International Review of Business Research Papers
Vol 4 No.1 January 2008 Pp.11-22

Analysis of Technical Efficiency in Banking Sector With Respect to Its Inputs and Outputs

Tanvir Ahmed* and Waseem Ahmad**

Pakistan is a developing country and sixth largest populous country in the world. Due to its large population size, it is a potential market for many commercial activities. The purpose of this paper is to investigate the technical efficiency of the commercial banks operating in Pakistan. For its estimation, input oriented Data Envelopment Analysis (DEA) is used. Two specifications of DEA are developed for analysis. In first specification, profit is considered as output of the commercial bank while advances, investments and lending to financial institutions (intermediate outputs) are considered as its inputs. In second specification, again profit is considered as output while number of employees, bills payable, borrowing from financial institutions and deposits and other accounts are considered as inputs of the commercial banks. After the estimation of technical efficiency from non-parametric DEA, double log regression model between technical efficiency scores and inputs used in second specification is developed to show the marginal effect of inputs on the technical efficiency scores.

Field of Research: Banking in emerging markets

1. Introduction

Pakistan is a developing country which is situated in South Asia. In its neighborhood two most populous countries of the world India and China are present. From 1980 to onward, both of these countries made a rapid progress. During the lifespan of the country, commercial banks became a major part of the financial sector and they played an important role in mobilizing savings and providing funds for day to day business operations and production.

Financial sector plays a formidable role in economic development. A very close relationship is present between financial sector growth and economic growth (Zaidi, 2005). An efficient financial sector is necessary for the optimal use of financial resources of the country. Financial sector in Pakistan has evolved from the state of nothingness.

---

*Tanvir Ahmed, Lecturer, Department of Economics, Faculty of Arts and Social Sciences, Government College University, Faisalabad. Pakistan. Email: tanvir@gcuf.edu.pk
**Waseem Ahmad, Lecturer, Department of Marketing and Agribusiness, Faculty of Agricultural Economics and Rural Sociology, University of Agriculture, Faisalabad. Pakistan. Email: waseemuaf@hotmail.com

Now Pakistan's financial sector consists of commercial banks, foreign banks, development finance institutions, micro finance companies (leasing companies, investment banks, discount houses, housing finance companies, venture capital companies, mutual funds), modarabas, stock exchanges and insurance companies.

In the financial sector of Pakistan, commercial banks are important component of the financial sector and play an important role in the financing of national economy. A modern and growing developing country requires a modern banking sector to tackle the needs of the country (Zaidi, 2005). A number of functions are performed by the commercial banks. Commercial banks receive deposits and advances loans. Banks enhance the productive capacity of the economy by mobilizing the savings of the people. At present 39 scheduled banks, 7 development finance institutions, and 5 micro finance banks are operating in Pakistan (Government of Pakistan, 2006) whose activities are regulated and supervised by the State Bank of Pakistan. The commercial banking sector consists of 4 public sector banks, 20 local private banks and 11 foreign banks (State Bank of Pakistan, 2006).

The outstanding macroeconomic performance of Pakistan in the last four years had resulted in the growth of Pakistan's economy at an average of 7.0 percent per annum (Economic Survey 2005-06). This portrayed Pakistan as a successful economy. One reason of sustaining this growth rate is high growth rate in services sector. In this sector, finance and insurance contribute significantly. In outgoing fiscal year 2005-06, Gross National Product (GNP) of the country grew by 6.6% and 23% increase in GNP was contributed by finance and insurance sector of the economy (Government of Pakistan, 2006).

In an emerging economy like Pakistan, the issue of the efficiency of commercial banks becomes very important. The term "efficiency" is a relative concept. For example, the efficiency of the banks in 2006 could be measured relative to 1990 efficiency or it could be measured relative to the efficiency of another bank in 2006. These measurements provide a framework within which commercial banks performance can be measured. This paper estimates the technical efficiency of profits of commercial banks operated in Pakistan and evaluates the marginal contribution of various inputs to the level of technical efficiency of the banks.

2. Review of Literature

Banks play an important role in the financial markets of the developing countries and it is very important to evaluate whether banks operate efficiently or not. There are many research studies that tried to look into the efficiency of banks operating within a country and across the countries.

