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Banks Efficiency Analyses in Dual Banking System

ABSTRACT

The share of Islamic banks is growing in the banking sector steadily. An increasing number of conventional banks are introducing Islamic banking services. We estimate the efficiencies of banks by applying Data Envelopment Analysis (DEA) and for bias correction, we apply the double bootstrap method. In the second stage, determinants of efficiency are analyzed. Annual data from the reports of the banks is employed for the analysis Conventional banks providing Islamic banking services are found to be performing better in terms of technical efficiency than pure Islamic and pure conventional banks. In the financial crisis period, there is no evidence of a difference in the performance of banks across all groups.

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1. INTRODUCTION

Banking is a major sector in the financial industry of an economy. It plays a role of a mediator between the fund suppliers and fund demanders. Islamic banking has shown steady growth in capturing its share of the financial system. Most Islamic banks are performing in dual banking systems of countries. In the financial crisis of 2008, many conventional banks faced difficulties. The Islamic banking industry was largely not that affected by the crisis (Yilmaz, 2009; Willison, 2009; Hasan & Dridi, 2011).

This study aims to analyze the performance of Islamic and conventional banks in Pakistan from 2003 to 2010. Banks are a significant part of the financial sector in Pakistan. There is an increasing number of conventional banks which are introducing Islamic financial services. Therefore, it is necessary to account for those banks. We will address these banks as hybrid banks in this paper.

The performance of the banks is commonly measured by estimating their efficiency. Efficiency refers to the maximizing of output in a way that minimizes the inputs. The optimal quantity would be the possible combinations of inputs and outputs that a specific bank can achieve under output maximization or input minimization conditions (Wheelock & Wilson, 1995). In this paper, we estimate the technical efficiencies of the banks. According to (Berger & Humparey, 1997), there can be three parametric approaches and two non-parametric approaches to measuring the technical efficiency of financial institutes. The three parametric approaches are the Stochastic Frontier Approach (SFA), the Distribution Free Approach (DFA), and the Thick Frontier Approach (TFA). The non-parametric approaches are Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH). The most widely used approach is DEA. Five approaches to defining the inputs and the outputs can be found in the literature: intermediation, production, asset, value-added and user cost. Most of the frontier studies in banking have adopted the intermediation approach, and some have used the production approach. To evaluate the entire bank's performance Berger and Humphrey (1997) suggested the intermediation approach be the best. Butt et al. (2018) investigated the perceptions of people and found that people do not believe the Islamic banking to be completely interest free.

The present study uses the non-parametric approach Data Envelopment Analysis (DEA) and intermediation approach to measure the efficiencies of banks. We apply the two-stage double bootstrap DEA of Simar and Wilson (2007). This approach enables us to overcome the issue of the non-statistical nature of simple DEA. In the second stage following the same approach, we analyze the environmental variables affecting the estimated efficiency score. Previous studies on this topic have not used the double bootstrap approach therefore may have biased results.

An efficiency comparison of Islamic banks working in the dual banking system would provide insights into their performance. The introduction of Islamic banking services by the already existing conventional banks has increased the competition for Islamic banks. There has been no study that considers hybrid banks as a separate group of banks. Mokhtar et al. (2006) consider only the Islamic windows of conventional banks and compare them to Islamic banks. As more and more conventional banks are offering Islamic banking products, we think it is viable to consider them separately as a full banking entity, not just their Islamic window in the efficiency analysis of the banking sector. As the introduction of Islamic banking services is likely to influence the whole operations of the banks, these hybrid banks may have more trust of the people as they have already established their reputation. It is also possible that people may not take them as Islamic banks and they lose trust.

The specific objectives of the study can be stated as:

- Determine the efficiency of all three groups of banks operating in Pakistan.
- Comparing the efficiencies across groups and bank sizes.
- Determining the impact of environmental variables on the efficiencies of all the groups.

The value added to this paper would be that it covers the whole lifetime of Islamic banks in Pakistan, so the results are more reliable. The hybrid banks introduced in this study are not used in any other study to the best of the author's knowledge. We use bank age and the number of branches to measure the impact of environmental variables on the efficiency of the banks.

The rest of the paper is structured as follows: section 2 gives a brief literature review on Islamic banks' efficiencies, section 3 discusses the methodology, and section 4 gives the details of the data used for the study. Results are discussed in section 5 and section 6 concludes the discussion.

2. LITERATURE REVIEW

Islamic banks are increasing their share in the banking industry consistently over the last few decades. Researchers are interested to compare the two banking systems from different aspects. The findings vary across the papers. On the one hand, some studies suggest Islamic banking to be more efficient and consistent than conventional banks, and others have findings opposite to this.

The nonparametric programming approach DEA used in this study to estimate the technical efficiency, and their changes over time is based upon the work of Farrell (1957). Based on the idea given by Farrell (1957), the DEA technique was introduced by Charnes et al. (1978) to estimate the technical efficiency of a unit under input orientation and constant returns to scale (CRS). Banker et al. (1984) extended the DEA technique to allow variable returns to scale (VRS). In a literature review study of 130 research papers Berger and Humphrey (1997) concluded that almost half of these studies used this approach. They also found that the average efficiency of banks is 77% average and the median is 82%, however, the statistics are significantly different across countries.

