Available Online
Journal of Economic Impact
ISSN: 2664-9764 (Online), 2664-9756 (Print)
http://www.scienceimpactpub.com/jei

ASSESSING THE DETERMINANTS OF EFFICIENCY: AN EMPIRICAL EVIDENCE FROM DEVELOPING ECONOMY

Warda Nadeem [a,*], Nadeem Iqbal [a], Hassan Hanif [a]

[a] *Air University School of Management, Air University Islamabad, Pakistan*

ARTICLE INFO

Article history
Received: August 5, 2021
Revised: October 25, 2021
Accepted: November 02, 2021

Keywords
Technical efficiency
Pakistani banks
Panel data
DEA

ABSTRACT

Increasing banks' efficiency may help boost the country's economic activity. This study aims to focus on the Pakistani bank's technical efficiency over the period 2014 to 2019. The study adopts the non-parametric estimation technique based on the output-oriented CCR model to measure banks' technical efficiency scores. The obtained results revealed that the six banks from 30 that remain technically efficient in the sample period from 2014-2019 were Bank Alfalah Ltd, CITI Bank NA Pakistan, Habib Metropolitan Bank Ltd, Industrial Development Bank, MCB Bank Ltd and Samba Bank Ltd. So, other banks should follow the efficient utilization of resources as these banks are utilizing and set as a benchmark of Technical Efficiency. From the results of GMM, it is concluded that the firm-specific determinants that have a significant negative effect on technical efficiency in the case of Pakistan are leverage. In contrast, profitability and solvency have a significant positive impact on the technical efficiency of banks. However, bank size and liquidity are found to be insignificant. Among the macroeconomic variables, GDP has a significant positive impact, whereas interest rate and regulatory quality have a significant negative effect on the technical efficiency of banks in Pakistan. However, political stability was found to be insignificant. The findings of this study have important policy implications for regulators and managers by focusing on the minimal utilization of input and by maximizing output through better management of resources like fixed assets, labor, operating expenses, deposits, and equity. To maximize the outcomes of the banks that are an investment, net profit, loans, other earning assets, and non-interest income, banks can maximize their technical efficiency. Secondly, the banking efficiency could also be enhanced through firm-specific and macroeconomic variables.

* *Email: wardanadeem2011@hotmail.com*
https://doi.org/10.52223/jei4012208

INTRODUCTION

In the growth of a country's economy banks play an important part. In terms of efficiency, a strong banking sector allows for the effective administration of financial investments and money, which helps to improve a country's economic and financial system (Ayadi et al., 2015; Claessens and Laeven, 2005). Furthermore, the banking sector's inefficiency harms economic development (Creel et al., 2014). The banking industry is striving to increase efficiency and improve performance due to the introduction of new technology (Wonglimpiyarat, 2014; Menor and Roth, 2008). Efficiency is a key notion in evaluating a bank's performance (future, present, and past) as efficiency is a financial metric that utilizes the ratio of outputs (such as loans and investments) to inputs (such as capital and deposits) to assess a bank's efficiency (Chapra, 2007; Iqbal et al., 2019). In the case of Pakistan, the current issue that banks are experiencing is how to use the inputs and outputs of banks best to improve their efficiencies in terms of technical efficiency, to increase the technical efficiency of the banking system to contribute to the country's economic growth.

Banks are having difficulty figuring out how to use the available inputs (resources) best to venture projects efficiently and effectively, thus advancing the country's financial intermediation possibilities and monetary development. Given the significant deregulation trends in financial and banking activity that occurred in Pakistan after the financial crises, assessing the determinants of bank efficiency is required (Technical). Financial institutions have been rapidly growing in Pakistan, and they play an important role in the monetary turn and development of the economy. However, their efficiency measurement is still ambiguous in Pakistan, so it is necessary to examine resource utilization performance to determine efficiency. Mansour and El Moussawi (2020) proposed that research be conducted to enable banks to better understand the components that affect their efficiency and recommend better shifts of activity, control, and anticipation. There is a

need to determine which variables are important in determining bank efficiency so that administrative experts and regulators may implement the best methods to ensure framework efficiency and stability.

Pakistan's financial and banking systems have seen significant fundamental changes due to deregulation and technological advancements after the financial crises. These technological patterns and deregulations removed the tight restrictions on market effects that had previously forced banks and monetary authorities to regulate operations volume. Although there is much research on bank technical efficiency in rich nations, there is still potential for comprehensive comparisons of bank efficiency in underdeveloped countries (Mansour and El Moussawi, 2020; Safiullah and Shamsuddin, 2020). As a result, the emphasis of this research is on performing a bank efficiency study in Pakistan, a developing nation. In the economic development of Pakistan, the banking industry is playing a very important role. The State Bank of Pakistan is the country's central bank, and the country's major banks include Habib Bank, National Bank, Allied Bank, UBL Bank, and MCB Bank. The banking system plays a critical role in improving the economy in that it provides investment possibilities by collecting deposits from various sources and then making loans on demand, which are critical for economic growth. The banking system is an important part of the financial sector in Pakistan, and it has shown a positive correlation with economic development (Bogoev, 2009; Bhatti and Hussain, 2010; Iqbal et al., 2013; Iqbal and Akhtar, 2015).

Another study sought to examine the indicators of the efficiency of various MFIs that provide financial aid in Pakistan. In addition, the research aimed to evaluate the social and financial effectiveness of MFI programs uniquely. The research used DEA which is a reliable and cutting-edge method when compared to others. More significantly, DEA addresses financial organizations' double bottom line goals by evaluating both social and financial efficiency at the same time. In addition, the research regressed explanatory factors to identify financial institutions' double bottom line goals. The results revealed that no MFIs were efficient by using only one input. The efficiency of MFIs, on the other hand, rises as the inputs grow. MFIs in Pakistan have a severe lack of efficiency, which has to be addressed across the board. MFIs should concentrate on improving human resource skills to produce optimum output using the most up-to-date and sophisticated methods. The research offers policymakers recommendations for rewarding and allocating money (resources) to MFIs based on social and financial effectiveness (Iqbal et al., 2019). The efficiency of the financial industry has been examined in several studies (Henriques et al., 2018; Kumar and Gulati, 2010; Ntwiga, 2020; Stewart et al., 2016).

