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Technical Efficiency of the Banking Sector in Pakistan

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This study uses a sample of 30 banks (4 public, 18 local private and 8 foreign banks) and two stage Data Envelopment Analysis (DEA) to provide evidence on the impact of macroeconomic and bank specific factors on banks' efficiency. We first use DEA to estimate technical and scale efficiency and then Tobit regression approach to find out the impact of several bank-specific and macroeconomic factors. The results indicate that banking efficiency has improved since 2000 and that foreign banks are more efficient than local private and state owned banks; there are technological and total factor productivity growths during 1995 to 2005.

JEL Codes: G21, G28, G38, L15
Key Words: Banking, DEA, Efficiency, Regulation, Tobit regression

1. Introduction

Emerging and transition economies provide a unique opportunity to study the impact of liberalization and regulation on the performance of banking sector. Liberalization and regulating the banking industry in developing economies has an impact on the performance and efficiency of the sector. Pakistan as a developing country is in the process of building market economy institution, where the State Bank of Pakistan (SBP) has the role of establishing the rules of the game and correcting for asymmetries in the banking sector. The frequent regulatory measures create distortions that may generate inefficiencies in resource allocation and can increase transaction cost. During the last ten years, SBP has introduced several regulatory measures to fulfill several objectives such as price stability, export promotion, and above all stability of the banking sector. In our study, we analyze the impact of these measures on the efficiency of the banking industry. We consider two models that allow the study of technical efficiency by using a panel data of 30 banks operating in Pakistan during the period 1996-2005.

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The review of literature shows a wide range of studies on developing economies. Berger and Humphery (1997) show that the information on cost efficiency can provide information to analysts about their performance in resource allocation. Asaftei and Kumbhakar (2005) conclude that the evidence for the Romanian banking system shows that the "one-size-fit-all" type of regulation aimed to stabilize the banking sector has been less effective. The regulation has a positive impact on the performance of the banking sector. Regulator should focus less on compliance with regard to controlling the risk.

Burki and Niazi (2006) investigate the impact of financial reforms on banking efficiency of State-owned, private, and foreign banks in Pakistan. They find that foreign banks have better efficiency scores during 1993-1996 and confirm a negative relationship between the size of bank and its efficiency score. Leong et al. (2003) analyze the banking sector of Singapore using the Stochastic Frontier Approach (SFA) and Data Envelopment Analysis (DEA) methodologies. The study concludes that by providing more information on the characteristics of different models, this framework might facilitate research design and variable specification. There is therefore a need to experiment with a number of alternative available models and select the one that behaves according to prior expectations.

In this paper, DEA approach is applied on a sample size of 30 Pakistani banks for the period 1996-2005. First, DEA efficiency scores are obtained under Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) assumptions. At second stage, DEA efficiency scores, under VRS assumption, are regressed on banking industry specific and macroeconomic variables to find out their respective impacts. Overall, results of the technical efficiency are similar to those reported by Burki and Niazi (2006). We find that the public sector banks are inefficient; whereas, the foreign banks are relatively more efficient in Pakistan.

The paper is organized as follows. Section 2 describes the DEA model. Sections 3 and 4 report and discuss the results. Section 6 concludes the paper.

2. The DEA Model

The DEA is a linear programming based technique for measuring the relative performance of organizational units where the presence of multiple input and output makes comparisons difficult. The mathematical model is as follows:

$$
\begin{aligned}
& Max\ \ h \ = \ \frac{\sum_r u_r y_{rj_0}}{\sum_i v_i x_{ij_0}} \\
& subject\ \ to \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (1) \\
& \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \le 1, \qquad j = 1, \cdots, n(\ for\ all\ j) \\
& u_r, v_i \ \ge \varepsilon
\end{aligned}
$$

Where x is the input vector and y is the output vector. The μ and ν are variables of the problem and are constrained to be greater than or equal to some small positive quantity ε in order to avoid any input or output being ignored in computing the efficiency. The solution to the above model gives a value h, the efficiency of the unit being evaluated. If $h = 1$ then this unit is efficient relative to the others. But, if it is less than l then some other units are more efficient than this unit that determines the most favorable set of weights. This flexibility can be a weakness because the judicious choice of weights by a unit possibly unrelated to the value of any input or output may allow a unit to appear efficient.