Chowdhury et al. (2021) in a study of Islamic banks of Southeast Asia concluded that efficiencies of these banks improved but still various inefficiencies are reported. Sufian et al. (2008) estimated efficiencies for 16 banks in the Middle East, North Africa, and Asia. They concluded that the efficiency of Islamic banks decreased from 2001 to 2003, increased in 2004, and again decreased in the years 2005 and 2006. Iranian banks were the most efficient banks and banks in Sudan and Gambia were found to be operating at relatively low efficiency. Analyzing 18 Islamic banks from 12 countries, through the DEA approach, Yudistira (2004) claimed that the overall efficiency of Islamic banks is very low i.e. about 10%. Islamic banks suffered but performed well after the crises of 1998-99. Middle Eastern banks showed less efficiency.

Samad and Hassan (1999) evaluate one Malaysian Islamic bank for risk and profitability with a group of conventional banks for the period 1984 to 1997. Islamic banks turned out to be less risky and the economic participation in the economy is the same for both types of banks. Mokhtar et al. (2006) estimated the efficiency of Islamic banks, Islamic windows, and conventional banks in Malaysia. The cost and technical efficiency of Islamic banks are lower but have improved more than the other counterparts. Islamic banks have higher costs and technical efficiencies as compared to Islamic windows.

Čihák and Hesse (2010) compared Islamic and conventional banking systems in different countries. They stated that large conventional banks are financially stronger than large Islamic banks, but small Islamic banks tend to be financially stronger than small conventional banks. Chong et al. (2009) argued that Islamic banks as practiced in Malaysia are not much different from conventional banks therefore for analysis should not be treated differently. Kassim et al. (2009) analyzed the impact of monetary policy shocks on conventional and Islamic banks in Malaysia through the impact of interest rate changes and found Islamic banks to be more sensitive to these shocks.

Parashar and Venkatesh (2010) analyzed the global financial crisis impact on the Islamic banking sector in GCC (Gulf Cooperation Council) countries and compared the two banking systems using five performance criteria. Islamic banks were found to be better in profitability but they suffered more in terms of the leverage ratio and capital adequacy as compared to conventional banks. Conventional banks suffered more in liquidity though. Srairi (2010) employed the stochastic frontier approach to investigate the cost and profit efficiency of Islamic and conventional banks in Gulf cooperation council countries. The results suggest on average Islamic banks are less efficient than their conventional counterparts. Saaid et al. (2003), and Shahid et al. (2010) also estimated the technical, profit, and cost efficiencies of Islamic and conventional banks for Sudan and Pakistan, and found Islamic banks to be less efficient. Hassan (2006) also got the same results of Islamic banks being less efficient for the analysis of 43 banks in 21 countries for the years 1994 to 2001.

Johnes et al. (2014) applied the DEA approach to Islamic and conventional banks in 18 countries. Their results conclude that both types of banks are performing similarly at gross efficiency scores. However Islamic banks are significantly higher in net efficiency and lower in type efficiency. The second stage analysis also seconds the results. Beck et al. (2013) found few significant differences in the business orientation of Islamic and conventional banks. Islamic banks are less cost-efficient but are better in intermediation ratio and are better capitalized. Large cross-country variations and size differences are found in the efficiencies of Islamic and conventional banks.

Islamic banks are less risky and capitalized better than there conventional counterparts, but profits of Islamic banks are estimated to be lower than the others (Majeed et al., 2021). Islamic banks are less efficient than conventional banks, and the Islamic branches of conventional banks are efficient than conventional branches (Majeed et al., 2016).

3. METHODOLOGY

In the present study, Data envelopment analysis (DEA) is used to estimate the technical efficiency (TE) scores. Data Envelopment Analysis (DEA) is a non-parametric approach to measuring the efficiency of decision-making units. In the relative measurement of the performance of banks, DEA is commonly used. Based on the idea given by Farrell (1957), the DEA technique was introduced by Charnes et al. (1978) to measure the efficiency of decision-making units under input orientation and constant returns to scale (CRS). Banker et al. (1984) extended the DEA technique to allow variable returns to scale (VRS).

DEA is a linear programming-based approach to measuring the efficiency of firms where there are multiple inputs and outputs which makes the comparison difficult. This approach uses the values of input and outputs to determine an efficiency frontier that envelops all the existing data points. Firms lying on the frontier are considered to be the most efficient ones. It gives a score of 1 to fully efficient firms and 0 to fully inefficient firms. The most efficient firm or firms does not necessarily mean that they are generating the maximum output level, but it indicates that it tends to produce best practice output among the given sample of firms.

