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Efficiency Measurement in Yemeni Banks Using DEA Pre- and Post-Financial Reforms

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Abstract

By using data envelopment analysis DEA to examine the efficiency and productivity of commercial and Islamic banks in Yemen. A new liberal economic policy was adopted in Yemen to promote financial market development and increase the efficiency and productivity of the financial sector by fostering competition among banks. The aims of this analysis are to identify the change in Yemen banks' efficiency and productivity following the program of deregulation initiated by the government in 1995. Results show there is not sufficient evidence to refute that financial reforms have contributed to improving the efficiency of Yemen banking industry in the short-term. However, the recorded efficiency trends in different types of banks suggest that banks may gain efficiency improvements in the long-term from reforms. Consequently, pur-technical efficiency consistently dominates the technical efficiency and scale efficiency of Yemen banks.

***Keywords*:** Yemen; banking; efficiency; productivity; deregulation.

1. Introduction

During the last two decades was great interest by researchers on measuring efficiency bank using the latest methods modern, the countries that have worked in the administrative financial reforms Establishments that have had the largest share of interest in these studies, this was of concern because of its financial and banking institutions from the control of state-owned enterprises on the freedom of the market and the banking business. For example, government ownership of banks is very common in emerging markets where, after decades of excessive government regulatory controls and dominance of foreign, state-owned banks, and private banks have recently been allowed to compete freely.

Based on that, liberalization and reforms have been introduced in many developing countries, including Yemen to address a similar set of issues. Under this approach commercial banks have been allowed to compete freely with Islamic banks. Financial reform, in general, involves replacing one deeply flawed system characterized by heavy government intervention with another with different flaws. Whether these changes will improve the allocation of savings and investment is fundamentally an empirical question.

In addition to what has previously mentioned there are many reasons explaining the main reason for the attention of researchers in Yemen and the world about the importance of study and research performance of banking, which include the following:

First, there is a strong desire to know the potential impact of government policies on efficiency. Second, the banking sector of the developing economies is beginning to face stronger competition due to the globalization of the financial system. Third, the introduction of central bank policies will depend on the competitive structure and efficiency of the banking system in the future in this relatively small but open economy. Fourth, Yemen intends to be part of the Gulf Cooperation Council (GCC) and this requires the banking industry to be financially efficient and productive.

Hence, an efficient financial intermediation system is a prime requirement for a country’s economic development. Consequently, improvement in real returns in the economy may result in higher savings which would, in turn, lead to better resource generation. Thus, the development of the financial system is essential for the enhancement of productivity and economic growth of a country and the development of a financial system is crucial.

2. Objectives of Financial Reforms and Deregulation

The financial and monetary policy set out to achieve its reforms for financial liberation based on the steps designed by the Ministry of Finance and the Central Bank of Yemen in 1995, which are represented by:

- Determination of the ceiling of non-developmental expenditures.
- Amendment of custom tariff law to be appropriated with the law of investment.
- Amendment of income tax laws and facilitates the collection procedures.
- Preserve the local currency exchange rate with lessens the limits of currency exchange in the local market.
- Reduce the public expenditure and optimal use of the financial resources available.
- The debited rate of interest liberation.
- Abolish the easy interest on the loans provided for the public corporations.
- Low the official and custom exchange rate.
- Determine the low benchmark deposit rate between 20 – 22%.
- Issuance of treasury notes for one month, beginning of December 1995.
- Abolish the official exchange rate and unify the exchange rate according to the market movement. In 1997, the Central Bank issued the procedures including:
- Reduce the deposit rate gradually from 27%, -22% and –14% to 11% and –10%.
- Reduce the reserves from 25% and -15% to 10%.

3. Methodology

The purpose of the study is to assess and study the efficiency of the Yemeni banking sector from 1992 to 2007. It is 16 years of the existence of the banking sector since the achievement of the Yemen Republic, which calls study, assessment and finding out productivity efficiency of this vital sector which contributes to the acceleration of development protests. Using the same starting point the study depended on tracing efficiency of Yemen banking industry by analyzing the stage of the study by using DEA.