To solve the model, we need to convert it into linear programming formulation, which is as follows:

$$
\begin{aligned}
& Max \quad h \ = \ \sum_r u_r y_{ry_0} \\
& subject\ \ to \qquad\qquad\qquad\qquad\qquad\qquad dual\ \ variable \\
& \sum_i v_i x_{ij_0} \ = 100(\%) \qquad\qquad\qquad\qquad\qquad Z_0 \\
& \sum_r u_r y_{rj} - \sum_i v_i x_{ij} \ \le 0, \quad j = 1, \cdots, n \qquad\qquad \lambda_j \qquad\qquad (2) \\
& -v_i \ \le -\varepsilon \qquad i = 1, 2, \cdots, m \qquad\qquad\qquad s_i^+ \\
& -u_r \ \le -\varepsilon \qquad r = 1, 2, \cdots, t \qquad\qquad\qquad s_r^-
\end{aligned}
$$

The dual variables $\lambda's$ are the shadow prices related to the constraints limiting the efficiency of each unit to be no greater than 1. The binding constraint implies that the corresponding unit has an efficiency of 1 and there will be a positive shadow price or dual variable. Hence, positive shadow prices in the primal or positive values for $\lambda's$ in the dual correspond to and identify the peer group for any inefficient unit.

The above models assume CRS. If we add a variable to the model, we can construct a DEA model with VRS. Variable returns mean that we might get different levels of output due to reduced performance or economies of scale. Banker, Charnes, and Cooper (1984) propose the following DEA model, which we call the BCC model.

With ε being a small positive quantity, the BCC Model is as follows:

$$\begin{aligned}
&Max\ \ h = \sum_r u_r y_{rj_0} - u_0 \\
&subject\ \ to \\
&\sum_i v_i x_{ij_0} = 100(\%) \\
&\sum_r u_r y_{rj} - \sum_i v_i x_{ij} \le u_0, \quad j = 1, \cdots, n \\
&-v_i \le -\varepsilon \quad i = 1, \cdots, m \\
&-u_r \le -\varepsilon \quad r = 1, \cdots, t
\end{aligned} \tag{3}$$

The efficiency computed from the BCC model is pure technical efficiency; whereas, the one from CRS model is an aggregate measure of technical and scale efficiency. Pure scale efficiency can therefore be defined to be CRS efficiency over BCC efficiency [Banker et al. (1984)].

In case of DEA model however selection of weights is very important as weights can change the results altogether; even a high number of units will become efficient because of change in weights. The DEA will therefore be having less ability to provide accurate results. It is also pertinent to note that a unit with the highest value of one of the outputs to one of the inputs becomes efficient. Previous research implies that the number of units evaluated is to be greater than 2 times the total number of variables. A general rule described by Banker et al. (1984) is that the number of units evaluated should be greater than 2 times the total number of variables plus output.

Another concern related to DEA is that pattern of inputs and outputs also affects the results as a consequence of structure of inputs and outputs and not due to any intrinsic efficiency. This issue can be resolved by constraining the input/output weights and can be done by assigning a minimum weight for any input and output. Limit can likewise be put on weights to have a check on miss representation of input and/or output. Any random adjustment of weights' restrictions would not be easy to support. Relationship of cost to output or inputs for the purpose of examination with reference to the particular context may however lead to acceptable restrictions on weights. Inputs and outputs can also be incorporated into the model as environmental factors.[1]

For the estimation of these non-parametric models, DEA CRS and DEA VRS, panel data would be required. We use the panel data under two different assumptions of DEA CRS and DEA VRS and calculate the average of the efficiency scores of each firm. There are several possibilities for the estimation of the DEA model; the DEA model may be estimated in the program developed by Coelli (1996) DEAP version 2.1.

2.3. DEA VRS and Malmquist Indices of Productivity Change

Panel data allows Total Factor Productivity (TFP) change to be estimated using DEA. These indices can be decomposed into technical efficiency change and technological change. The DEA program can be used to calculate the Malmquist index of productivity change [Coelli (1996)]. The Malmquist Index measures the TFP change between two data points by calculating the ratio of the distances between each data point relative to a common technology. Following Fare et al. (1989), specification of an output-based Malmquist productivity change is expressed as a geometric mean of two output based Malmquist indices as given in the following equation:

$$m_0(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{d_0^t(x_{t+1}, y_{t+1})}{d_0^t(x_t, y_t)} \times \frac{d_0^{t+1}(x_{t+1}, y_{t+1})}{d_0^{t+1}(x_t, y_t)} \right]^{1/2} \quad (4)$$

Equation (4) gives us the productivity of the production point (x_{t+1}, y_{t+1}) relative to the production point (x_t, y_t). d_0 represents the distance from the frontier. A value greater than 1 will indicate positive TFP growth from period t to period $t+1$. The index given in Equation (4) is a combination of two indices. One index uses period t technology and other uses $t+1$ period technology. The subscripts in m and d indicate that it is an output-based productivity index.