We use the input-oriented approach under variable returns to scale for the estimation of TE:

$$\hat{\theta}(u,v) = max\{\theta|\theta v \leq \sum_{i=1}^{n} \lambda_i v_i\,; u \geq \sum_{i=1}^{n} \lambda_i u_i\,; \sum_{i=1}^{n} \lambda_i = 1;\ \ \lambda \geq 0\ \ , i = 1, \dots, n\} \qquad (1)$$

where u_i is a vector of inputs, v_i is a vector of output, and λ_i is an $N \times 1$ vector of constants. The obtained value of $\hat{\theta}_i$ will be the technical efficiency of the ith bank. A value of $\hat{\theta}_i = 1$ represents that the bank is efficient and $\hat{\theta}_i > 1$ will be the indicator of inefficient banks. The value $1/\,\hat{\theta}_i$ will define the technical efficiency score, which ranges from 0 to 1. This linear programming problem is solved n times, once for each bank. For detailed literature on this method refer to Coelli et al. (1998) and Fried et al. (2008).

As the method of DEA is a linear programming method, the issue of the statistical limitation of DEA has been raised. The estimated scores strongly depend on each other and may generate biased results. Simar and Wilson (1998, 1999) suggested a “bootstrap” method to overcome this issue and to generate good statistical properties of the efficiency scores. Bootstrap is a resampling method to obtain the statistical properties of a variable of interest. It generates a sampling distribution by mimicking the data generation process. We assume our original sample data is generated by a data-generating process and we can simulate this process by taking a pseudo data set, which is drawn from the original data set. By using this new data set we re-estimate DEA and repeat this 2000 times, which gives us a Monte Carlo approximation of the sampling distribution and helps the inference procedure

We also extend the analysis for the impact of the environmental variable on efficiency. A common approach is to use Tobit regression to estimate the impact of these control variables on the obtained technical efficiency. Simar and Wilson (2007) emphasized using a double bootstrap approach to improve the accuracy of the estimates of regression and also construct confidence intervals for efficiency scores. The regression model would be

$$\hat{\theta}_i = z_i\beta + \varepsilon_i \tag{2}$$

where z_i is a vector of environmental variables that can affect the efficiency of banks in our sample. Here β refers to a vector of parameters, ε_i denotes a noise term. The use of Ordinary Least Squares (OLS) may lead to estimation problems of correlation and endogeneity of the efficiency score, which violate the assumption of ε_i to be independent of z_i. The double bootstrap procedure of Simar and Wilson (2007) is illustrated as follows:

1. Using the original data compute $\hat{\theta}_i = \hat{\theta}(u_i, v_i), i = 1, \ldots, n$, by using the linear programming problem in equation (1).
2. Using the method of maximum likelihood obtain the estimates of truncated regression in equation (2), $\hat{\beta}$ and $\hat{\sigma}_\varepsilon$.
3. Loop the next 4 steps (a to d) L1 times to obtain a set of bootstrap estimates.
$$\theta^*_{i,l}(u_i, v_i), l = 1, \ldots, L1$$
   a. Draw ε_i^* from the $N(0, \hat{\sigma}_\varepsilon^2)$ with left truncation (1- $\hat{\beta}\ z_i$).
   b. Compute $\theta_i^* = \hat{\beta} z_i + \varepsilon_i^*\ , i = 1, \ldots, n$
   c. Construct a pseudo data set by setting $u_i^{\,*} = u_i\ , v_i^* = v_i\hat{\theta}_i/\theta_i^{\,*}$, for all $, i = 1, \ldots, n$
   d. Compute $\hat{\theta}_i^{\,*} = \theta(u_i, v_i), i = 1, \ldots, n$, by replacing (u_i, v_i) by $(u_i^{\,*}, v_i^*)$.
4. For each $i = 1, \ldots, n$, compute the bias-corrected estimator by using bootstrap estimates and original estimates. $\hat{\hat{\theta}}_i = \hat{\theta}_i - bias(\hat{\theta}_i)$
5. Use the maximum likelihood method to estimate the truncated regression of $\hat{\hat{\theta}}_i$ on z_i, yielding $(\hat{\hat{\beta}}, \hat{\hat{\sigma}})$.
6. Loop over the next three steps (a to c) L2 times to obtain a set of bootstrap estimates.
7. $\left(\hat{\hat{\beta}}_l^*,\ \hat{\hat{\sigma}}_l^*,\ \ l = 1, \ldots, L2\right)$.
   a. For each $i = 1, \ldots, n$, ε_i is drawn from $N(0, \hat{\hat{\sigma}})$ with left truncated regression at $(1 - \hat{\hat{\beta}}\ z_i)$.
   b. For each $i = 1, \ldots, n$, compute $\theta_i^{**} = z_i\hat{\hat{\beta}} + \varepsilon_i^{**}$.
   c. Use the maximum likelihood to again estimate the truncated regression of θ_i^{**} on z_i to yield estimates$(\hat{\hat{\beta}}^*, \hat{\hat{\sigma}}^*)$.
8. Construct confidence intervals by using the bootstrap efficiency scores.

4. DATA

To measure the efficiency of Islamic banking, data from 6 Islamic banks, 11 conventional banks providing Islamic banking, and 18 pure conventional banks are used. Unbalanced yearly panel data is available for the period 2003 to 2010. The main sources for the variables used in this study are various editions of Banking Statistics of Pakistan (published annually), annual and quarterly financial reports of the individual banks, the Economic survey of Pakistan, and International Financial Statistics. A detail of the variable is given in Table 1. The year-by-year breakdown of the banks in three categories is given in Table 2.