Vassiloglou and Giokas (1990) applied DEA to evaluate the relative efficiency of commercial bank branches in Greece.

Al-Firaj, Alidi and Bu-Bshait (1993) evaluated the relative efficiency of bank branches of the largest commercial bank in Saudi Arabia by means of data envelopment analysis. One year actual input-output data of fifteen branches of the bank were used for the study. Eight inputs and seven output factors were identified at branch level on the basis of consultation and personal interviews with the administrators of the several banks. DEA enabled them to identify three inefficient branches out of fifteen branches of this bank.

Ayadi, Adebayo and Omolehinwa (1998) measured the bank performance in Nigeria by applying data envelopment analysis to the financial data of ten banks from 1991 to 1994. They used interest paid on deposits, total expenses, and total deposits as inputs while total loans, interest and non-interest incomes were considered as outputs. They found that banks in existence for long period of time were relatively efficient than other banks in the sample and banks having poor management showed bad performance and was key determinant of the bad performance of banks in Nigeria.

3. Methodology and Model Specification

Data Envelopment Analysis (DEA) technique was introduced by Charnes, Cooper and Rhodes (1978) to measure the technical efficiency of decision making units under input orientation and constant returns to scale. In input orientation, DEA model focuses on the input reduction to achieve given level of output efficiently. DEA technique was first applied in the banking sector by Sherman and Gold (1985) to evaluate operating efficiency of bank branches. Berger and Humphrey (1997) studied 122 frontier studies of financial institutions and among these studies 69 studies used non-parametric technique of frontier estimation and out of these non-parametric studies 62 used DEA.

For the understanding of DEA methodology under input orientation and constant returns to scale, assume there are C commercial banks each having I inputs to produce O outputs. For C commercial banks, X represents input matrix of all banks inputs having order I*C (each column represents the inputs used by different banks under consideration) and Y represents output matrix containing output data of all banks having order O*C (each column represents the outputs produced by different banks under consideration). For a particular p-th bank, X_p is a column vector representing measured inputs of the p-th bank and Y_p is column vector representing measured outputs of the p-th bank. The DEA linear programming problem under constant returns to scale for p-th bank's technical efficiency is specified as

$$\text{Min}_{\lambda,\theta}\ (\theta)$$
$$\text{Subject to}$$
$$Y\lambda \geq Y_P$$
$$\theta X_P - X\lambda \geq 0$$
$$\lambda \geq 0$$

In the above programming linear problem, objective is to minimize input combinations to produce specific level of output, λ is a column matrix having order C*1 and containing vector of constants only while θ is a scalar. To measure the technical efficiency of each bank in the sample, we have to estimate C times this linear programming problem.

In this paper, two different specifications of DEA are used to measure the technical efficiency of commercial banks in Pakistan. DEA specifications of inputs and outputs are inspired from the study of Thanassoulis (1993), who make a comparison of regression analysis and data envelopment analysis as alternative methods for performance assessment. He considered number of teaching units, regular patients and severe patients as outputs of the hospitals while total cost of the hospital is considered as input for DEA specification. On the same pattern, we consider outputs and inputs for the banking sector. Usually advances, investments and lending to financial institutions are considered as outputs of the bank while number of employees, bills payable, borrowing from financial institutions and deposits and other accounts are considered as inputs of the bank. But for this study we define above outputs as intermediate outputs of the bank that are used to produce final output of the commercial bank i.e. profit of the bank. So only output considered from commercial banks is profit in both specifications of DEA. Factors influencing profits in specification 1 are intermediate outputs and acts as inputs. The purpose of first specification is to show possible reduction of these intermediate outputs of the bank that can be carried out to obtain attained level of profit at technical efficient point. In this specification, number of commercial banks, number of outputs and number of inputs are 33, 1 and 3 respectively.

In the second specification of DEA, commercial banks employees, bills payable, borrowing from financial institutions and deposits and other accounts are considered as inputs. The purpose of this specification is to show possible reduction of inputs used by the commercial bank that can be carried out to obtain attained level of profit at technical efficient point. In this specification, number of commercial banks, number of outputs and number of inputs are 33, 1 and 4 respectively.