3.1 Data Envelopment Analysis (DEA)

To measure bank efficiency this study uses data envelopment analysis, it is linear programming that produces best border applications (among influencing factors) composed of decision-making units (DMU). This technique was invented by Charnes, Cooper and Rhodes, (1978) to assess non-profit making corporations of the public sector.

The first to put efficiency conditions on decision-making units was Ali A. (1994). He clarified those decision-making units are efficient if it was found, that there was no unit or combinations of the unit having a linear relationship that produces the same outputs. In other words, it is not necessary that the (input) be equal to (outputs) while (input-oriented model) indicated that the outputs might be smaller than or equal to the number of inputs or vice versa.

3.2 Methodology and Models used in the study

This paper uses a research framework which comprises two stages to estimation and decomposition of bank efficiency and productivity.

First Stages (IA)

Examine efficiency and of individual banks for each year. The estimated using a non-parametric frontier approach called data envelopment analysis (DEA). Using constant and variable return to scale DEA models, technical efficiency, scale efficiency, and pure technical efficiency are estimated. Furthermore, descriptive statistics, together with Mann- Whitney test scores, are used to identify the efficiency differences in different forms of banks. Malmquist productivity indices (MPI) are used to examine the productivity improvements recorded from different sources during the study period.

So, standard constant return to scale CRS and variable return to scale VRS DEA models that involve the calculation of technical and scale efficiencies (where applicable). The methods are outlined in (Fare, Grosskopf, and Lovell (1994)). The application of Malmquist DEA methods to panel data to calculate indices of total factor productivity (TFP) change; technological change; technical efficiency change and scale efficiency change (Fare, Grosskopf, Norris and Zhang 1994).

Charnes et al. (1978) extended the single input-output model of Farrell (1957) to a multiple input-output generalizations. The technical efficiency is measured as the ratio of virtual output produced to virtual

input used. Known as the CCR model (after their names) Charnes et al. (1978) popularized the application of Data Envelopment Analysis (DEA)1

There are a number of papers that describe the methodology of DEA as applied to the bank. Let us say that there are N banks. Let xi represent the input matrix of the ith bank, and yi represent its output matrix. Let the KxN output matrix be denoted X and the MxN input matrix be denoted Y.

The efficiency measure of each of the N banks is maximized by the DEA searching for the ratio of all weighted outputs overall In the first stage DEA specimen was adopted to determine the technical efficiency of licensed commercial banks in Yemen supposing that input oriented constant return to scale (CRS) according to the standard formula of the following equation Maghtereh, (2004):

Min θ = θCRS

$$-y_{it} + \sum_{j=1}^{n} \lambda_i y_{ir} \geq 0, r = 1 \ldots M$$

$$\theta x_{is} - \sum_{j=1}^{n} \lambda_j x_{js} \geq 0, s = 1 \ldots K$$

Such that

$$\lambda_i \geq 0, \; j = 1 \ldots N \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Whereas: (Θ) Measurement unit of efficiency (scalar) λ= is (N X 1) vector of constants yi =represent its output matrix, Xi = represent the input matrix of the ith bank. The value of (Θ) calculated by linear programming technique for DEA is the degree of efficiency of observation. (i) The value of (Θ) is in the range (0-1). If the value of the degree of efficiency is (Θ) = 1, it points to a point on (frontier), and subsequently, observations (i) is of high efficiency relevant to the sample. Equation (1) above must solve a number of (N) of times, once for each observation in the specimen (One of the problems of linear programming to DEA approach) also an equation. (1) Above proposed constant return in relation to (CRs) for each observation of the specimen. We also find that it did not take into consideration the factors which make companies alone outside the specimen of the inputs (θxis) and outputs Yir. An example is inefficiency resulting from the level of operation in frameworks increasing return (IR) or (decline return) due to the existence of determinations of size.