Table 1: Description of the variables

Variables	Notations	Names
Inputs	X1	Labor
	X2	Assets
	X3	Borrowing and deposits
	X4	Admin and other expenses
Outputs	Y1	Loans and advances
	Y2	Investments
Environmental	RE	Return on Equity
	RA	Return on Assets
	EI	Total Expenses to total income
	EA	Earning assets to total assets
	EE	Earning per employee
	AG	Bank age
	BR	Number of branches
	AT	Number of ATM
	DI	Dummy for Islamic banks
	DC	Dummy for Conventional banks
	DH	Dummy for Hybrid banks

Table 2: Year-wise number of banks

Types of the Banks	2003	2004	2005	2006	2007	2008	2009	2010
Islamic Banks	2	2	2	4	6	6	6	5
Hybrid Banks	3	4	6	10	10	10	11	11
Conventional Banks	21	22	21	20	20	20	18	18
Total	26	28	29	34	36	36	35	34

5. RESULTS

5.1 Efficiency

We estimated the efficiency scores for the banks included in our sample through the double bootstrap method discussed in section 3.

Table 3 contains the mean and standard deviations of the inputs and outputs used to estimate the efficiency scores from the years 2003 to 2010. The average loans and advances (Y1) have increased from 6.69 billion rupees to 28.99 billion rupees for Islamic banks from the year 2003-2010. The increase is steady except for the year 2006 when it decreased. A similar kind of trend in loans and advances is observed for hybrid banks i.e. an increase from 56.97 billion to 217.90 billion at the same time, whereas the conventional banks have not shown this trend. Their loans and advances remain almost constant over the period with little variation. Islamic banks have also shown a steady increase in output Y2, from 0.78 billion to 19.06 billion for the period 2003-2010. Hybrid banks show an increasing trend overall except for two years and their investments increased from 30.90 billion to 142.35 billion for the sample period. As of output Y1, the conventional banks have not shown any specific trend overall and decreased from 24.14 billion to 17.92 billion over the sample period.

For average inputs, i.e. labor, assets, borrowings/deposits, and admin expenses, an overall increasing trend has been observed for the Islamic and hybrid banks. For conventional banks, these input factors are nearly constant over the years, in some cases, they even show a decrease.

The year-wise individual estimated efficiency scores for the three types of the bank are presented in Appendix. These tables contain raw efficiency scores, bias-corrected efficiency scores, and confidence intervals, which we estimated by applying the methodology described in section 3.

Table 3: Descriptive statistics of banks (in billion Rupees, except X1: labour)

Years	Banks	Descriptive	Loans/adv (Y1)	Investment (Y2)	Labor (X1)	Assets (X2)	Borr/dep (X3)	Ad.ex (X4)
2003	Islamic Banks	Mean	6.69	0.78	206.50	0.46	8.45	0.20
		Std. Dev	1.00	0.62	44.55	0.44	0.42	0.09
	Hybrid Banks	Mean	56.97	55.57	4250.00	5.46	116.80	3.23
		Std. Dev	50.50	63.70	5258.93	5.13	116.23	3.83
	Conventional Banks	Mean	40.15	24.14	2916.29	3.76	72.30	1.87
		Std. Dev	59.58	49.02	4987.09	7.01	118.84	2.95
2004	Islamic Banks	Mean	9.67	0.92	358.00	0.90	13.19	0.29
		Std. Dev	3.78	0.72	216.37	0.93	4.87	0.17
	Hybrid Banks	Mean	69.57	30.90	3643.50	6.11	109.11	2.77
		Std. Dev	61.88	27.08	4365.70	6.09	95.58	3.29
	Conventional Banks	Mean	49.47	20.07	2838.45	4.17	81.31	2.07
		Std. Dev	74.60	41.62	4946.02	7.25	133.88	3.52
2005	Islamic Banks	Mean	13.58	0.85	519.00	1.39	18.76	0.47
		Std. Dev	8.71	1.07	377.60	1.60	9.89	0.35
	Hybrid Banks	Mean	127.23	45.77	6532.33	9.77	182.17	4.58
		Std. Dev	116.32	37.14	6527.86	8.91	160.54	5.04
	Conventional Banks	Mean	48.57	17.56	2728.81	4.14	72.00	1.82
		Std. Dev	76.93	36.06	4336.17	7.55	118.82	2.93
2006	Islamic Banks	Mean	11.64	1.35	625.25	1.47	15.15	0.56
		Std. Dev	13.18	1.06	529.09	1.04	16.85	0.42
	Hybrid Banks	Mean	168.51	55.98	7975.40	14.41	240.72	6.38
		Std. Dev	124.77	43.81	6497.87	12.69	179.75	5.95
	Conventional Banks	Mean	28.83	8.75	1440.95	2.54	39.40	1.09
		Std. Dev	43.40	12.30	2107.02	3.66	56.94	1.40
2007	Islamic Banks	Mean	13.39	3.69	763.50	1.88	18.15	0.77
		Std. Dev	15.19	3.51	764.64	1.36	19.98	0.67
	Hybrid Banks	Mean	182.20	86.92	8115.30	21.00	281.49	7.34
		Std. Dev	136.28	67.80	5894.86	18.76	212.59	6.26
	Conventional Banks	Mean	36.90	16.21	1824.40	4.91	54.32	1.42
		Std. Dev	50.76	24.01	2492.10	8.35	76.36	1.62