To develop relationship between estimated technical efficiency scores and considered inputs of specification 2 along with aggregate price of intermediate outputs of the banks, double log model used for this purpose is given below.

$$\ln Y_i = \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \mu_i$$

Where Y_i=Technical efficiency score obtained by i-th bank from specification 2 of DEA.

X_{1i}=Deposits and other accounts hold by i-th bank
X_{2i}=Borrowing from financial institutions by i-th bank
X_{3i}=Bills payable by i-th bank
X_{4i}=Number of Employees i-th bank have
X_{5i}=Price of intermediate output (obtained by dividing mark up/return/interest earned by total of advances, investments and lending to financial institutions)

$\beta_{1i}, \beta_{2i}, \beta_{3i}, \beta_{4i} and \beta_{5i}$ are parameters to be estimated in the regression equation by using available data and β_1 shows the percent change in Y due to one percent change in X_1 keeping all other independent variables constant. Similarly other parameters $\beta_2, \beta_3, \beta_4 and \beta_5$ also show the percent change in dependent variable due to one percent change in corresponding independent variable while keeping other independent variables constant.

Thirty six commercial banks for year 2004 were considered for the analysis and three commercial banks having negative profits for this period were excluded from analysis. So at the end 33 commercial banks were considered for analysis. Data for this study were taken from the Banking Statistics of Pakistan 2004-05, published by State Bank of Pakistan.

4. Discussion of Findings

To estimate technical efficiency under suggested specifications, Data Envelopment Analysis (Computer) Program developed by Coelli (1996) is used. Under specification 1, our objective is to study how efficiently bank uses intermediate outputs to produce profit. After analysis, 33 commercial banks included in sample obtained 28 different technical efficiency scores and among these banks, 6 commercial banks got the highest technical efficiency score (i.e. one) and the lowest technical efficiency score observed by commercial bank in the sample is 0.011. From calculated technical efficiency scores, we obtained possible reduction of banks intermediate outputs that should be carried out to achieve obtained level of profits at technical efficient point by subtracting estimated technical efficiency scores from one. Highest intermediate output reductions that should be carried out by lowest technical efficient bank to achieve obtained level of profit at technical efficient point is about 98.90 percent of currently produced intermediate outputs.

In specification 2, inputs of the commercial banks are considered as factors that produce profit. Commercial banks operating in Pakistan got 27 different technical efficiency scores under this specification of DEA and among these banks 7 got the highest technical efficiency score. Lowest technical

efficiency score obtained by a bank under this specification is 0.003 so the highest input reduction under this specification that should be carried out by that bank to achieve obtained level of profit efficiently is about 99.70 per cent of the current level of inputs.

The technical efficiency scores of commercial banks calculated under specification 1 and 2 are represented in table 1 and figure 1 while possible intermediate outputs and inputs reductions that should be carried out in both specifications are also calculated in table-1. These calculated values can be used to interpret possible intermediate output and input reductions by respective bank that it should be carried out to achieve obtained profit at technically efficient point in specification 1 and 2 respectively.

The difference in efficiency score and ranks assigned to banks under specification 1 and 2 is depicted in figure 2 and table 2. From table 2 one can see that the bank efficient in one DEA specification may not be efficient in other DEA specification and this leads to difference in ranks due to technical efficiency score of the bank. Greater difference in two efficiency score leads to greater difference in ranks as is shown in figure 2.