The DEAP 2.1 program developed by Coelli (1996) gives five indices in its output file. It gives technical efficiency change relative to CRS technology called as efficiency change (EFFCH), technological change (frontier shifts) abbreviated as

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[1] Environmental factors are defined as variables beyond the control of individual bank such as economic growth, inflation etc.; specifically, the macroeconomic variables.

TECHCH, pure technical efficiency change relative to a VRS technology (PECH), scale efficiency change (SECH), and Total Factor Productivity change (TFPCH).

2.4. Data and Sources

In Pakistan, there were 37 commercial banks at the end of 2005 licensed by the SBP, with majority of them having private sector ownership. For this study, we select 30 commercial banks for the period 1996 to 2005 due to the non-availability of complete time series for some banks.[2] The financial indicators are collected from the annual reports published by the banks. These indicators are largely in accordance with the International Accounting Standards (IAS). The data on macroeconomic indicators are taken from the SBP's Annual Reports.

2.5. Definitions and Measurement Issues

In order to measure the efficiency of banking sector and to find out the determinants, the selection of output and input variables is a debatable issue. There are different approaches to define and measure the variables. In Fixler and Zieschang's (1992) view the output consists of transaction services and portfolio management services that banks provide to depositors while acting as their mandatory. Again, there is a lack of consumer as bank's mandate. The most commonly used approaches to bank production are: (i) Assets approach: banks work as financial intermediates; (ii) User – Cost approach: the net revenue generated by a particular asset or liability item determines whether that financial product is input or output; and (iii) Value Added approach: liability and assets categories have some output characteristics.

Each approach has its own advantages and disadvantages. For our study, value added approach is employed. This approach enables to differentiate between various functions performed by the banks. In selecting the variables, it is important to understand the goals of the banks. Bergendahl (1998) mentions five fundamental goals of efficient bank management: profit maximization, risk management, service provision, intermediation, and utility provision.

Finally, after a comprehensive review of all available output and input variables, the variables selected for this study are presented in Table 1. Table 2 presents a list of macroeconomic and bank specific factors used for the estimation. Labor as an

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[2] Very small banks, specialized banks in terms of scope or targets, and the banks that did not exist in the later period of the sample have all been excluded from the main sample.

Table 1. DEA Output and Input Variables

CRS Outputs	VRS Outputs	Inputs
Net loan	Net loan	Operating expense
Liquid assets	Liquid Assets	Interest expense
Deposits	Deposits	Fixed assets

Table 2. Macroeconomic and Bank Specific Factors

Macroeconomic factors	Inflation rate; Per Capita Income; Stock Capitalization; Real GDP; Real GDP rate
Bank specific factors	Ownership; Net loans; Deposits; Fixed Capital; Banks' Assets to Total Assets Ratio; Loans to Total Asset Ratio; Number of Branches; Capital Adequacy Ratio; Equity to Assets Ratio

input variable could not be added in the model because the data before 2000 was not reported for several banks. Acknowledging the presence of these problems, we still hope to provide a useful framework for analyzing banking efficiency.

3. DEA Efficiency Results

The efficiency of Pakistan's banking sector is measured for the period 1996 to 2005 as a part of estimating the productivity growth in this sector. This allows us to assess the performance of the sector. Table 3 presents a summary of average efficiency results. The efficiency scores presented in Table 3 indicate that there are 17 inefficient banks under VRS and 21 under CRS assumptions. There are 20 scale inefficient banks. This confirms that there is a potential for the banks to increase their technical and scale efficiency. An efficiency score equal to 100 means that the bank is technically efficient. It implies that the bank is maximizing the output at given inputs or minimizing the inputs at given out put level depending on the methodology used to estimate the DEA model.

Table 3. Summary of Efficiency Scores

	CRS	VRS	SE
Number of efficient banks	12	16	13
Number of inefficient banks	21	17	20
Maximum efficiency	100	100	100
Minimum efficiency	64.1	66.1	74.2
Average efficiency	88.2	91.7	96.2

Source: Authors' estimates

Note: CRS, VRS, and SE mean constant returns to scale, variable returns to scale, and scale efficiency respectively.

To estimate the performance and efficiency of the banks several models with different variables are estimated. The DEA model can be estimated by choosing the option of CRS or VRS. The DEA efficiency scores under CRS suggest that on average the commercial banks can increase their efficiency by up to 12 percent. The DEA model under VRS can provide a better indication of the relative performance of the banks. The VRS results suggest that 13 out of 30 banks have 100 percent efficiency score. The 12 efficient banks in DEA CRS are also efficient under the VRS assumption. The other four banks, which were slightly inefficient in the CRS model, are efficient in the VRS model. The reason is that VRS is less restrictive and also compares firms within same sample sizes.