Table 3: (Continued) (in billion Rupees, except X1: labour)

Years	Banks	Descriptive	Loans/adv (Y1)	Investment (Y2)	Labor (X1)	Assets (X2)	Borr/dep (X3)	Ad.ex (X4)
2008	Islamic Banks	Mean	19.07	4.71	1117.33	2.65	24.91	1.25
		Std. Dev	19.67	4.87	1047.04	1.90	25.19	0.86
	Hybrid Banks	Mean	216.50	75.68	8492.00	25.89	310.79	9.46
		Std. Dev	164.35	53.76	5909.55	21.98	233.84	7.71
	Conventional Banks	Mean	40.58	12.05	2031.85	6.45	55.60	2.21
		Std. Dev	57.16	19.36	2694.65	9.28	79.11	2.49
2009	Islamic Banks	Mean	25.43	6.81	1387.33	3.42	35.49	1.65
		Std. Dev	26.63	8.26	1159.65	2.64	36.81	1.06
	Hybrid Banks	Mean	208.05	111.20	7871.09	26.31	335.45	9.90
		Std. Dev	162.73	67.22	5578.66	25.26	243.93	8.06
	Conventional Banks	Mean	33.57	15.82	1788.28	6.05	52.30	2.09
		Std. Dev	61.62	24.94	2859.48	10.34	86.98	2.35
2010	Islamic Banks	Mean	28.99	19.06	1721.20	4.01	54.56	2.24
		Std. Dev	21.19	20.60	1509.46	1.62	48.14	1.35
	Hybrid Banks	Mean	217.90	142.35	7934.82	28.48	375.58	11.24
		Std. Dev	164.82	93.10	5285.68	24.15	270.83	8.83
	Conventional Banks	Mean	34.17	17.92	1645.33	3.76	54.92	2.29
		Std. Dev	60.89	29.91	2875.76	4.04	90.84	2.96

Table 4: Bias-corrected average efficiency scores 2003-2010

Type of Banks	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Islamic Banks	0.775	0.748	0.783	0.784	0.719	0.812	0.804	0.755
Hybrid Banks	0.964	0.858	0.858	0.884	0.926	0.907	0.909	0.918
Conventional Banks	0.823	0.776	0.821	0.771	0.849	0.837	0.840	0.826

As we are interested in comparing the efficiency scores of three groups of banks over the sample period, table 4 presents the average bias-corrected efficiency scores. The efficiency of the hybrid banks is relatively higher than that of the Islamic and conventional banks over the sample period. The efficiency of Islamic banks was 0.775 in 2003, remained almost the same till 2006, and decreased in 2007 to 0.719, it may have happened because of the new Islamic banks entering the market.

Figure 1 presents the graphical representation of the results. We can see in the figure that except for the year 2007, all the bank groups are showing a similar trend. After 2008 efficiency declined and almost by the same ratio for all three types of banks. In 2010 the banks again show an increase in efficiency except for Islamic banks which it shows a small decrease.

Figure 1 shows that HBs are outperforming the other two types of banks in terms of efficiency in almost all years. To understand whether this difference is statistically significant, we perform a pairwise comparison of the banks (Figures 2 to 4). Here we calculated CI for the efficiencies of average banks, which we calculated by adding the three average banks in our DEA calculations of the banks (year-wise table in Appendix). Non-overlapping 95% confidence intervals mean that differences are significant at the 10% level (Bonferroni correction, Bonferroni. 1936).