TABLE 1: ESTIMATED TECHNICAL EFFICIENCY SCORE OF COMMERCIAL BANKS UNDER SUGGESTED SPECIFICATIONS

Bank Number	Bank Name	SPECIFICATION-1		SPECIFICATION-2	
		Technical Efficiency	Possible Percentage Intermediate Output Reduction to Produce Obtained Level of Profit	Technical Efficiency	Possible Percentage Input Reduction to Produce Obtained Level of Profit
1	Allied Bank of Pakistan Ltd.	0.06	94.00	0.08	92.00
2	Askari Commercial Bank Ltd.	0.934	6.60	0.682	31.80
3	Bank Al Falah Ltd.	0.347	65.30	0.286	71.40
4	Bank Al- Habib Ltd.	0.435	56.50	0.327	67.30
5	Bolan Bank Ltd.	0.210	79.00	0.252	74.80
6	Faysal Bank Ltd.	0.918	8.20	0.897	10.30
7	First Women Bank Ltd.	0.524	47.60	1.000	0.00
8	Habib Bank Ltd.	0.422	57.80	0.447	55.30
9	KASB Bank Ltd	0.108	89.20	0.068	93.20
10	Meezan Bank Ltd.	0.622	37.80	0.274	72.60
11	Metropolitan Bank Ltd	0.547	45.30	0.506	49.40
12	Muslim Commercial Bank Ltd.	0.441	55.90	0.629	37.10
13	National Bank of Pakistan	0.674	32.60	1.000	0.00
14	NDLC-IFIC Bank Ltd.	0.069	93.10	0.052	94.80
15	PICIC Commercial Bank Ltd.	0.490	51.00	0.682	31.80
16	Prime Bank Ltd.	0.334	66.60	0.294	70.60
17	Saudi-Pak Commercial Bank Ltd.	0.354	64.60	0.34	66.00
18	Soneri Bank Ltd.	0.514	48.60	0.473	52.70
19	The Bank of Khyber	0.272	72.80	0.317	68.30
20	The Bank of Punjab	0.770	23.00	1.000	0.00
21	Union Bank Ltd.	0.700	30.00	0.452	54.80
22	United Bank Ltd.	0.534	46.60	0.63	37.00
23	Zarai Taraqiati Bank Ltd.	1.000	0.00	1.000	0.00
24	ABN AMRO N.V.	0.919	8.10	0.749	25.10
25	Al Baraka Islamic Bank B.S.C. (E.C)	1.000	0.00	0.404	59.60
26	American Express Bank Ltd.	0.062	93.80	0.045	95.50
27	Citi Bank, N.A.	1.000	0.00	0.769	23.10
28	Deutsche Bank AG	0.011	98.90	0.003	99.70
29	Habib Bank AG Zurich	0.433	56.70	0.43	57.00
30	Rupali Bank Ltd.	1.000	0.00	1.000	0.00
31	Standard Chartered Bank	1.000	0.00	1.000	0.00
32	The Bank of Tokyo-Mitsubishi Ltd.	0.696	30.40	1.000	0.00
33	The Hong Kong & Shanghai Banking Corporation Ltd.	1.000	0.00	0.333	66.70

Technical efficiency is estimated by using computer program DEAP developed by Coelli (1996).
*Possible percentage input reduction was estimated as (1-technical efficiency)*100*

FIGURE 1: RELATIONSHIP BETWEEN ESTIMATED TECHNICAL EFFICIENCIES SCORES OF COMMERCIAL BANKS UNDER SUGGESTED SPECIFICATIONS