The literature on the efficiency indicators includes the studies of Teng (2012) and Tan and Anchor (2017) that witnessed liquidity risk immensely influenced the Chinese financial sector, i.e., banks. Improvement, diversification, Gross domestic product development rate, CPI, and stock exchange advancement were the significant determinants that explain the efficiency comparisons in the Chinese financial system. Another study by Singh and Thaker (2020) analyzed DEA to gauge the efficiency (profit) and its components for banks of India. The outcomes indicated that enormous foreign, private, and public banks were more effective than medium and small banks. In the subsequent stage, Regression was applied to apprehend the exogenous components influencing the profit efficiency. Gross domestic product development rate and CAR were insignificant, whereas equity ratio, ownership structure, ROA, size of the operation, HHI, and the number of branches were significant determinants of the efficiency of banks. Ilyas and Rajasekaran (2019), examined the Indian insurance sector's performance (efficiency and productivity). Two-stage DEA was applied to assess the cost efficiency and its determinants. The outcomes showed that the private insurers were less cost-efficient than public insurers. The findings indicated that the relationship between reinsurance and size with efficiency was negative and significant.

The empirical outcomes uncovered that leverage benefits productivity and profitability (Nwanna and Ivie, 2017). From the results, it could be inferred that the utilization of obligation improves administrative efficiency as administrators should guarantee more benefit is made to pay interests and still be beneficial. Economies of scale will decrease expenses and increase profit, so bank size could positively affect banks' outputs. Smirlock (1985), Berger and Mester (2003) found a significant and positive connection between profit and bank size. Short (1979) and Goddard et al. (2004) have all connected bank size to capital proportions, guaranteeing to be decidedly identified with size. These results affirm an immediate connection between profit and size, particularly in the case of little to medium-sized banks. A negative effect of liquidity on the effectiveness (efficiency) of proficient banks was found to have high liquidity to answer for surprising requirements of money quickly. The abundance of liquidity could adversely affect efficiency (Bitar et al., 2020; Sakouvogui, 2020).

In Pakistan, performance analysis of banks in terms of efficiency is of considerable interest to shareholders; nevertheless, there are just a few studies with restricted time frames and small sample size. There is an urgent need to undertake comprehensive research on banking efficiency in Pakistan to enhance its performance and economic development. It would enable banks to better understand the factors that influence their profitable execution to increase efficiency, and it would provide them with a higher degree of control, resource execution, and counteraction. The motive behind this investigation is to gain a better understanding of the drivers of bank efficiency in Pakistan, as well as to teach how to efficiently channel inputs into outputs (investment projects, etc.) by improving the nation's monetary movement and, as a result, its financial development. In light of the significant deregulation trends in financial mobility that occurred in Pakistan after the financial crisis. Increasing the efficiency of Pakistan's banks may help to boost the country's economic activity. By effectively using inputs to produce outputs (such as credit and services, such as encouraging savings, insurance, and operational support for successful loan usage) (resources). Our motivation for leading this investigation is to gain a better understanding of the drivers of bank efficiency in Pakistan, as well as to teach how to efficiently channel inputs into outputs (investment projects, etc.) by improving the nation's monetary movement and, as a result, its

financial development. In light of the significant deregulation trends in financial mobility that occurred in Pakistan after the financial crisis. This study aims to focus on the Pakistani bank's technical efficiency over the period 2014 to 2019.

This study is very important for stakeholders in various ways like; a bank's efficiency ratings are very important (including banks employees, shareholders, customers, regulators, and investors). Because these ratings would be generated using various financial performance factors (outputs and inputs), stakeholders may utilize them as a decision-making tool. This study will compare the technical efficiency of banks in Pakistan to see the differences among them and identify the benchmark banks.

To the best of the researcher's knowledge, no study has evaluated technical efficiency in Pakistan using the five components of both input and output variables. Prior research in Pakistan has focused only on calculating efficiency ratings with fewer variables, very few banks, and little data. For example, in a research on the efficiency of five microfinance banks performed by Iqbal et al. (2018), they computed the efficiency score while neglecting the usage of additional variables. Firstly, this study attempted to address this gap by measuring and evaluating technical efficiency using the top five input and output variables to learn about the most efficient DMUs that might be used as a reference for inefficient DMUs. Secondly, this study, after measuring the technical efficiency scores of Pakistani banks through DEA, compares the efficiency of banks in Pakistan to offer suggestions for banks on how to best use the inputs to achieve the greatest output or cost-effectively return from venture projects and to improve bank efficiency to help the country's monetary and financial operations progress and its financial growth.

In addition, for the first time in Pakistan, technical efficiency comparisons will be made across all of Pakistan's banks, providing comprehensive knowledge and comprehension of the aspects that should be prioritized to improve the efficiency of Pakistani banks. Thirdly, to the best of the researcher's information, there is room for space in Pakistan to conduct research based on first estimating the technical efficiency and then determining its indicators. The prior studies in Pakistan include only the calculation of efficiency scores with exceptionally limited banks and restricted data. Like, Iqbal et al. (2018) conducted a study on the efficiency of 5 microfinance banks; they only calculated the efficiency score while ignoring its determinants. Whereas this research will first estimate the efficiency scores of all the banks of Pakistan through DEA, its specific and macroeconomic indicators will be estimated using GMM. This research will be the pioneer in estimating the indicators of technical efficiency of banks in Pakistan.