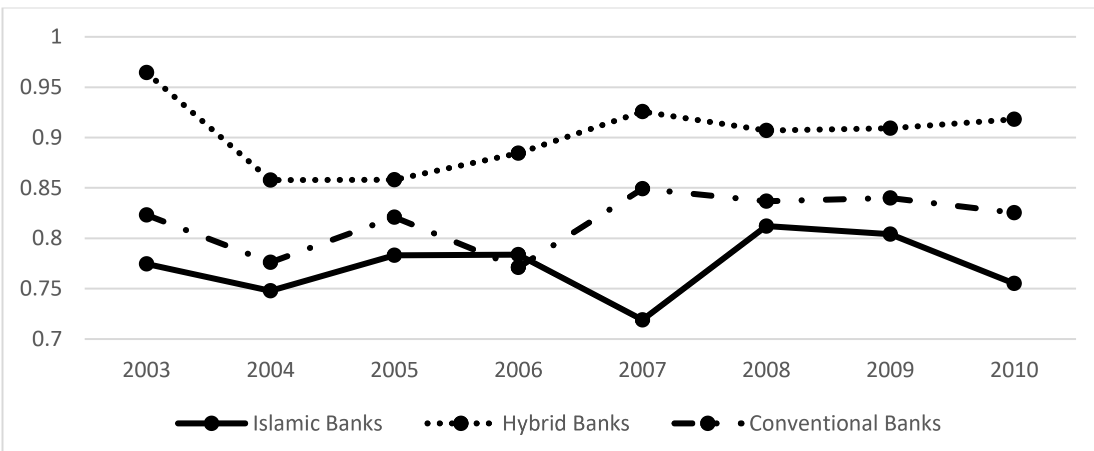

Figure 1: Bias-corrected average efficiency scores 2003-2010

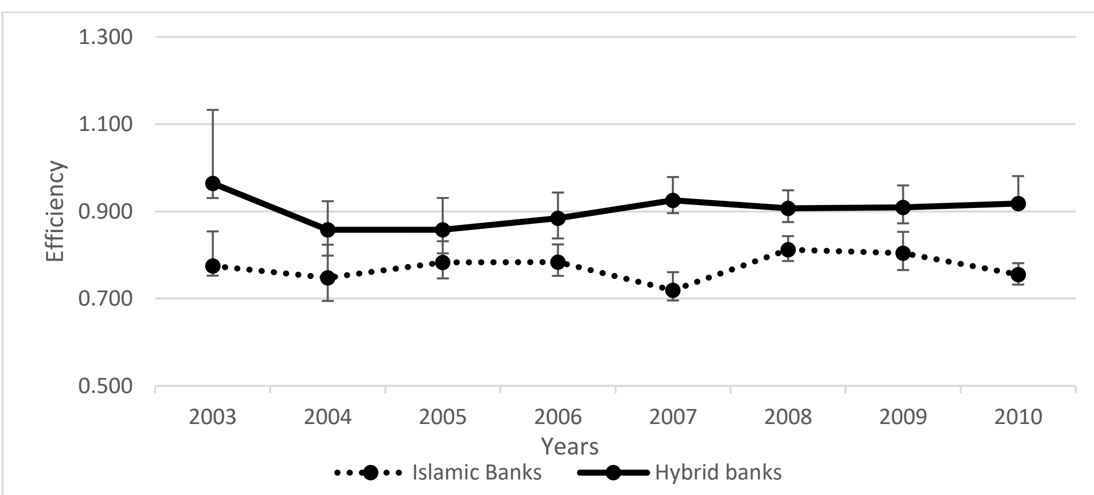

Figure 2: Comparison of efficiency among Islamic and Hybrid banks

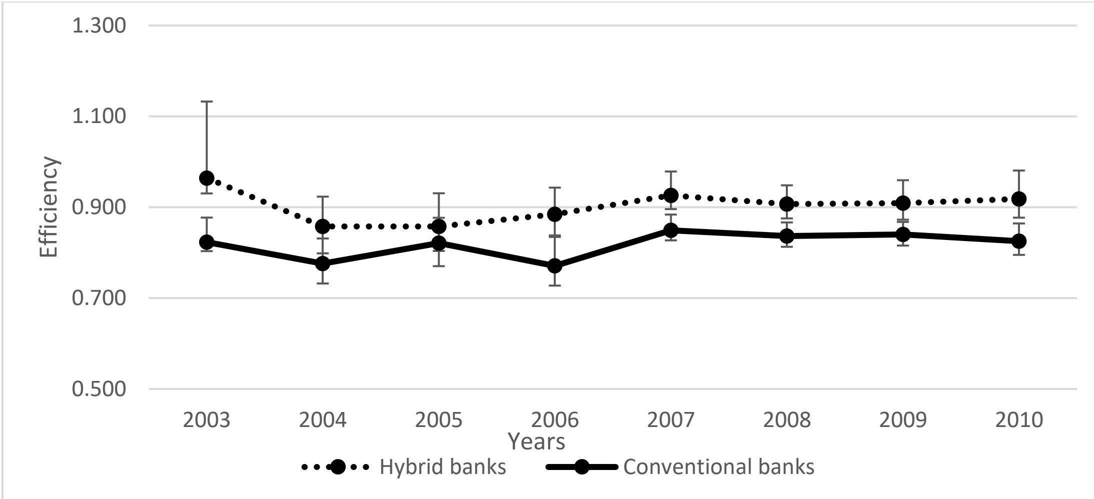

Figure 3: Comparison of efficiency among Conventional and Hybrid banks

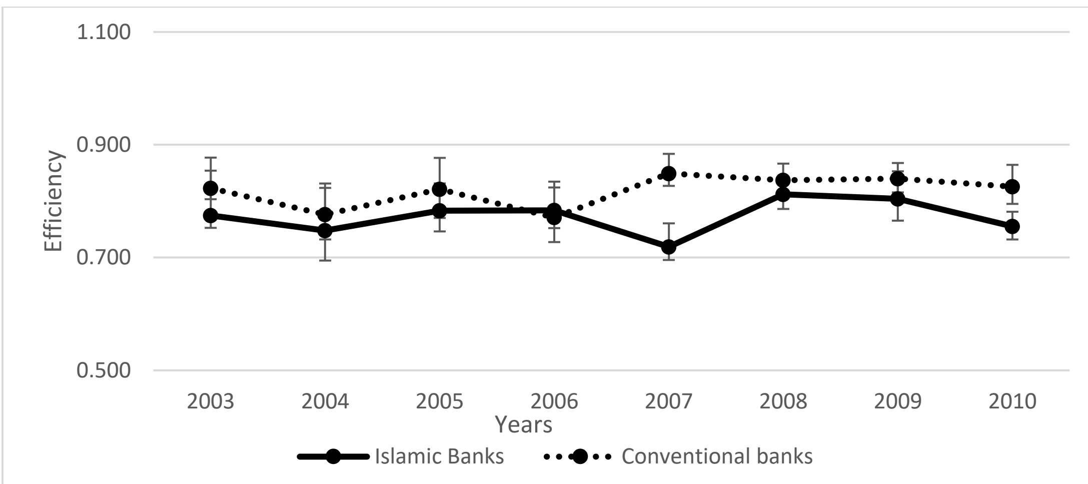

Figure 4: Comparison efficiency among of Islamic and Conventional banks

Figure 2 shows the average efficiencies of IB and HB. Here we can see that except for two years, the CI is not overlapping, and hence we can say that for most of the years, the difference between the efficiencies scores of both groups of banks is statistically significant at the 10% level. From figure 3 we can see that for Conventional and Hybrid banks, the CI are overlapping for three years from 2004 to 2006 and for the rest of the years there is a statistical difference in the efficiency scores of the two groups. From figure 4 it is clear that when we compare Islamic banks to conventional banks then we only see 2 years where the CI of the efficiency scores are not overlapping, for the rest of the years we can easily say that there is no statistical difference in their efficiency scores of both.

5.2. Determinants of the Efficiency

To determine the sources of variations in TE, the study estimates the relationship between TE and some environmental variables. We have explained the bootstrap procedure in section 3. The model is written as:

$$\hat{\theta}_{it} = \beta_0 + \beta_1 DC_{it} + \beta_1 DH_{it} + \beta_1 EA_{it} + \beta_1 EI_{it} + \beta_1 EE_{it} + \beta_1 RE_{it} + \beta_1 RA_{it} + \beta_1 AG_{it} + \beta_1 BR_{it} + \beta_1 AT_{it} + \varepsilon_{it} \quad (3)$$

where $\hat{\theta}_{it}$ is the biased corrected efficiency score. The environmental variables notations are described in table 1.

Table 5 shows the results of the truncated regression. The dummy for conventional banks (DC) and the dummy for Hybrid banks (DH) are significant and positive. This also implies a significant difference in the efficiencies of the three groups of banks presented in Table 4 and Figure 1.

Table 5: Truncated Regression

Variables	**Coefficients**	**Standard Error**
DC	0.039**	0.019
DH	0.041**	0.018
EA	-0.007	0.043
EI	-0.021	0.016
EE	0.000***	0.000
RE	0.009	0.029
RA	-0.559	0.467
AG	-0.001**	0.001
BR	0.000***	0.000
AT	0.000***	0.000