Table 4. Banking Efficiency Summary

Bank	CRSTE	VRSTE	Scale efficiency	Scale level
Bank 5	0.751	0.76	0.98	DRS
Bank 23	1	1	1	-
Bank 6	0.88	0.92	0.95	DRS
Bank 28	1	1	1	-
Bank 24	1	1	1	-
Bank 25	0.82	0.82	0.99	DRS
Bank 7	0.64	0.66	0.97	DRS
Bank 8	0.91	0.94	0.97	DRS
Bank 3	0.81	0.85	0.94	DRS
Bank 22	0.84	0.84	0.99	DRS
Bank 4	0.81	0.93	0.87	DRS
Bank 10	0.88	0.94	0.94	DRS
Bank 26	0.82	1	0.82	DRS
Bank 27	0.67	0.68	0.98	DRS
Bank 9	1	1	1	-
Bank 1	0.69	0.74	0.93	IRS
Bank 14	0.86	1	0.86	DRS
Bank 29	0.88	0.88	1	-
Bank 18	1	1	1	-
Bank 12	0.77	0.9	0.85	DRS
Bank 11	0.91	1	0.91	DRS
Bank 2	0.87	1	0.87	DRS
Bank 19	1	1	1	-
Bank 20	1	1	1	-
Bank 13	0.66	0.68	0.96	DRS
Bank 21	0.78	0.79	0.98	IRS
Bank 30	1	1	1	-
Bank 15	0.97	0.98	0.98	DRS
Bank 17	1	1	1	-
Bank 16	0.8	0.87	0.92	DRS
Mean efficiency	**0.88**	**0.91**	**0.96**	

Source: Authors' estimates

Note: CRSTE: technical efficiency from DEA CRS; VRSTE: technical efficiency from DEA VRS; Scale Efficiency: CRSTE/VRSTE; Scale Level: DRS and IRS are Decreasing and Increasing Returns to Scale, respectively.

On average, as given in Table 4, the banking sector is 91 percent efficient; therefore, there is an almost 9 percent inefficiency in the sector under VRS assumption. The most inefficient bank is Bank 7 (66.1). The VRS efficiency scores are better than in the CRS model because in the VRS model the banks are benchmarked against the bank of similar size. It also shows better performances of the sector as compared to the CRS model.

At this point, it is important to note that the performance and efficiency of banks may also be influenced by other factors such as number of branches, GDP, inflation, or regulatory measures taken by the central bank. The DEA itself does

Table 5. Ownership based Banking Sector Efficiency

	Bank	Efficiency
State Owned Banks	Bank 1	0.74
	Bank 2	1
	Bank 3	0.85
	Bank 4	0.93
	Average	**0.88**
Local Private Banks	Bank 5	0.76
	Bank 6	0.92
	Bank 7	0.66
	Bank 8	0.94
	Bank 9	1
	Bank 10	0.94
	Bank 11	1
	Bank 12	0.9
	Bank 13	0.68
	Bank 14	1
	Bank 15	0.98
	Bank 16	0.87
	Bank 17	1
	Bank 18	1
	Bank 19	1
	Bank 20	1
	Bank 21	0.79
	Bank 22	0.84
	Average	**0.91**
Foreign Banks	Bank 23	1
	Bank 24	1
	Bank 25	0.82
	Bank 26	1
	Bank 27	0.68
	Bank 28	1
	Bank 29	0.88
	Bank 30	1
	Average	**0.93**

Source: Authors' estimates

not accommodate the effect of such variables, but provides gross efficiency scores. To get the net efficiency, we need to analyze the impact of environmental variables, which is called second stage estimation.

The average scale efficiency of 96 percent indicates that the sector is not working at full scale. The least scale efficient bank is Bank 26 (82.3) that is quite understandable as it can increase its performance by increasing its network size and loan activities. To gain efficiency, Bank 7 should follow the policies of Bank 18 and Bank 30. Bank 7 also has the diminishing returns to scale which implies that any increase in inputs will reduce its output. The only way to improve its efficiency is therefore by reducing over employed inputs.

The DEA VRS also provides information on peer and peer weights. The inefficient banks may improve their performance by choosing the policies and managerial structure of their respective peer bank. Banks' peer and peer weights that are derived from the VRS efficiency model for the preferred model are given in Appendix (Tables A1 and A2).