The study results will be useful in a variety of ways. This study will provide a better understanding of the drivers (factors) of technical efficiency in Pakistani banks and how to best channel the available inputs to get the best output (through venture projects and investments) while also improving Pakistan's monetary movement and financial development. Regulators may use the results of this study to create new changes that will ensure that financial frameworks are efficient, strong, and flexible. The findings of this study may help regulators implement the most effective and efficient methods to improve the banking system's efficacy and efficiency. The results of this study will serve as a reference for investors in making decisions based on the bank's rating concerning technical efficiency scores of Pakistani banks. The results of this study will be helpful to bank management as a reference guide for making banks more efficient. It may be utilized as guidance by strategy makers, especially the State Bank of Pakistan, on the most effective way to make banks technically efficient by keeping an eye on their variables. Financial professionals may use the results of this study to provide consulting services to their clients to help them improve their technological efficiency. This study will also be useful to analysts, academics, and students as a source of comparisons between various kinds of banks in terms of efficiency.

METHODOLOGY

Several methods for evaluating the bank's performance have been developed in the literature, including regression analysis, ratio analysis, scorecard approach, and data envelopment analysis. Each method has its own set of advantages and disadvantages. The most suitable method for evaluating banks' efficiency is to consider the characteristics of their different outputs and inputs. The most frequently used method is the intermediation approach, which has three main ways of determining the outputs and inputs in DEA models for evaluating bank efficiency (Akinsoyinu, 2015; Mansour and El Moussawi, 2020; Mohsin, 2020; Safiullah and Shamsuddin, 2020; Singh and Thaker, 2020; Hou et al., 2019). In the intermediation method, business banks are the ones that provide financial intermediation services. Banks are seen as intermediaries in this study, with deposits, operating costs, labour, fixed assets, and equity serving as inputs to generate a variety of outputs such as investments, loans, other earning assets, non-interest income, and net profit (the above-mentioned inputs and outputs were used by various studies under intermediation approach for reference see Table 1). These output and input sets are consistent with the intermediation method for evaluating bank efficiency, and they are appropriate for covering the full range of resources (inputs) and outputs while maintaining adequate efficiency prediction power. The second method is the Production approach, which claims that banks use labor, other expenses, and capital to produce outputs like deposits and advances (Subramanyam et al., 2020).

The difference between these two methods is related to deposits; in the intermediation approach, deposits are treated as inputs, while deposits are treated as outputs in the production approach. For efficiency assessment, the intermediation method is utilized for bank-level data, while the production approach is used for branch-level data. As a result, the production method utilizes deposit account numbers as outputs, loan numbers as inputs, and operational costs as outputs (Fujii et al., 2014; Sheerz et al., 2016). The profitability method (Dekker and Post, 2001) is the third technique, and it is used to quantify the relationship between costs and benefits in banks. Workforce costs, working expenditures, and finance costs are used as information sources, while revenues or benefits are used as outputs (Drake et al., 2006). The CCR DEA model is used to compute the efficiency scores of banks (DMUs)

in the first stage, and rankings are created based on the efficiency scores of banks.

This study is different from the previous investigations that used a smaller number of years (short period) to measure bank performance (Iqbal et al., 2018; Mohsin, 2020; Singh and Thaker, 2020) which ignored the impacts of variable vulnerability on bank efficiency performance. Second, in the previous literature, only a few input and output variables were used to measure bank efficiency. In contrast, in this study, five input and output variables are used to measure efficiency so that bank management can use or change the construction of banks' resources (inputs), liabilities, and outputs to improve bank efficiency and bring it to the efficient level. As a result, the effect of input and output factors is evaluated in this research by generating bank technical efficiency scores from 2014 to 2019, which will aid in the development of policy suggestions for banks to enhance efficiency. As a result, the DEA method is utilized in this study to address the problems mentioned above in evaluating bank efficiency.

The technical efficiency score will be calculated using input and output variables and DEA at the first step of the analysis. Each year, a technical efficiency score for each bank will be determined. The efficiency scores of all DMUs will be used to rank them. After that, determinants of efficiency would be estimated amongst all Pakistan's banks. In terms of efficiency, banks' behaviour will be evaluated throughout the duration, run from 2014 to 2019.

The basic CCR (Charnes et al., 1978) Model is used to measure the technical efficiency score of banks in our research, and it was also utilized by Iqbal et al. (2018).

$$(TE0)\ max\ v,u\ \theta = \frac{u_1 y_{1_o} + u_2 y_{2_o} + u_3 y_{3_o} + u_4 y_{4_o} + u_5 y_{5_o}}{v_1 x_{1_o} + v_2 x_{2_o} + v_3 x_{3_o} + v_4 x_{4_o} + v_5 x_{5_o}} \quad (1)$$

Subject *to*

$$\frac{u_1 y_{1_j} + u_2 y_{2_j} + u_3 y_{3_j} + u_4 y_{4_j} + u_5 y_{5_j}}{v_1 x_{1_j} + v_2 x_{2_j} + v_3 x_{3_j} + v_4 x_{4_j} + v_5 x_{5_j}} \leq 1\ (j = 1, \dots, n) \quad (2)$$

$$v_1, v_2, v_3, v_4, v_5 \geq 0$$

$$u_1, u_2, u_3, u_4, u_5 \geq 0$$

Where; θ signify efficiency, u signify weighted outputs, v signify weighted inputs, y signify outputs, x signify inputs, and j signify DMUs. Each year's efficiency score of a DMU was calculated by using the above-mentioned weighted outputs (u) and weighted inputs (v) ratio (j that is the individual bank). All of DMU's technical efficiency scores were evaluated this way. Impact of macroeconomic and firm-specific regressors on the regressand variable. Given the considerations of the empirical and theoretical studies described in the literature, the following basic models are specified as:

$$Technical\ Efficiency_{i,t} = \alpha 0 + \beta_1 Technical\ Efficiency_{i,t-1} + \beta_2 BS_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Liq_{i,t} + \beta_5 Solv_{i,t} + \beta_6 P_{i,t} + \beta_7 GDP_t + \beta_8 IR_t + \beta_9 PS_t + \beta_{10} RQ_t + \varepsilon_{i,t} \quad (3)$$

Where, BS denotes bank size, Lev denotes leverage, Liq denotes liquidity, Solv denotes solvency, P denotes profitability, GDP denotes gross domestic product, IR denotes interest rate, PS denotes political stability and RQ denotes regulatory quality. Generalized Methods of Moments (GMM) of Arellano-Bond (1991) model estimates the model as mentioned above equations. Whereas, Tobit as a censored regression for the second stage of DEA was considered inappropriate by McDonald (2009). Because the efficiency score is fraction data and not generated by the censoring process, he suggested using GMM as the most appropriate measure. Mansour and El Moussawi (2020), Sultana and Rahman (2020) have also used it in the second stage of DEA. So, this study will use GMM regression to regress the set of exogenous variables on efficiency scores. Determinants regression is run on the overall sample of banks.