The second phase is an analysis of the degree of analysis (Θ) more than equation no. (1) Which exclude supposition of constant returns (non-CRs) that requires an additional equation of DEA equation to determine escape efficiency the equations is (4.1). It is solved without (unit frontier) for example the determinant for the output group $\sum j\lambda$ j = 1 was cancelled. This process enables comprises to appear in their budgets. But increase in returns for (increasing returns to scale (IRS) or reduction in returns (decreasing returns to scale) or (constant return to scale (CRS). for more details about this model, we follow Charnes, A., Cooper, W., Lewin, A.Y., and Seiford, L.M. (1997).

In short equation we can calculate as:

TECCR = PTEBCC × SE

SE = TECCR ÷ PTEBCC

Where: TECCR = Technical efficiency, PTEBCC= Pur technical efficiency, SE = Scale efficiency

The input-oriented model:

- **Constant returns-to-scale:**

This is the CCR (Charnes-Cooper-Rhodes) model, see2. We obtain the technical efficiency θ* for each unit j=1... N by solving the following linear programming problem (stages I):

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1 Tavares 2002) produces a bibliography of DEA (1978-2001), There are 3203 DEA authors whose studies cover a wide range Of fields. Banxia.com also compiles DEA papers from 1978 until present

2 Charnes, A., Cooper, W., Lewin, A.Y., and Seiford, L.M. (eds.) (1997). Data Envelopment Analysis - theory, Methodology and Applications, Dordrecht, the Netherlands, Kluwer.

Min θ,

$$\theta x_o - x\lambda \geq 0$$

S.t $$-y_o + y\lambda \geq 0$$

$$\lambda \geq 0 \qquad \text{.. (2)}$$

In the above, if k is the number of inputs and m the number of outputs: x^0 and y^0 are the (kx1) and (mx1) input and output vectors for the target unit j, X and Y are the (kxn) and (mxn) input and output matrices and λ are the (nx1) peer weights (lamdas) vector.

First stages (I, B) Model Productivity measurement

The second measurement in the first stage is to examine the productivity of individual banks for each year. The main obstruction of the DEA approach is that the efficiency scores obtained from an exacting sample are confined to that particular sample and cannot be compared with another sample in a different time period. This limitation does not allow the measurement of productivity growth, which allows for improvement in efficiency as Well as technical progress. The idea of comparing the input of a decision-making unit over two periods of Time period (1) and period (2) by which the input in period 1 could be decreased holding the same level of output in period 2 is the basis of the Malmquist Index.Fare et al. (1994) developed a Malmquist productivity measures using the DEA approach based on constant returns to scale. The Malmquist productivity index (M) enables Productivity growth to be decomposed into changes in efficiency (catch-up) and to Changes in technology (innovation). Alternatively, the technology in period (1) base period can also be used as reference technology. This is the approach taken by Casu et al. (2004), Wheelock and Wilson (1999) and Fare et al. (1994).

The Malmquist index (M) of total factor productivity change is the geometric mean of the two indices based on the technology for periods 1 and 2 respectively. In other words:

$$M = \left[\frac{d_1(y_{1,} x_1) d_2(y_{1,} x_1)}{d_1(y_{2,} x_2) d_1(y_{1,} x_1)} \right]^{\frac{1}{2}}$$

An equivalent way of writing (2):

$$M = \frac{d_1(y_{1,} x_1)}{d_2(y_{2,} x_2)} \left[\frac{d_2(y_{1,} x_1) d_2(y_{1,} x_1)}{d_1(y_{2,} x_2) d_1(y_{1,} x_1)} \right]^{\frac{1}{2}} \qquad \text{.................... (3)}$$

Or M = ET

Where: M = the Malmquist productivity index, T = a measure of technical progress measured by shifts in the frontier from period 1 and 2 (the two ratios in the square bracket),D= the input distance function, E = a change in efficiency over the period t and t+1 (the term outside the square bracket)When the reference technology is based in period 2 as in (3), then M < 1 means that there has been a positive total factor productivity change between periods 1 and 2. This study relies on a non-parametric DEA approach. Respective MPIs are estimated using 'DEA-Solver software' developed by Kaoru Tone. Both VRS and CRS approaches have been applied in applications on productivity changes (Krishnasamy, 2004; Mukherjee, Ray and Miller, 2001). MPI estimated using the CRS approach ignores the difference in size between DMUs in the sample, thus providing relatively higher discriminatory power when using a Small sample. Therefore, this study is limited to the CRS-based MPI. Respective MPIs are estimated from individual year data to facilitate the estimation of productivity and technical and technological changes.