The peer weights are presented in Table A1. For example, Bank 13 has 32 percent technical and 4 percent scale inefficiency. The results indicate that Bank 13 has over employed inputs. There should therefore be -77.58 slack movements. Bank 18 and Bank 30 is peer for Bank 13 with peer weights of 0.80 and 0.18. It implies that 80 percent of the Bank 18 policies are suitable for Bank 13 and 18 percent in the case of Bank 30. Similarly, Bank 12 has a peer for Bank 2 and Bank 30.

Table A2 provides the summary of output and input targets with radial and slack movement for inefficient banks. For brevity sake, the details are not given here. Table 5 presents efficiency scores on ownership basis and shows that banks are very close in efficiency scores.

The Malmquist Index of Productivity Changes

The Malmquist index of productivity change makes it possible to assess the change in TFP for the banks. Table 6 presents annual productivity change for the banks during 1997 to 2005 and decomposition of productivity changes. A value greater than 1 for Malmquist Index or any of its components indicates improvements in that source of efficiency and a value smaller than 1 means deterioration in TFP. The average growth rate in the specific source is the difference between the measured index and 1.

Table 6. TFP Growth: Summary of Annual Means

Year	Effch	Techch	Pech	Sech	Tfpch
1997	1.02	0.84	1.02	1	0.87
1998	1.02	0.95	1.01	1	1.09
1999	1.02	1.06	1.01	1	1.09
2000	0.94	1.07	0.97	0.96	1
2001	1.02	0.98	1.01	1.01	1.01
2002	0.87	1.28	0.95	0.92	1.12
2003	1.02	1.74	0.98	1.03	1.78
2004	0.91	1.21	0.97	0.93	1.11
2005	1.04	0.72	0.97	1.07	0.75
Mean	**0.98**	**1.06**	**0.99**	**0.99**	**1.05**

Source: Authors' estimates
Note: Effch, Techch, Pech, Sech, and Tfpch means efficiency change, technological efficiency change, pure efficiency change, scale efficiency change, and total factor productivity change, respectively.

On average, the TFP change is 1.05 (which is greater than 1); it indicates a 5 percent growth rate over the 9 years. The value of TFP is small when compared to the growth in other sectors of the economy despite the banking reforms, mergers, and acquisitions. The highest improvement is in technological change over the period 1997-2005 (6 percent). There was no growth in efficiency and scale level during the period of 10 years. There was 2 percent, 1 percent, and 1 percent deterioration in efficiency, pure efficiency (managerial growth), and scale level during 1997-2005 respectively.

Table 7 provides the Malmquist index summary of firms' means. It shows that Bank 12 scores the highest TFP growth. All this growth is a result of technological growth. In the sample all banks have improved the technological growth except for the Bank 28 that registered deterioration in its components of TFP.

Regarding TFP growth on the basis of ownership, the state owned bank performed well in terms of efficiency change, technological change, and TFP growth as compared to private and foreign banks. The state owned banks have highest TFP growth and there is no deterioration in the TFP components while the local private banks have highest technological growth among all banks. The foreign banks have deterioration in scale efficiency which confirms that these banks need to increase their network to improve their performance.

The highest deterioration was in local private banks and the minimum was in the state owned banks. There was 6 percent technological growth on average in all banks. The highest TFP was in the state owned bank which implies that the state

Table 7. TFP Growth in the Banking Sector, 1997 to 2005

	Bank	E	TE	PE	SE	TFP
State Owned Banks	Bank 1	1.02	1.04	1.03	0.99	1.06
	Bank 2	1	1.1	1	1	1.11
	Bank 3	0.98	1.03	0.98	1	1.01
	Bank 4	1.02	1.13	1	1.01	1.15
	Average	**1**	**1.07**	**1**	**1**	**1.08**
Local Private Banks	Bank 5	1.03	1.12	1.03	1	1.16
	Bank 6	0.98	1.07	0.99	0.99	1.05
	Bank 7	1.03	1.06	1.04	0.99	1.11
	Bank 8	0.99	1.09	0.99	1	1.09
	Bank 9	1	1.1	1	1	1.1
	Bank 10	0.85	1.02	0.85	0.99	0.87
	Bank 11	1.01	1.02	1	1.01	1.03
	Bank 12	1.02	1.15	1.01	1.01	1.18
	Bank 13	1	1.08	0.99	1	1.08
	Bank 14	1	1.11	1	1	1.12
	Bank 15	0.99	1.04	0.99	0.99	1.03
	Bank 16	0.97	1.09	0.97	0.99	1.07
	Bank 17	0.99	1.13	1	0.99	1.09
	Bank 18	0.9	1.08	0.91	0.99	0.98
	Bank 19	0.94	1.07	0.94	0.99	1.01
	Bank 20	0.98	1	0.98	1	0.98
	Bank 21	0.96	1.02	0.96	1	0.99
	Bank 22	0.95	1.15	0.97	0.97	1.09
	Average	**0.98**	**1.08**	**0.98**	**1**	**1.06**
Foreign Banks	Bank 23	0.95	1.09	0.95	0.99	1.04
	Bank 24	0.98	1.07	0.99	0.99	1.05
	Bank 25	0.97	1.05	0.98	0.99	1.03
	Bank 26	1.02	1.02	1	0.87	0.9
	Bank 27	1.04	1.06	1.04	1	1.11
	Bank 28	1	0.89	1	1	0.89
	Bank 29	1	1.03	1.01	0.98	1.03
	Bank 30	1	1.04	0.99	0.99	1.03
	Average	**1**	**1.03**	**1**	**0.98**	**1.01**
	Mean	**0.98**	**1.06**	**0.99**	**0.99**	**1.05**