Variables specification and data. In this research, the secondary data of the said variables from all the Pakistan banks for the period from 2014 till 2019 is used. Secondary data is taken from the annual reports of banks, financial statement analysis, State Bank of Pakistan website, International Financial Statistics, Bank Scope database, World Development Indicators, and Worldwide Governance Indicators. Computer software DEA SOLVER LV8 is used to analyse the data. It is an EXCEL-based software providing easy access to various DEA models for analysis, and then GMM will be run for determinants regression in Stata MP 14 software. Technical efficiency is the viability with which a given set of resources (inputs) is utilized to create more outputs. The bank is supposed to be technically efficient if a bank is creating the greatest output by utilizing minimum inputs, for example, deposits, labour, equity (inputs), etc. The banks with a technical efficiency score of one will be considered efficient banks as they will be lying on the efficiency frontier, while those with a technical efficiency score less than one will be lying below the frontier, so they will be considered inefficient banks. Construction of all the variables of this study are explained in the Table 1.

RESULTS AND DISCUSSION

This section of the paper elaborates the results of the study with its detailed discussion. The results of the DEA model for technical efficiency of all the sample banks of Pakistan over the period 2014 to 2019 are displayed in Table 2. One of the objectives of this study was to measure and examine the technical efficiency of all the banks operating in Pakistan by using the non-parametric approach by applying DEA. This approach processes efficiency by applying the linear averages of outputs and inputs. The research findings contrast in numerous aspects from the previous studies. Firstly, the past researches evaluate the effectiveness of banks before the extent of 2007 to 2009, but on the other hand, our research findings evaluate the efficiency of all the banks in Pakistan after the financial crisis period from 2014 to 2019. Secondarily we use the DEA approach to determine the methodological efficiency of the banks. This study has applied the CCR output-oriented model to evaluate the efficiency of Pakistani banks; through this study, we can propose an abstract structure of sustainability to measure the working performance by accumulating numerous wide-ranging sets of outputs and inputs factors to increase the technical efficiency of banks. Among the study period from 2014 to 2019, if we compare the sampled years in terms of the number of technically efficient banks, 2014 and 2015 were the years in which the maximum number of banks (12) were technically efficient, with a score of 1. While in 2017, the efficient banks were 10. 2018 and 2019 were the years in which the efficient banks were 9. On the other hand, 2016

was the year showing the least number of efficient banks, which were 8. If we compare the sampled years from 2014 to 2019 in terms of the number of technically inefficient banks, then the years in which the least number of inefficient banks (18) were in 2014 and 2015. While in 2017, the inefficient banks were 20 and 2018 and 2019 were the years in which the inefficient banks were 21. On the other hand, 2016 was the year showing the maximum number of inefficient banks, which was 22. The six banks that remained technically efficient in the whole sample period from 2014 to 2019 were Bank Alfalah Ltd, CITI Bank NA Pakistan, Habib Metropolitan Bank Ltd, Industrial Development Bank, MCB Bank Ltd, and Samba Bank Ltd. The bank that remained efficient for four years during the sample period was the Bank of Khyber. The two banks that remained technically efficient for three years during the sample period were Faysal Bank Ltd and SME Bank Ltd. In comparison, five efficient banks in 2 years were Askari Bank Ltd, Bank AL-Habib Ltd, Habib Bank Ltd, JS Bank Ltd, Summit Bank Ltd, and The Bank of Punjab. The bank that was technically efficient for one year only was MCB Islamic Bank Ltd. Albaraka Bank Ltd, Allied Bank Ltd, Bank Islami Pakistan Ltd, Dubai Islamic Bank Pakistan Ltd, First Women Bank Ltd, National Bank of Pakistan, Silk Bank Pakistan, Sindh Bank Ltd, Soneri Bank Ltd, Standard Chartered Bank Ltd, The Punjab Provincial Co-operative Bank Ltd, United Bank Ltd and Zarai Taraqiati Bank Ltd were the banks which were inefficient in the whole sample period.

Table 1. Construction of variables.

Variables	Construction of variables
Loans	The total amount of customer loans
Investment	Total investment
Non-Interest Income	It includes other operating income, net gains on derivatives, trading, and other securities, net fees and commissions, net insurance income.
Net profit	Profit after taxes
Other Earning Assets	It includes advances and loans to banks, derivatives and other securities
Deposits	Total deposits include total customer deposits (current, savings and term deposits)
Equity	Shareholder's Equity
Labour	Labour is proxies by number of employees
Operating expenses	All operating expenses like equipment, insurance, marketing, costs of inventory, rent, payroll.
Physical capital	It is measured by fixed assets
Bank size	Log of total assets.
Leverage	Debt/TA
Liquidity	Net loans/ Total deposits
Solvency	Debt/Equity
Profitability	ROA=Net income/total assets
GDP	The annual growth rate of GDP (of Pakistan)
Interest Rate	Real interest rate of Pakistan
Political Stability	Political Stability or Absence of Terrorism (measures perceptions of the likelihood of political instability)
Regulatory Quality	Perceptions of the government's ability to form and apply sound regulations and policies that stimulate the development of different sectors of the economy.