Constant	0.843	0.042

***, **, and * indicate significance at 1%, 5%, and 10% level of significance.

Earning assets to total assets (EA), total expenses to total income (EI), Return on assets (RA), and return on equity (RE) are found to be insignificant. Bank age (AG) is significant and has a negative coefficient, indicating bank age has a negative effect on efficiency, although the impact is very small. The impact of many branches (NB) and the number of ATMs (AT) is significant and positive but its magnitude is almost near zero.

6. CONCLUDING REMARKS

The number of Islamic banks has grown over the sample period and more conventional banks are offering Islamic banking products. The technical efficiency analysis by applying the double bootstrap approach has enabled us to estimate the bias-corrected efficiency score. We can conclude that hybrid banks are performing better than their other counterparts in recent years. The reason can be the trust of people in already established banks. It’s always hard to make a reputation in any business.

Islamic banks have shown a steady increase in capturing their share in the banking industry of Pakistan from 2003 to 2010. Islamic banks are almost at par with conventional banks in terms of technical efficiency. In the financial crisis period of 2008-2009, all banks suffered almost the same in terms of technical efficiency. We do not have evidence that Islamic banks were better performing in terms of technical efficiency in a crisis period, we can say hybrid banks were also a bit better off in that period too.

The environmental variable regression reveals that there is a significant difference in the technical efficiencies of the three groups of banks, and it’s not by chance. Moreover, the number of branches and number of ATMs have a significant effect, but very small in magnitude. Interestingly bank age is having a negative impact on bank efficiency, although the magnitude here is also very small.

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REFERENCES

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*(9), 1078-1092.

Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2013). Islamic vs. conventional banking: Business model, efficiency and stability. *Journal of Banking & Finance*, *37*(2), 433-447.

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European journal of operational research*, *98*(2), 175-212.

