computing technical, pure-technical and scale efficiencies under input-oriented DEA models to find out the impact of internal or bank-specific determinants on bank efficiency. For this purpose, the “efficiency scores calculated in the first” phase are reduced against the particular variables of the bank. These variables include profitability (measured by asset return), market share (as a natural deposit log proxy), liquidity "(as a ratio of loans and advances to total assets)", bank size (natural total asset log), and quality of assets (measured by the ratio of Non-performing Loans to Net Loans and Advances). As a proxy for efficiency measurement, "technical efficiency, pure technical efficiency, and scale efficiency" have been used and treated as dependent variables. Table 3 provides the results of the Tobit regression. The "results show that profitability has a positive and statistically significant effect of 1% and 5% respectively" on technical and pure-technical efficiencies. Yilmaz and Güneş (2015) and Saha, Ahmad, and Dash's research (2015) found similar results with respect to profitability. It does, however, have a positive but statistically insignificant effect on scale efficiency.

This means that banks with high-efficiency scores also earn more profits. Likewise, at the 5% level of significance, liquidity, and bank size have a positive and statistically significant impact on banks' technical efficiency. This means that, with a high liquidity position and bank size, the efficiency of the bank improves. The analysis by D. Singh and Fida (2015) found that the impact of liquidity on the efficiency of banks in Oman was both positive and statistically significant. The studies by Saha et al. (2015), Said et al. (2013) also found that a bank's size has a positive and statistically important impact on a bank's efficiency. Market share and asset quality, however, have a negative effect on all parameters of efficiency. In the case of pure-technical efficiency, it is statistically significant at 1% and 5% for technical and scale efficiencies, respectively, but statistically insignificant. The negative market share coefficient shows that efficiency decreases as the market share of banks increases. On the other hand, the negative indication of asset quality means that the bank's efficiency is reduced by increasing the asset quality ratio. Batir et al. (2017) obtained similar results for Turkish banks and Saha et al. (2015) for Malaysian banks.

Conclusion

The aim of this study was to evaluate the impact of bank-specific determinants on the efficiency of Pakistani commercial banks. Input orientation data envelopment analysis was used to compute the efficiency parameters of technical, pure-technical and scale efficiencies of Pakistan's twenty-seven commercial banks for the year 2015. Based on the intermediation approach, the input and output variables used for measuring efficiency were selected. The DEA results showed that during 2015, the technical efficiency (TE) of Pakistan's commercial banks stood at 90 percent (TE = 0.90). It implied that by consuming 10 percent less of current inputs (labor, fixed assets, deposits, and total costs) used, the actual outputs (loans & advances, investments, and total revenue) could be obtained. In addition, the technical effectiveness was broken down into components of pure-technical and scale efficiencies to explore the possible cause(s) behind technical inefficiency. Pure technical efficiency (PTE) measures management's competence and ability to convert inputs into outputs. Whereas the efficiency of scale (SE) measures whether a company operates on an optimum or economic scale.

At about 95 percent (PTE = 0.949), the PTE score was observed, implying that the management capabilities remained underused to the tune of 5 percent. Similarly, 95 percent (SE = 0.95) of the mean SE score was noted, implying that the 5 percent inefficiency is due to operating at an uneconomic scale size. It can be concluded that the components of both the PTE and SE have contributed equally to technical inefficiency. However, the technical inefficiency of the individual banks was mainly due to scale inefficiency and the decreasing return to scale (DRS) of the majority of banks. In addition, through the profitability, size, market share, liquidity, and asset quality of the bank, scores of technical, pure technical and scale efficiencies have been regressed to determine the impact of bank-specific variables on the efficiency of banks. The results showed that profitability, the size of the bank and liquidity had a statistically significant and positive impact on the efficiency parameters, while the quality of the assets and the market share had a negative and statistically significant impact on the efficiency of the technical, purely technical and scale.

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