The descriptive statistics of the variables for the study period of 2014 to 2019 are given in Table 3, indicating that, on average, all the sample banks have an average technical efficiency score of 78%, a bank size of 8.4 billion approximately, in the same manner. All the sample banks of Pakistan, on average, have a leverage ratio of 39%, liquidity ratio of 59%, solvency ratio of 56%, return on assets of 0.9% approximately. The macroeconomic variable political stability has an average value of negative 2.38, Regulatory quality in Pakistan has an average value of negative 0.6, on average gross domestic product value is 4.5, and the average value of interest rate from 2014 till 2019 is 5.2 approximately. The standard deviation of technical efficiency is about 0.23, and that bank size is 0.69, the standard deviation of leverage is 13% and that of liquidity is 48%, etc. Similarly, all the explanatory variables' minimum and maximum values are mentioned in the 4th and 5th columns of Table 3. The results of correlation among the technical efficiency and all the explanatory variables, which are firm-specific variables of Pakistani banks and macroeconomic variables of Pakistan for the period 2014 to 2019, are mentioned in Table 4. The result shows the correlation between technical efficiency and bank size is 31%, with a positive association and significant at 10%. The correlation found between technical efficiency and leverage is about 51%, with a negative association that is significant at 10%. Liquidity has a 53% correlation with technical efficiency with a negative association that is significant at 10%. Solvency has 15% correlation with technical efficiency with a negative association that is significant at 10%. A positive significant (at 10%) correlation is found among return on assets and technical efficiency. The correlation of political stability and GDP with technical efficiency is positive but insignificant. The correlation of regulatory quality and interest rate with technical efficiency is negative but insignificant.

Table 2. Results of technical efficiency of Pakistani banks for the period 2014 to 2019.

No	DMU	2014	2015	2016	2017	2018	2019
1	Albaraka Bank Ltd	0.737	0.406	0.394	0.375	0.380	0.375
2	Allied Bank Ltd	0.847	0.869	0.800	0.846	0.909	0.785
3	Askari Bank Ltd	1	1	0.943	0.997	0.902	0.766
4	Bank AL-Habib Ltd	1	0.962	0.954	1	0.937	0.968
5	Bank Alfalah Ltd	1	1	1	1	1	1
6	Bank Islami Pakistan Ltd	0.936	0.601	0.494	0.483	0.451	0.621
7	CITI Bank NA Pakistan	1	1	1	1	1	1
8	Dubai Islamic Bank Pakistan Ltd	0.564	0.583	0.521	0.767	0.989	0.508
9	Faysal Bank Ltd	1	1	1	0.688	0.678	0.494
10	First Women Bank Ltd	0.542	0.697	0.498	0.775	0.757	0.810
11	Habib Bank Ltd	1	1	0.901	0.844	0.904	0.676
12	Habib Metropolitan Bank Ltd	1	1	1	1	1	1
13	Industrial Development Bank Ltd	1	1	1	1	1	1
14	JS Bank Ltd	0.955	0.862	0.832	1	1	0.872
15	MCB Bank Ltd	1	1	1	1	1	1
16	MCB Islamic Bank Ltd		1	0.313	0.424	0.473	0.346
17	Meezan Bank Ltd	1	0.603	0.570	0.598	0.652	0.760
18	National Bank of Pakistan	0.640	0.736	0.690	0.900	0.860	0.791
19	Samba Bank Ltd	1	1	1	1	1	1
20	Silk Bank Pakistan	0.359	0.371	0.377	0.397	0.371	0.499
21	Sindh Bank Ltd	0.951	0.789	0.609	0.923	0.663	0.523
22	SME Bank Ltd	0.311	0.722	0.800	1	1	1
23	Soneri Bank Ltd	0.668	0.764	0.741	0.777	0.974	0.918
24	Standard Chartered Bank Ltd.	0.666	0.730	0.442	0.581	0.657	0.922
25	Summit Bank Ltd	0.616	0.731	0.765	0.897	1	1
26	The Bank of Khyber	0.974	1	1	1	0.980	1
27	The Bank of Punjab	1	1	0.940	0.983	0.903	0.811
28	The Punjab Provincial Co-operative Bank Ltd	0.196	0.185	0.114	0.142	0.154	0.177
29	United Bank Ltd	0.716	0.764	0.745	0.874	0.774	0.658
30	Zarai Taraqiati Bank Ltd	0.831	0.629	0.625	0.621	0.647	0.643

Note: This table's second column presents the DMUs (banks) names, columns 3-8 present the technical efficiency scores of banks for the year 2014 till 2019. The banks having a score 1 are technically efficient, while the banks that have a score less than 1 are technically inefficient banks. Technical efficiency score is calculated through input and output variables through DEA.

Table 3. Descriptive statistics of dependent and explanatory variables from 2014 to 2019.

Variables	Mean	Std. Dev.	Min	Max
te	0.784	0.236	0.114	1
banksize	8.435	0.695	6.658	9.509
leverage	0.397	0.136	0.002	0.691
liquidity	0.597	0.485	0.183	3.924
solvency	0.563	0.806	0.224	8.626
roa	0.009	0.02	-0.067	0.183
Political stability	-2.38	0.094	-2.48	-2.25
Regul quality	-0.637	0.026	-0.68	-0.59
gdp	4.552	1.655	0.989	5.836
Interest rate	5.239	1.683	3.326	8.321

GMM Model Estimations and Interpretation of Results

There could be the problem of endogeneity in our model; therefore, to estimate the model, GMM estimation technique is used. As an instrument, lagged values of the variables were used. Results of the GMM model are stated in Table 5 which shows the empirical results of firm-specific and macroeconomic explanatory variables on the Technical efficiency score of banks in Pakistan (which is calculated through DEA). The coefficient of lagged regress and variable (technical efficiency) indorses the vigorous character of model specification. The significant F-

statistics confirm the joint significance of the variables. Hansen J-test is used to check the validity of instruments because of its consistency in the presence of heteroscedasticity and autocorrelation. We used the system GMM model for first and second-order correlation. Starting with the firm-specific explanatory variables, we found that the coefficient of bank size is insignificant and negative, showing that bank size has no impact on technical efficiency. Its negative sign refers to the fact that the bank managers proficiently manage the smaller banks as compared to larger ones. The significant negative value of leverage with technical efficiency depicts a negative impact of leverage on the technical efficiency of banks in Pakistan.