Source: Authors' estimates

Note: E, TE, PE, SE, and TFP means efficiency, technical efficiency, pure efficiency, scale efficiency, and total factor productivity, respectively

owned banks are becoming more competitive. This may also be the result of prudent regulatory policies of the SBP.

The lowest TFP growth is in foreign banks (1 percent) over the period 1997-2005. It indicates that foreign banks are not expanding their activities and reluctant to develop their infrastructure and investment in Pakistan. The SBP policies of increasing number of branches will increase the technological growth of the foreign banks as well and will also increase their operations, performance, and quality of services in Pakistan.

Table 8. Impact of Ownership and Branches (Bank Specific Factors)
Dependent variable: DEA VRS Efficiency Scores

	Coefficient	S. Error	t	P>t	95% Conf.
Branches	0.0001	0	4.24***	0	0.0001
Ownership	0.0154	0.0505	0.3	0.761	-0.084
Constant	0.9911	0.0492	20.13***	0	0.8943
Sigma	0.255	0.171			
Number of observations	330				
Log likelihood	-120.04				

Note: *** denote the significant at the 1% level

Table 9. Impact of other Bank Specific Factors
Dependent Variable: DEA VRS Efficiency Scores

	Coefficient	S. Error	t	P>t	95% Conf.
Net loans	6.58E-06	1.79E-06	3.67***	0	3.06E-06
Fixed assets	-0.00014	0	-4.38***	0	-0.0002
Bank's asset to total assets ratio	0.0345	0.1262	2.74***	0.006	0.0097
Loan to total asset ratio	-0.0068	0.0034	-1.97**	0.05	-0.0136
Capital adequacy ratio	0.0583	0.0849	0.69	0.493	-0.1088
Equity to asset ratio	0.0065	0.0037	1.75*	0.082	-0.00083
Constant	0.8973	0.0382	23.49***	0	
Sigma	0.2339	0.0157			
Number of observations	330				
Log likelihood	-95.185				

Note: *, ** and *** denote the significant at the 10%, 5%, and 1% levels, respectively

4. Determinants of Banking Sector Efficiency

We also find out the determinants of efficiency of commercial banks in Pakistan through estimating a Tobit model. The reason for estimating the Tobit model is that the dependent variable (DEA VRS) ranges from 0 to 1. This approach has been adopted by other studies on efficiency determinants, such as Barros (2007). To find out the impact of environmental variables, we estimate the model into the following categories: (i) Bank Specific, ownership and branches, Factors; (ii) Other Bank Specific Factors; and (iii) Macroeconomic Environment.

4.1. Impact of Bank Specific Factors

Table 8 and 9 present the results when we control only for bank-specific variables. Ownership does matter for the banking sector performances. As evident, public ownership has negative but not statistically significant impact on the technical efficiency of the bank. This is also confirmed by the results of DEA efficiency scores that the state owned banks had highest technological growth which implies that that these banks are becoming more competitive and market oriented though the number of the state owned banks is getting smaller. This is consistent with the previous study of Burki and Niazi (2003), Pasiouras (2007) and Gringorian and Manole (2002). Dc Nicole (2000) finds that banks operating in countries with higher level of state ownership exhibits high insolvency risk.

To measure the impact of bank size on the performance of the bank, we find that there is a positive and significant impact of banking size. An increase in the number of bank branches will increase efficiency of banks performances providing room for SBP's increasing the banks' branches policy. It also broadens the service network and retail level competition in the banking industry. This result is also consistent with Burki and Niazi (2003).