Input-Output

Selection of input-output has a material effect on the results, nevertheless there is accuracy in selection of variables because of the reliability of data, for example, the variables (VARs) is comprised of different information despite it bears the same labels, or the same information may be reported with different names. This problem is due to the absence of standards of reports related to the banking industry. In this study, our election of variables depended on the classical view. In literature, there are two main approaches in the classification of input-output that may be specified as follows, Cinea, (2002) Production approach and Intermediate approach.

- **Production Approach**

The financial institution is known as a service product for accounts owners, that it makes exchanging on account expense of deposits and tackle the loans documents. Based on this approach, a number of accounts for different loans and deposits categories may be considered the appropriate classification of production Ferriers, (1993).

- **Intermediation approach**

Intermediation institutions are to transfer and transmit the financial assets from surplus units to deficit units. Using this approach, subsequently, the production is known as the value of all assets categories from which it obtains the interest in the balance sheet, while the borrowed deposits and assets as well as capital and labor as inputs. Ferrier, (1990) indicated that the production approach is a favorite one when the objective is cost adequacy, because this approach concentrates on operational costs of banks from one part, the intermediate approach take an interest in the total cost of banks which is favorably used in our study for it is favorite at studying the economic ability for development in banks. In our study, the main attention is to assess the adequacy and effectiveness in the Yemeni banking sector. The researcher applied the intermediate approach sue to it is harmonize with at what the study results are aimed, that the banks are viewed as financial intermediation, and due to the commercial banks in Yemen are characterized y legal and legislative variables occurred because of financial reform program started in the year 1995. See Sealley and Lindley (1977); Berger and Humphrey (1992); Lightener and Lovell (1998); Iqbal and Molyneux (2005). Also, the banks are using inputs: labor, deposits, and capital…etc. to produce outputs: revenue assets such as (liquid assets, loans, and investments) are off – balance sheet activities and other services.

Selection of Input-Output:

By using approach of Cinea, (2002), the number of inputs were estimated with three variables to complete the analysis, as follows: labor, paid capital and the last approach is the total value of deposits, and the number of outputs was estimated with three variables in analysis in the same approach, as follows: loans, revenue assets, and off-balance sheet activities, and also other income. The category of other income results from off-balance sheet activities. It is consists of revenue liquid assets: loans, liquid assets, and investments.

First: Inputs

Regarding the inputs: the (labor) approach is expressed by wages and salaries and their similar for each observance (i) in separate specimen, while paid capital adequacy ratio approach is expressed by The sum of physical capital and premises (fixed assets) for each observance a lonely, and in relation to the used final approach which is (deposits) approach is expressed by the total value of deposits for each observance (i) per specimen a lone.

Second: Outputs

In respect of the outputs, the assets outputs are expressed by the (total value of assets), while the (Earning assets) outputs are expressed by liquid and investments outputs, and also the last outputs is expressed by the (total value of loans). All variables are expressed as cash variables: such as loans, deposits and liquid assets…etc. which are expressed by millions of Yemeni Rials based on the foundation year 1990 of Yemeni consumer. For the foundation year 1990, the index number of Yemeni consumer id used to make deflator. Such an expression would not apply to the labor approach, which was measured by the actual cost of used salaries and wages.

4. Empirical Results

The previous parts presented models of efficiency and productivity measurements used in the literature. This part extends those models to analyses the efficiency and productivity changes of the Yemen banking industry during the post-reform era. Discussion in this part is based on this proposition, which assumes that "financial reforms have improved the efficiency and productivity gains of the Yemen banking industry.