Bonferroni, C. E. (1936). Teoria statistica delle classi e calcolo delle probabilit `a. Pubblicazioni del R Istituto Superiore di Scienze Economiche e Commerciali di Firenze 8, 3--62.

Butt, I., Ahmed, N., Naveed, A., & Ahmed, Z. (2018). Determinants of low adoption of Islamic banking in Pakistan, *Journal of Islamic Marketing*, 9(3), 655-672.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*(6), 429-444.

Chong, B. S., & Liu, M. H. (2009). Islamic banking: interest-free or interest-based? *Pacific-Basin Finance Journal*, *17*(1), 125-144.

Chowdhury, M.A.M., Haron, R .(2021). The efficiency of Islamic Banks in the Southeast Asia (SEA) Region. *Future Business Journal*, 7, 16.

Čihák, M., & Hesse, H. (2010). Islamic banks and financial stability: An empirical analysis. *Journal of Financial Services Research*, *38*(2-3), 95-113.

Coelli, T., D.S.P. Rao and G.E. Battese (1998). An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers, 101 Philip Drive, Assinippi Park, Nowell, Massachusetts 02061, USA.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General)*, *120*(3), 253-290.

Fried, H. O., Lovell, C. K., & Schmidt, S. S. (2008). The measurement of productive efficiency and productivity growth. Oxford University Press.

Hasan, M., & Dridi, J. (2011). The effects of the global crisis on Islamic and conventional banks: A comparative study. *Journal of International Commerce, Economics and Policy*, *2*(02), 163-200.

Hassan, M. Kabir (2006). The X-efficiency in Islamic Banking, Islamic Economic Studies, 13(2), 49-78.

Islamic Banking, December 2010 (quarterly) Vol. 5, No. 4, Islamic Banking Department, State Bank of Pakistan

Johnes, J., Izzeldin, M., & Pappas, V. (2014). A comparison of performance of Islamic and conventional banks 2004–2009. *Journal of Economic Behavior & Organization*, *103*, S93-S107.

Kassim, S., Majid, A., & Shabri, M. (2009). Impact of monetary policy shocks on the conventional and Islamic banks in a dual banking system: Evidence from Malaysia. *Journal of Economic Cooperation and Development*, *30*(1), 41-58.

Majeed, M.T. and Zanib, A.. (2016). Efficiency analysis of Islamic banks in Pakistan, *Humanomics*, 32(1), 19-32.

Majeed, M.T. and Zainab, A.. (2021). A comparative analysis of financial performance of Islamic banks vis-à-vis conventional banks: evidence from Pakistan, *ISRA International Journal of Islamic Finance*, 13(3), 331-346.

Mokhtar, H. S. A., Abdullah, N., & Al-Habshi, S. M. (2006). Efficiency of Islamic banking in Malaysia: A stochastic frontier approach. *Journal of Economic Cooperation*, *27*(2), 37-70.

Parashar, S. P. & Venkatsh, J. (2010), How Did Islamic Banks Do During Global Financial Crisis, *Banks and Bank System*, *5*(4), 54-62.

Saaid E, Rosly SA, Ibrahim MH et al (2003). The X-Efficiency of the Sudanese Islamic banks. *IIUM Journal of Economics and Management 11*(2), 123-41.

Samad, A., & Hassan, M. K. (1999). The performance of Malaysian Islamic bank during 1984-1997: An exploratory study. *International Journal of Islamic Financial Services*, *1*(3), 1-14.

Shahid, H., Rehman, R., Niazi, G. K., & Raoof, A. (2010). Efficiencies comparison of Islamic and conventional banks of Pakistan. *International Research Journal of Finance and Economics*, *49*(9), 24-42.

Simar, L., & Wilson, P. W. (1998). Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models. *Management Science*, *44*(1), 49-61.

Simar, L., & Wilson, P. W. (1999). Estimating and bootstrapping Malmquist indices1. *European Journal of Operational Research*, *115*(3), 459-471.

Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of Econometrics*, *136*(1), 31-64.

Srairi, S. A. (2010). Cost and profit efficiency of conventional and Islamic banks in GCC countries. *Journal of Productivity Analysis*, *34*(1), 45-62.

Sufian, F., Mohamad, A. M., & Muhamed-Zulkhibri, A. M. (2008). The efficiency of Islamic banks: Empirical evidence from the MENA and Asian countries Islamic banking sectors. *The Middle East Business and Economic Review,* 20(1)

Wheelock, D., & Wilson, P. (1995). Evaluating the efficiency of commercial banks: Does our view of what banks do matter? *Federal Reserve Bank of St. Louis Review*, (Jul), 39-52.

Willison, B. (2009). Technology trends in Islamic investment banking. *Islamic Finance News*, *6*(19), 22-23.

Yılmaz, D. (2009). Islamic finance-during and after the global financial crisis. Islamic finance-during and after the global financial crisis. *IMF-World Bank Annual Meetings 2009*

Yudistira, D., (2004). Efficiency in Islamic banking: An empirical analysis of eighteen banks, *Islamic Economic Studies*, 12(1), 1-19.