Table 4. Correlation of variables from the year 2014 to 2019.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) te	1.000									
(2) banksize	0.313*	1.000								
(3) leverage	-0.510*	0.127	1.000							
(4) liquidity	-0.532*	-0.358*	0.431*	1.000						
(5) solvency	-0.153*	-0.095	0.226*	0.151*	1.000					
(6) roa	0.278*	-0.034	-0.430*	-0.157*	-0.467*	1.000				
(7) politicalstabi~y	0.013	0.099	0.165*	0.029	0.018	-0.133	1.000			
(8) regulqual	-0.007	0.055	-0.036	-0.087	-0.131	-0.044	-0.115	1.000		
(9) gdp	0.027	-0.051	-0.019	-0.008	-0.041	0.044	-0.493*	0.181*	1.000	
(10) interestrate	-0.058	-0.034	-0.065	-0.047	-0.068	0.060	-0.500*	-0.022	0.569*	1.000

*** p<0.01, ** p<0.05, * p<0.1; Note: *, ** and *** denotes significance at 10, 5 and 1% levels, respectively.

Table 5. Empirical estimates of dynamic panel-data estimation, two-step system GMM.

	Coefficient	t-Statistic
lag of TE	0.589***	17.29
Firm-specific variables		
banksize	-0.053	-1.49
leverage	-0.402***	-4.98
liquidity	0.317	0.97
solvency	0.085**	2.56
roa	1.498***	4.24
Macroeconomic variables		
GDP	0.012***	4.19
interest rate	-0.001***	-4.33
political stability	-0.357	-1.45
regulatory quality	-1.652***	-8.23
Constant	2.678***	6.53
No. of Observations	149	
No. of Instruments	37	
F-test	18413.324***	
AR(2)	z = 0.08	P=0.933
Hansen-J test	20.16	P=0.738

Note: *, ** and *** denotes significance at 10, 5 and 1% levels, respectively*; *** p<.01, ** p<.05, * p<.1.*

Because if a bank takes more debt than its total assets, it may lead to not being able to pay back the debt and to pay back the debt, it will utilize more inputs and hence leads to a decrease in technical efficiency. This is consistent with the findings of (Singh and Thaker, 2020). The insignificant coefficient of liquidity refers to no impact of liquidity on the technical efficiency of banks in Pakistan. The coefficient of solvency is significant and positive, showing that there is a positive impact of solvency on technical efficiency. Its positive sign refers to the fact that the banks are proficiently managing their debt backed by equity and hence helped increase outputs and ultimately increase technical efficiency. The same relationship was evidenced by Sakouvogui (2020) on the cost efficiency of US banks. The results reveal that profitability has a statistically significant effect on technical efficiency, and its sign is positive in Pakistan. These results are similar to that of Mansour and El Moussawi (2020), Singh and Thaker (2020), Casu and Girardone (2010). The reason behind it is that when the bank earns more profit, the management will permit a bank to generate more outputs from their given inputs and, hence, increase technical efficiency.

Now moving toward the empirical results of macroeconomic variables. The results reveal that GDP has a significant positive impact on technical efficiency. The result signifies that the demand for lending increases in the growing economy. Higher economic growth (growth rate of per capita GDP) improves the business environment and lowers the bank entry barriers, and leads to an increase in intermediation opportunities and a reduction in the possibility of default by customers will lead to a decline in the banking costs and doubtful credits will also decrease and hence will lead to increase in technical efficiency. The results are inconsistent with the results of Mansour and El Moussawi (2020), Singh and Thaker (2020), Safiullah and Shamsuddin (2020), and Shayanewako et al. (2018).

The results reveal that interest rate has a statistically significant effect on technical efficiency with a negative sign. The reason behind it could be that the interest rates are frequently changing in the case of Pakistan. Due to the high-interest rate, customers will be less willing to take loans from banks, and hence output decreases which ultimately leads to a decrease in technical efficiency. For customers who have taken loans from banks, there is a possibility that the customer will not be able to pay back the loan, and in order to meet this deficiency, the bank will utilize more inputs, leading to a decrease in technical efficiency. The bank's management may not adjust its risk-weighted assets with the interest rate shock, which could lead to an increase in risky outputs from their given inputs and, hence, a decrease in technical efficiency (Mubin and Mannan, 2013). Another reason could be that due to more interest banks operational cost increases, which leads to an increase in inputs cost; by giving more compensation to their competent labor costs increases, which could disturb the balance among inputs and outputs of bank and hence leads to decrease in technical efficiency. Chortareas et al. (2012) found a negative association of interest rate with efficiency but was insignificant in the case of the Mexican banking industry.

The results reveal that political stability is insignificant however regulatory quality of the country has a statistically significant negative impact on technical efficiency. The result signifies that if the country's regulatory quality is not good, it will adversely impact technical efficiency. Higher regulatory quality improves the business environment and lowers the banking costs, smooths banking processes, and leads to an increase in intermediation opportunities and a reduction in the possibility of default by banks due to effective management of resources and hence will lead to an increase in the efficiency. Chortareas et al. (2013) evidenced a positive association between efficiency and regulatory quality. However, in the case of Pakistan, regulatory quality is not good as it has all the negative values from 2009 till 2019 that tend to decrease banks' technical efficiency. It means that due to poor regulatory quality, banking efficiency reduces.