In terms of Bank's assets to total assets which is proxy for bank's capital. The results indicate that the increase in bank's assets has positive impact on bank's performance. This is in line with the conventional wisdom of capital playing a role of implicit deposit insurance, which in turn encourages more deposits. The bank's share means the banks can also enjoy the economies of scale. It can play the role of a market maker on loanable funds market. Another reason for larger capitalized bank is that the depositors think the larger banks are too big to fail and therefore enjoy the credibility.

For the control variable equity to asset, profitability has positive but less significant impact on the bank's efficiency. It implies that profitability does not appear to have a major impact on efficiency. Regarding net loan it has positive and significant impact on the bank's performance. It means that technical efficiency increases with lower loan activity. Higher the net loan means business and economy is expanding and the banks have an opportunity to increase their revenue by increasing loan activities. A positive and significant impact of fixed assets on the bank's performance is also found. It means that the more capitalized banks enjoy the economies of scale and creditability.

4.2. Impact of Macroeconomic Environment

As presented in Table 10, we observe that inflation rate, per capita income, real GDP growth rate, and stock market capitalization have impact on technical efficiency of the banks. In particular, per capita income has strong negative impact on the bank's efficiency. Similarly, real GDP rate has negative impact as well.

Table 10. Impact of Macroeconomic Environment
Dependent variable: DEA VRS Efficiency Scores

	Coefficient	S. Error	t	P>t	95% Conf.
M2 GDP ratio	-0.1159	0.0045	2.57***	0.011	-0.02
Inflation rate	-0.0028	0.0054	-0.53	0.598	-0.0134
Per capita income	-0.0003	0.0001	-2.21**	0.028	0
Stock capital	-0.00004	0	-2.18**	0.03	0
Real GDP rate	-0.0163	0.0074	-2.20**	0.029	-0.309
Constant	1.119	0.04	0.04	27.94	0
Sigma	0.2596	0.017			
Number of observations	330				
Log likelihood	-127.28				

Notes: ** and *** denote the significant at the 5%, and 1% levels, respectively

One possible explanation is that under inflationary conditions banks might feel less pressure to control their inputs and therefore become less efficient. Similar to Grigorian and Manole (2002), there is a reason to believe that securities market and non bank financial institution development have negative and significant impact on the bank's performance. The reason is that the securities market development reduces the revenue based efficiency. It reduces the demand for bank loans by borrowers and customers will prefer to invest in securities rather in banks because of availability of more information.

The results also indicate a negative relationship between M2 to GDP ratio and the bank's efficiency. This is quite interesting and can be explained in the context that if the monetary growth is more than the real GDP growth this will increase the M2 to GDP ratio in the economy. Moreover, due to faster monetary expansion than real GDP, inflation is likely to accelerate that will have negative impact on efficiency of banks. As the inflation accelerate, it becomes less attractive for the depositors to place their funds with the banks and this may reduce their ability to invest/lend which may bring down their efficiency. This is particularly evident in the inflation coefficient, which though negative is statistically insignificant. Also, banks feel reduction in real interest payment as real interest rate declines due to higher inflation rate.

Thus, summarizing the results: (i) There is a positive relationship between capital adequacy and efficiency of the banks; (ii) The results suggest that there is a strong positive relationship between number of branches and the efficiency; (iii) As a result of financial liberalization, competition, and regulation, the state owned banks are emerging as more competitive and market oriented banks; (iv) The results confirm that increasing bank's assets have significant positive impact on the bank's performance; (v) The results confirm a positive but not significant relationship between higher inflation rate and banking efficiency.

6. Conclusion

The issue of efficiency is one that is considered highly important in the banking sector. High efficiency and an effective banking regulation seem to have a positive relationship. Since 1990s financial sector was liberalized with the objective to improve performance and competition in the sector. Overall, the results envisage that the banking sector improved its performance especially after 2000. In conclusion, there are ample possibilities for efficiency improvements in this sector, where there is almost 12 per cent technical inefficiency under CRS and 9 percent under VRS assumptions. It is also found that there is 4 per cent scale inefficiency in the sector.

The major reason for inefficiency is over employed inputs. The banks are using more inputs than required to get the same level of output. The results also indicate that there has been technological growth during the last ten years and as a result there is a 5 per cent TFP growth in the sector, which is low, compared to other sectors in the economy. Comparing efficiency on the basis of ownership, the results suggest that the state owned banks scored the lowest technical efficiency (88 percent) and the foreign banks have the highest technical efficiency score (93 percent) in the sample. It implies that the foreign banks are more efficient than the state owned and local private banks.