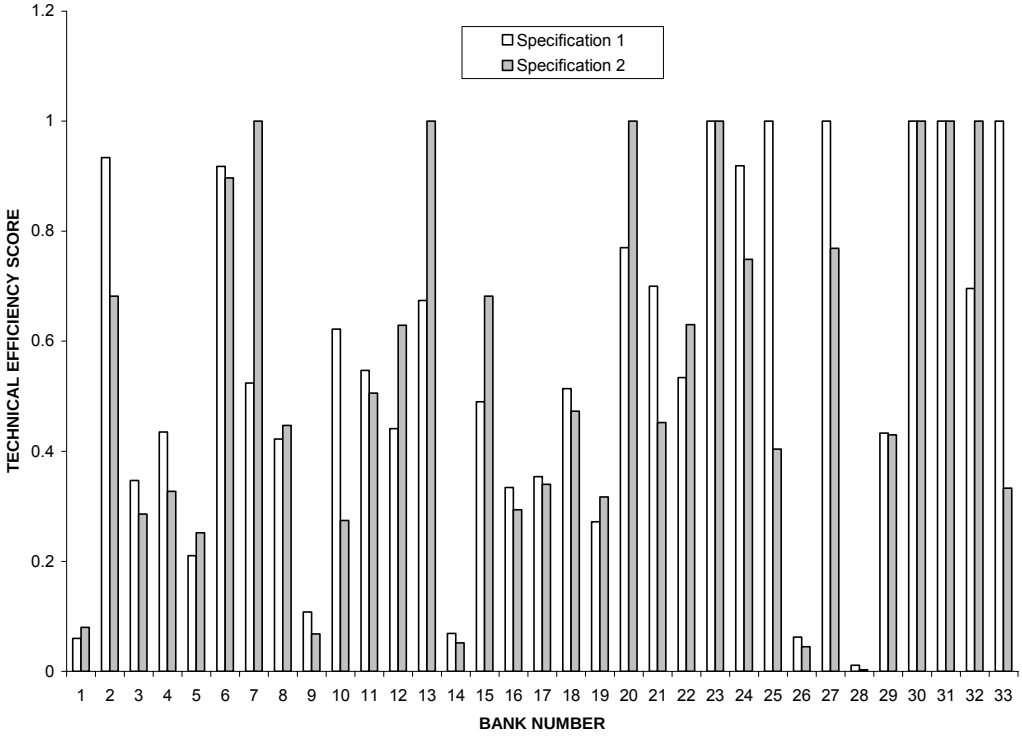

FIGURE 2: RELATIONSHIP BETWEEN DIFFERENCE IN RANK AND TECHNICAL EFFICIENCY SCORE OF COMMERCIAL BANKS

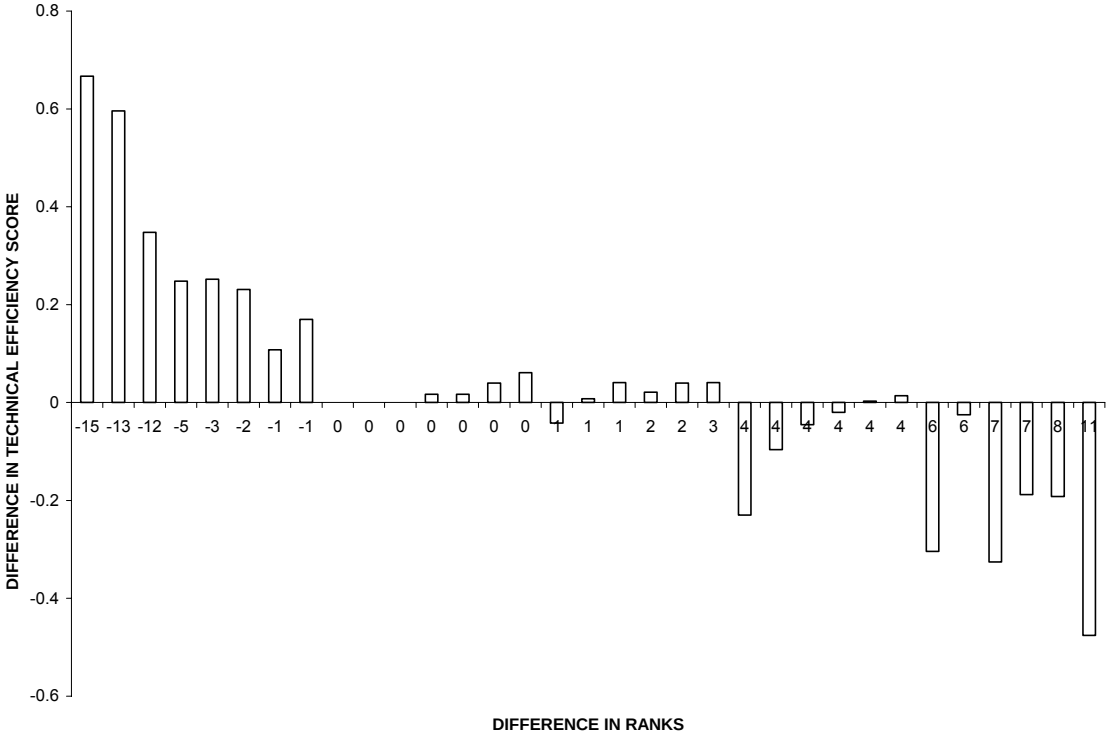

TABLE 2: DIFFERENCE IN TECHNICAL EFFICIENCY SCORE AND RANK OF COMMERCIAL BANKS UNDER SUGGESTED SPECIFICATIONS

Bank Name	SPECIFICATIONL-1		SPECIFICATION-2		Difference in Technical Efficiency Scores of Bank in Two Specifications	Difference in Ranks of Bank in Two Specifications
	Technical Efficiency Score	Rank of the Bank on the Basis of Technical Efficiency Score	Technical Efficiency Score	Rank of the Bank on the Basis of Technical Efficiency Score		
The Hong Kong & Shanghai Banking Corporation Ltd.	1.000	1	0.333	16	0.667	-15
Al Baraka Islamic Bank B.S.C. (E.C)	1.000	1	0.404	14	0.596	-13
Meezan Bank Ltd.	0.622	9	0.274	21	0.348	-12
Union Bank Ltd.	0.700	6	0.452	11	0.248	-5
Askari Commercial Bank Ltd.	0.934	2	0.682	5	0.252	-3
Citi Bank, N.A.	1.000	1	0.769	3	0.231	-2
Bank Al- Habib Ltd.	0.435	16	0.327	17	0.108	-1
ABN AMRO N.V.	0.919	3	0.749	4	0.17	-1
Zarai Taraqiati Bank Ltd.	1.000	1	1.000	1	0	0
Rupali Bank Ltd.	1.000	1	1.000	1	0	0
Standard Chartered Bank	1.000	1	1.000	1	0	0
American Express Bank Ltd.	0.062	26	0.045	26	0.017	0
NDLC-IFIC Bank Ltd.	0.069	25	0.052	25	0.017	0
KASB Bank Ltd	0.108	24	0.068	24	0.04	0
Bank Al Falah Ltd.	0.347	20	0.286	20	0.061	0
Bolan Bank Ltd.	0.210	23	0.252	22	-0.042	1
Deutsche Bank AG	0.011	28	0.003	27	0.008	1