CONCLUSIONS AND POLICY IMPLICATIONS

The objective of this study was to measure and examine the factors and determinants of technical efficiency of all the banks operating in Pakistan by using the non-parametric approach by applying DEA and GMM. DEA approach processes efficiency by applying the linear averages of outputs and inputs. The research findings contrast in numerous aspects from the previous studies. Firstly, the past researches evaluate the effectiveness of banks before the extent of 2007 to 2009, but on the other hand, our research findings evaluate the efficiency of all the banks of Pakistan after the financial crisis period from 2014 to 2019. Secondarily we use the DEA approach to determine the methodological efficiency of the banks. This study has applied the CCR output-oriented model to evaluate the efficiency of Pakistani banks; through this study, we can propose an abstract structure of sustainability to measure the working performance by accumulating numerous wide-ranging sets of financial input, output, and firm-specific variables as well as macroeconomic variables. The six banks that remained technically efficient in the whole sample period from 2014 till 2019 were Bank Alfalah Ltd, CITI Bank NA Pakistan, Habib Metropolitan Bank Ltd, Industrial Development Bank, MCB Bank Ltd and Samba Bank Ltd. Albaraka Bank Ltd, Allied Bank Ltd, Bank Islami Pakistan Ltd, Dubai Islamic Bank Pakistan Ltd, First Women Bank Ltd, National Bank of Pakistan, Silk Bank Pakistan, Sindh Bank Ltd, Soneri Bank Ltd, Standard Chartered Bank Ltd, The Punjab Provincial Co-operative Bank Ltd, United Bank Ltd and Zarai Taraqiati Bank Ltd were the banks which were inefficient in the whole sample period. From the results of GMM as explained in Table 5, it is concluded that the firm-specific determinants that have a significant negative effect on technical efficiency in the case of Pakistan are leverage. In contrast, profitability and solvency have a significant positive impact on the technical efficiency of banks. However, bank size and liquidity are found to be insignificant. Among the macroeconomic variables, GDP has a significant positive impact, whereas political stability and regulatory quality have a significant negative effect on the technical efficiency of banks in Pakistan. This research has important policy implications for regulators and managers because it focuses on maximizing output through better management of resources such as fixed assets, labor, operating expenses, deposits, and equity in order to maximize the outputs of banks, which are an investment, net profit, loans, other earning assets, and non-interest income through which the banks maximize their outputs and also through the firm-specific and macroeconomic variables. Inefficient banks may learn from technically efficient banks and have a score of one by looking at benchmarked banks they use to achieve the best output and become technically efficient. Technical efficiency scores of banks in Pakistan hold vital significance for the stakeholders (including banks employees, shareholders, customers, regulators, and investors). As these scores are calculated through multiple variables of financial performance (outputs and inputs), they could be used as a tool by stakeholders for decision-making. The strategy creators, particularly the State Bank of Pakistan, could advise the most proficient method to make banks technically efficient by keeping watch on its factors. Future studies in this area may be done using parametric approaches. Researchers can also use productivity indexes like Luenberger and Holder index based on the metric distance function, which can measure efficiency and bank productivity into account. Profit efficiency, cost efficiency, and revenue efficiency are all examples of efficiency that may be measured in this area. The greater number of inputs and outputs utilized in our research have not been examined in other nations and for other institutions that future studies may examine.

REFERENCES

Akinsoyinu, A.C., 2015. Efficiency evaluation of European financial co-operative sector. A data envelopment analysis approach. Int. J. Acad. Res. Accounting, Financ. Manag. Sci. 5, 11–21.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev. Econ. Stud. 58, 277–297.

Ayadi, R., Dabrowski, M., De Wulf, L., 2015. Economic and social development of the southern and eastern Mediterranean

countries. Economic and social development of the southern and eastern mediterranean Countries. Springer Int. Pub. pp. 1–339. doi.org/10.1007/978-3-319-11122-3.

Berger, A.N., Mester, L.J., 2003. Explaining the dramatic changes in performance of US banks: technological change, deregulation, and dynamic changes in competition. J. Financ. Intermediation 12, 57–95.

Bhatti, G.A., Hussain, H., 2010. Evidence on structure conduct performance hypothesis in Pakistani commercial banks. Int. J. Bus. Manag. 5, 174-184.

Bitar, M., Pukthuanthong, K., Walker, T., 2020. Efficiency in Islamic vs. conventional banking: The role of capital and liquidity. Glob. Financ. J. 46, 100487. doi.org/10.1016/j.gfj.2019.100487.

Bogoev, J., 2009. Banks' Risk Preferences and its Impact on the Loan Supply function: an empirical investigation for the Republic of Macedonia. J. Bus. Econ. 1, 160–203.

Casu, B., Girardone, C., 2010. Integration and efficiency convergence in EU banking markets. Omega, 38(5), 260–267.

Chapra, M.U., 2007. Challenges facing the Islamic financial industry. Handb. Islam. Bank. Chapters, in: M. Kabir Hassan & Mervyn K. Lewis (ed.), Handbook of Islamic Banking, chapter 21, Edward Elgar Publishing.

Charnes, A., Cooper, W.W., Rhodes, E., 1979. Measuring the efficiency of decision-making units. Eur. J. Oper. Res. 3, 338–339.

Chortareas, G.E., Garza-García, J.G., Girardone, C., 2012. Competition, efficiency and interest rate margins in Latin American banking. Int. Rev. Financ. Anal. 24, 93–103.

Chortareas, G.E., Girardone, C., Ventouri, A., 2013. Financial freedom and bank efficiency: Evidence from the European Union. J. Bank. Financ. 37, 1223–1231.

Claessens, S., Laeven, L., 2005. Financial dependence, banking sector competition, and economic growth. J. Eur. Econ. Assoc. 3, 179–207.

Creel, J., Hubert, P., Labondance, F., 2014. Financial stability and economic performance. SSRN Electronic J. 266800, 1–28.

Dekker, D., Post, T., 2001. A quasi-concave DEA model with an application for bank branch performance evaluation. Eur. J. Oper. Res. 132, 296–311.

Drake, L., Hall, M.J.B., Simper, R., 2006. The impact of macroeconomic and regulatory factors on bank efficiency: A non-parametric analysis of Hong Kong's banking system. J. Bank. Financ. 30, 1443–1466.

Fujii, H., Managi, S., Matousek, R., 2014. Indian bank efficiency and productivity changes with undesirable outputs: A disaggregated approach. J. Bank. Financ. 38, 41–50.