4.1 Sample of Data

The sample covers a 16-year cross section from 1992 to 2007. Bank-related data for the study are mainly collected from published financial statements of all banks operating in Yemen. So, all banks which have been operating for more than five years within the study period are included in the sample. The macroeconomic data are collected from various annual reports and other publications of the central bank of Yemen. Three modes of classification are used to cluster banks in the sample for analysis of estimated efficiency and productivity scores as given below:

- by function: banks which are functioning as Islamic banks and conventional banks which are functioning as commercial banks;

As stated before, the sample is composed of 16 years of unbalanced panel data. Only six banks are represented in the first year of the sample period. Efficiency differences in various types of banking units are examined on the mean estimated efficiency scores. The Mann-Whitney test is used to test the significance of differences in efficiency distributions of various forms of banks.

4.2 Analysis of Estimated Efficiency Scores

This part presents the outcome and discussion of an analysis of estimated efficiency scores. Primarily, it presents mean values, standard deviations and correlation coefficients of input and output variables used in the efficiency analysis. After that, it produces the results and discussion of efficiency analysis using the intermediary approach.

The mean and standard deviation of input and output variables

Table 5.1 shows the data summary and its statistical descriptions of the commercial and Islamic banks in Yemen for all input and output variables used in this study. These statistics indicate that mean total assets of banks have increased more than three-fold from RY 20,779 million in 1992 to RY. 78,498 million in 2007, Deposits and funds have increased by approximately more than four-fold from RY. 13,880 million in 1992 to RY. 68,847 million in 2007, through a period of study. Similarly, total loans have increased from RY. 8,086 million in 1992 and RY. 38,813 million in 2007. On the other hand increases in labor costs may have been due to both normal salary raise and the increase in more highly-skilled banking experts that is an increase of more than five-fold from RY. 67million in 1992 to RY.457million in 2006.

As shown in table 5.1 almost all of the variables indicate high standard deviations. Specifically, variables such as total assets, deposits, labor, and other earning assets indicate high coefficients of variation. The Yemen banking industry comprises a few big banks and a number of medium- and small-size banks. Thus, the recorded differences in values of observed variables have resulted from those scalar differences. However, the methodology used allows assessment of efficiency and productivity improvements of DMUs ignoring their scale of operations (Cooper, Seiford and Kaoru, 2000)

Table 5.1: Descriptive statistics of input and output data

Years DMU	Mean & standard deviation	Labor	Fixed capital	Deposits and funds	total assets	Total loans	Other earning assets
1992	Mean	67	129	13,880	20,779	8,086	5,207
	St.Div.	46	129	11,237	31,133	12,991	4,741
1993	Mean	66	117	12,659	18,826	7,925	4,635
	St.Div.	54	122	12,456	30,626	13,554	4,572
1994	Mean	77	204	12,923	20,053	8,385	4,291
	St.Div.	65	82	13,127	31,086	14,189	4,867
1995	Mean	123	256	14,429	18,057	10,902	10,855
	St.Div.	58	221	14,230	22,170	19,809	18,485
1996	Mean	165	222	15,336	15,699	9,086	8,345
	St.Div.	96	135	14,820	16,502	14,139	12,267
1997	Mean	196	238	14,740	15,439	15,201	6,738
	St.Div.	137	152	10,772	11,502	29,826	6,272
1998	Mean	209	237	15,928	15,397	13,742	7,046
	St.Div.	187	188	10,530	11,471	27,702	6,264
1999	Mean	182	751	16,875	17,872	12,553	8,937
	St.Div.	113	1,523	10,695	14,595	24,847	8,569
2000	Mean	192	504	19,232	19,859	12,690	23,767
	St.Div.	116	500	13,957	14,268	9,258	6,697
2001	Mean	213	484	20,674	21,608	12,635	9,594
	St.Div.	129	538	16,493	16,703	24,054	7,045
2002	Mean	249	645	22,576	24,117	12,478	11,656
	St.Div.	172	534	17,998	18,694	23,404	8,845
2003	Mean	285	685	27,454	29,494	12,662	14,046
	St.Div.	193	497	20,773	21,435	19,584	10,884
2004	Mean	365	832	34,099	37,935	16,482	17,864
	St.Div.	196	621	26,080	27,661	23,713	14,806