Metropolitan Bank Ltd	0.547	10	0.506	9	0.041	1
Faysal Bank Ltd.	0.918	4	0.897	2	0.021	2
Prime Bank Ltd.	0.334	21	0.294	19	0.04	2
Soneri Bank Ltd.	0.514	13	0.473	10	0.041	3
The Bank of Punjab	0.770	5	1.000	1	-0.23	4
United Bank Ltd.	0.534	11	0.63	7	-0.096	4
The Bank of Khyber	0.272	22	0.317	18	-0.045	4
Allied Bank of Pakistan Ltd.	0.060	27	0.080	23	-0.02	4
Habib Bank AG Zurich	0.433	17	0.430	13	0.003	4
Saudi-Pak Commercial Bank Ltd.	0.354	19	0.340	15	0.014	4
The Bank of Tokyo-Mitsubishi Ltd.	0.696	7	1.000	1	-0.304	6
Habib Bank Ltd.	0.422	18	0.447	12	-0.025	6
National Bank of Pakistan	0.674	8	1.000	1	-0.326	7
Muslim Commercial Bank Ltd.	0.441	15	0.629	8	-0.188	7
PICIC Commercial Bank Ltd.	0.490	14	0.682	6	-0.192	8
First Women Bank Ltd.	0.524	12	1.000	1	-0.476	11

Technical efficiency is estimated by using computer program DEAP developed by Coelli (1996).
Rank is assigned to commercial bank on the basis of respective estimated technical efficiency score.

To see the effect of aggregate price of intermediate outputs specified in specification 1 and amount of inputs specified in specification 2 on the technical efficiency scores obtained from specification 2, result of the estimated double log regression model is give below.

$$\ln Y_i = 1.223 \ln X_{1i} - 0.169 \ln X_{2i} - 0.807 \ln X_{3i} - 0.071 \ln X_{4i} + 2.764 \ln X_{5i}$$

Standard Error	0.265724	0.143131	0.183744	0.204510	0.606042
T-Test	(4.602548)	(-1.183020)	(-4.393289)	(-0.345924)	(4.560044)