Goddard, J., Molyneux, P., Wilson, J.O.S., 2004b. The profitability of European banks: a cross-sectional and dynamic panel analysis. Manchester Sch. 72, 363–381.

Henriques, I.C., Sobreiro, V.A., Kimura, H., Mariano, E.B., 2018. Efficiency in the Brazilian banking system using data envelopment analysis. Futur. Bus. J. 4, 157–178.

Hou, Y., Iqbal, W., Muhammad Shaikh, G., Iqbal, N., Ahmad Solangi, Y., Fatima, A., 2019. Measuring energy efficiency and environmental performance: A case of South Asia. Processes 7, 325. doi.org/10.3390/pr7060325.

Ilyas, A.M., Rajasekaran, S., 2019. An empirical investigation of efficiency and productivity in the Indian non-life insurance market. Benchmarking An Int. J. 26(7), 2343–2371.

Iqbal, N., 2021. Measuring credit risk in a quantitative way for countryside microfinance institutions: Case study of China. City Univ. Res. J. 11, 253–266.

Iqbal, N., Ahmad, N., Kanwal, M., 2013. Impact of corporate social responsibility on profitability of Islamic and conventional financial institutions. Appl. Math. Eng. Manag. Technol. 1, 26–37.

Iqbal, N., Akhtar, M.R., 2015. Statistical evaluation, measuring and managing poverty in rural pakistan. Pak. J. Statist, 31(6), 709-716.

Iqbal, N., Tufail, M.S., Mohsin, M., Sandhu, M.A., 2019. Assessing Social and Financial Efficiency: The Evidence from Microfinance Institutions in Pakistan. Pakistan J. Soc. Sci. 39(1), 149–161

Iqbal, Z., Ali, H.F., Ahmad, M.B., 2018. Evaluating the efficiency of Pakistani microfinance banks through data envelopment analysis : A Non-Parametric Approach. 3, 73–85.

Kumar, S., Gulati, R., 2010. Measuring efficiency, effectiveness and performance of Indian public sector banks. Int. J. Product. Perform. Manag. 59(1), 51–74.

Mansour, R., El Moussawi, C., 2020. Efficiency, technical progress and productivity of Arab banks: A non-parametric approach. Q. Rev. Econ. Financ. 75, 191–208.

McDonald, J., 2009. Using least squares and tobit in second stage DEA efficiency analyses. Eur. J. Oper. Res. 197, 792–798.

Menor, L.J., Roth, A. V, 2008. New service development competence and performance: an empirical investigation in retail banking. Prod. Oper. Manag. 17, 267–284.

Mohsin, M., ullah Awan, R., Abbas, Q., Shair, F., 2020. Assessing Performance and Efficiency of Financial Institutions through Data Envelopment Analysis (DAE). Pakistan J. Soc. Sci. 40, 467–478.

Mubin, S., Mannan, A., 2013. Innovative approach to risk analysis and management of oil and gas sector EPC contracts from a contractor's perspective. J. Bus. Econ. 5, 149-170.

Ntwiga, D.B., 2020. Technical efficiency in the Kenyan banking sector: Influence of fintech and banks collaboration. J. Financ. Econ. 8, 13–22.

Nwanna, I.O., Ivie, G., 2017. Effect of financial leverage on firm's performance: A study of Nigerian banks (2006-2015). Int'l J. Recent Sci. Res. 8, 18554–18564.

Safiullah, M., Shamsuddin, A., 2020. Technical efficiency of Islamic and conventional banks with undesirable output: Evidence from a stochastic meta-frontier directional distance function. Glob. Financ. J. 5, 1-15. doi.org/10.1016/j.gfj.2020.100547.

Sakouvogui, K., 2020. Impact of liquidity and solvency risk factors on variations in efficiency of US banks. Manag. Financ. 46(7), 883–895.

Shayanewako, V.B., Tsegaye, A., 2018. The impact of interest rate spread on the banking system efficiency in South Africa. Cogent Econ. Financ. 6, 6(1), 1–11.

Sheeraz, M., Khattak, A.K., Mahmood, S., Iqbal, N., 2016. Mediation of attitude toward brand on the relationship between service brand credibility and purchase intentions. Pakistan J. Commer. Soc. Sci. 10, 149–163.

Short, B.K., 1979. The relation between commercial bank profit rates and banking concentration in Canada, Western Europe, and Japan. J. Bank. Financ. 3, 209–219.

Singh, P.K., Thaker, K., 2020. Profit efficiency and determinants of Indian banks; A truncated bootstrap and data envelopment analysis. Cogent Econ. Financ. 8, 1724242. doi.org/10.1080/23322039.2020.1724242.

Smirlock, M., 1985. Evidence on the (non) relationship between concentration and profitability in banking. J. money, Credit Bank. 17, 69–83.

Stewart, C., Matousek, R., Nguyen, T.N., 2016. Efficiency in the Vietnamese banking system: A DEA double bootstrap approach. Res. Int. Bus. Financ. 36, 96–111.

Subramanyam, T., Venkateswarlu, B., Mythili, G. Y., Donthi, R., Satish Kumar, V., 2020. Assessing the environmental efficiency of indian commercial banks-an application of data envelopment analysis. Adv. Mathemat. Sci. J. 9(10), 8037–8045.

Sultana, I., Rahman, M.M., 2020. Determinants of Bank Cost Efficiency: Empirical Evidence from Bangladesh. Int. J. Bank. Financ. 15, 39–71.

Tan, Y., Anchor, J., 2017. The impacts of risk-taking behaviour and competition on technical efficiency: evidence from the Chinese banking industry. Res. Int. Bus. Financ. 41, 90–104.

Teng, J., 2012. Optimal monetary noise in an economy with Bayesian consumers and risk-averse investors. J. Bus. Eco. 4(2), 200-215.

Wonglimpiyarat, J., 2014. Competition and challenges of mobile banking: A systematic review of major bank models in the Thai banking industry. J. High Technol. Manag. Res. 25, 123–131.