Regarding the TFP growth, the state owned banks have the highest TFP growth (8 per cent) and the foreign banks have lowest TFP growth (1 per cent). The major growth in TFP is due to technological growth (7 per cent) in the state owned banks. The highest technological growth is in local private banks (7 per cent) compared to the state owned and the foreign banks.

The results on the determinants of efficiency in the banking sector and with respect to the bank specific characteristics, we find that higher loan activity results in improving technical efficiency while lower fixed asset can have positive impact on the performance of banks. The results also provide evidence in favor of Basel II that promotes the adoption of capital adequacy standards and equity to assets ratio has positive impact. However, the latter one is significant in all our specifications. Bank capitalization has a significant positive impact on efficiency of the banks. The results confirm a positive relationship between efficiency and branches but negative for public ownership.

There are three methodological limitations in our study. First, we could not use labor as input because data on labor was not available before 2000 for several banks. Similarly, the data was also not available on several regulatory measures taken by SBP such as borrowers limit, foreign exchange exposure, and paid up capital requirements for banks. Second, in the absence of accurate measure of input prices, we have focused on technical and scale efficiency rather than cost and profit efficiency. While acknowledging these limitations, we hope that they do not significantly reduce the importance of comprehensive analysis of the relationship between efficiency and regulation in Pakistan. Third, this methodology yields efficiency scores in a relative sense. This means that banks which are declared as efficient may be highly inefficient compared to an international benchmark. This methodology will always result in declaring some banks to be efficient, even if we apply this to a set of known inefficient banks.

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Appendix

Table A1. Peers and Peer Weights

Bank	Peers					Peer Weights				
5	30	18				0.241	0.175			
23	2					1				
6	30	19	18			0.543	0.019	0.438		
28	28					1				
24	24					1				
25	18	21	30	20		0.017	0.185	0.388	0.367	
7	30	18				0.406	0.584			
8	20	30	21	18		0.002	0.101	0.733	0.152	
3	20	30	11	19		0.025	0.127	0.144	0.704	
22	18	26	20			0.513	0.305	0.18		
4	2	30	11			0.028	0.073	0.897		
10	11	5				0.24	0.658			
26	26					1				
27	21	20		30	11	0.553	0.066	0.13	0.23	
9	9					1				
1	30	19	18			0.062	0.815	0.117		
14	14					1				
29	21	18	30	2	19	0.067	0.145	0.153	0.088	0.546
18	18					1				
12	30	2				0.138	0.314			
11	11					1				
2	2					1				
19	19					1				
20	20					1				
13	18	30				0.801	0.182			
21	19	30	18			0.862	0.005	0.111		
30	30					1				
15	19	18	30	20		0.309	0.449	0.238	0.004	
17	17					1				
16	11	2	30			0.803	0.004	0.185		

Source: Authors' estimates

Table A2. Input and Output Slacks

	Output Slacks			Input Slacks		
Bank	**Net Loans**	**Liquid Assets**	**Deposits**	**Operating Expenses**	**Interest Expenses**	**Fixed Assets**
5	635.894	2610.051	0	0.00	0.00	462.496
23	0	0	0	0.00	0.00	0
6	2501.098	182.891	0	0.00	0.00	199.773
28	0	0	0	0.00	0.00	0
24	0	0	0	0.00	0.00	0
25	0	0	0	0.00	0.00	0
7	1253.424	755.973	0	0.00	0.00	97.672
8	0	0	0	0.00	0.00	86.323
3	7.088	0	0	0.00	0.00	69.182
22	0	0	0	0.00	0.00	33.156
4	1065.361	0	0	0.00	0.00	111.686
10	876.594	0	376.154	0.00	0.00	0
26	0	0	0	0.00	0.00	0
27	0	0	0	0.00	0.00	6.966
9	0	0	0	0.00	0.00	0
1	1144.496	315.667	0	0.00	0.00	0
14	0	0	0	0.00	0.00	0
29	1292.956	0	0	0.00	0.00	0
18	0	0	0	0.00	0.00	0
12	1809.657	11944.783	0	0.00	0.00	754.299
11	0	0	0	0.00	0.00	0
2	0	0	0	0.00	0.00	0
19	0	0	0	0.00	0.00	0
20	0	0	0	0.00	0.00	0
13	565.759	203.65	0	0.00	0.00	77.588
21	0	63.996	0	0.00	0.00	0
30	0	0	0	0.00	0.00	0
15	100.824	0	0	0.00	0.00	118.686
17	0	0	0	0.00	0.00	0
16	80.578	0	0	0.00	0.00	102.505
Mean	343.446	487.182	11.399			64.252

Source: Authors' estimates