From estimated regression model, we find that the deposits and other accounts, bills for payable and price of outputs have significant impact on technical efficiency score and coefficient of these parameters are significant at 1 percent level of significance while borrowing from financial institutions and number of employees has insignificant impact on the technical efficiency scores. In above double log model, estimated β coefficients represents elasticities of technical efficiency with respect to independent variable and also shows the percent change in dependent variable due to one percent change in independent variable while keeping other independent variables constant. From analysis we found that the deposits and other accounts have significant positive impact on the technical efficiency scores of the bank. Similarly increase in price of output also has a positive impact on the efficiency estimates of the bank. So bank having large deposits and high price for their outputs are technically more efficient as compared to the banks having less deposits and other accounts and charging less price of their outputs. On the other hand bills payable have significant negative impact on the efficiency estimates, so banks having large liabilities in the form of bills payable were less efficient as compared to the banks having less bills for payable.

5. Conclusions

This study estimated technical efficiency of profit of 33 commercial banks operating in Pakistan in year 2004 under two different specifications. In specification 1, objective is to minimize intermediate output combinations used by banks to produce profit at technical efficient point while in specification 2, objective is to minimize input combinations used by bank to produce profit at technical efficient point. Results indicate that the commercial banks can improve their performance by increasing deposits and enhancing prices of intermediate outputs they produced. Commercial banks can also increase the technical efficiency estimates of profit by decreasing payable bills. So this study provides an insight to commercial banks about their technical efficiency level of profit with respect to other banks operating in the market. At the same time, it ranks the commercial banks on the basis of input used to produce profit and intermediate output produced to generate profit. Further, it provides required inputs reduction by the commercial banks that are desired to produce obtained profit at

technically efficient level in one specification while intermediate output reductions by commercial banks that they should be carried out to produce obtained level of profit at technically efficient level in other specification.

References

Al-Firaj, T.N., A.S. Alidi and K.A. Bu-Bshait. 1993. "Evaluation of Bank Branches by Means of Data Envelopment Analysis", *International Journal of Operations & Production Management.* Vo.13 No. 9, pp-45-52.

Ayadi, O.F., A.O. Adebayo and E. Omolehinwa. 1998. "Bank Performance Measurement in a Developing Economy: An Application of Data Envelopment Analysis", *Managerial Finance.* Vol. 24 No.7, pp. 5-16.

Berger, A.N. and D.B. Humphrey. 1997. "Efficiency of Financial Institutions: International Survey and Directions for Future Research", *European Journal of Operational Research.* 98:175-212.

Charnes, A., W.W. Cooper and E. Rhodes. 1978. "Measuring the Efficiency of Decision Making Units", *European Journal of Operational Research.* 2:429-44.

Coelli, T., D.S.P. Rao and G.E. Battese. 1998. An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers. USA.

Coelli, T.J. 1996. "A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program", CEAP Working Paper No. 8/96. Department of Econometrics, University of New England, Armidale. Australia.

Government of Pakistan. 2006. Pakistan Economic Survey, Economic Advisor's Wing, Finance Division, Islamabad.

Sherman, H.D. and F. Gold. 1985. "Bank Branch Operating efficiency: Evaluation with Data Envelopment Analysis", *Journal of Banking and Finance.* Vol. 9 No. 2, pp. 297-315.

Sherman, H.D. and F. Gold. 1985. "Bank Branch Operating efficiency: Evaluation with Data Envelopment Analysis", *Journal of Banking and Finance.* Vol. 9 No. 2, pp. 297-315.

State Bank of Pakistan. 2005. Banking Statistics of Pakistan 2004-05, Karachi.

State Bank of Pakistan. 2006. BSR-Banking System Review for the year ended December 31, 2005, Karachi.

Thanassoulis, E. 1993. “A Comparison of Regression Analysis and Data Envelopment Analysis as Alternative Methods for Performance Assessments”, *Journal of Operational Research Society.* Vol. 44 No.11, pp-1129-44.

Vassiloglou, M. and D. Giokas. 1990. “A study of the Relative Efficiency of Bank Branches: An Application of Data Envelopment Analysis”, *Journal of Operational Society.* Vol. 41 No.7, pp-591-7.

Zaidi, S.A., 2005. Issues in Pakistan’s Economy, Oxford University Press, Karachi, Pakistan.