2005	Mean	446	952	39,308	44,958	21,006	19,893
	St.Div.	225	680	31,885	33,868	29,792	17,524
2006	Mean	457	1,101	54,058	60,235	22,306	31,701
	St.Div.	246	792	42,442	48,761	31,468	26,558
2007	Mean	435	1,141	68,847	78,498	29,073	38,194
	St.Div.	261	947	53,846	62,943	38,813	34,353

All values in the table are in millions of YR. (1 US$=200 YR)

Table 5.2 identifies correlations among input and output variables. However, deposits and funds which have been used as input in the second specification show high correlations with total assets, total loans, and other earning assets.

Table 5-2: Correlation of input and output variables

	total assets	**Total loans**	**Other earning assets**
Labor	0.836	0.903	0.823
Fixed capital	0.845	0.854	0.848
Deposits and funds	0.990	0.940	0.924

The recorded high correlation of deposits and funds with total assets, total loans, and other earning assets may have more effect on the estimation of efficiency in the asset intermediation process since such assets represent a high proportion of total assets.

As explained by Avkiran (1990), correlation coefficients among input and output variables can be used to show the appropriateness of such variables. The recorded high correlation coefficients between input and output variables table 5.3, confirm that selected input and output variables for performance evaluations are appropriate.

Table 5-3: Coefficient of Variation (Input and output data)

DMU	Labor	Fixed capital	Deposits and funds	total assets	Total loans	**Other earning assets**
1992	0.679	0.996	0.810	1.498	1.607	0.910
1993	0.825	1.047	0.984	1.627	1.710	0.986
1994	0.837	0.403	1.016	1.550	1.692	1.134
1995	0.468	0.863	0.986	1.228	1.817	1.703
1996	0.582	0.607	0.966	1.051	1.556	1.470
1997	0.699	0.636	0.731	0.745	1.962	0.931
1998	0.895	0.792	0.661	0.745	2.016	0.889
1999	0.622	2.029	0.634	0.817	1.979	0.959
2000	0.602	0.992	0.726	0.718	1.873	0.723
2001	0.604	1.110	0.798	0.773	1.904	0.734
2002	0.691	0.829	0.797	0.775	1.876	0.759
2003	0.675	0.725	0.757	0.727	1.547	0.775
2004	0.537	0.747	0.765	0.729	1.439	0.829
2005	0.503	0.714	0.811	0.753	1.418	0.881
2006	0.538	0.720	0.785	0.810	1.411	0.838
2007	0.600	0.830	0.782	0.802	1.335	0.899
Pooled Sample Data	0.561	0.789	0.713	0.750	1.490	0.812

The remainder of this section presents the estimated efficiency scores. The discussion of estimated efficiency scores begins by reproducing the average estimated efficiency scores. Average efficiency scores of different forms of banks are presented, together with the Mann-Whitney test scores.

Further, the graphical presentation is used to highlight the trends in efficiency and differences in estimated efficiency scores in different forms of banking units. The graphical presentation is used to make a longitudinal analysis of estimated efficiency trends.

5. Efficiency Scores

A bank can be efficient if it can create a relatively high volume of income-generating assets and liabilities for a given level of capital. A pure efficiency and scale efficient bank can generate a relatively high volume of income from its services and intermediation operations with the given level of inputs. This is the basis used to measure and compare the three aspects of the efficiency of banks.

Figures 5.1, 5.2 and 5.3 depict estimated mean efficiency scores in each year. Tables 5.4 and 5.5 present overall means and the Mann-Whitney Test scores, which measure the significance of the differences in estimated efficiency between banking clusters. The aim of these figures and tables is to demonstrate differences in efficiency among different types of banks.

5.1 All Banks

Table 5.4 descriptive statistics efficiency scores, the estimated overall means of technical efficiency, pur-technical efficiency and scale efficiency scores show a similar trend. The first year (1992) produces a TE of 92.1%, a PTE of 99.9%, and a scale efficiency score of 92.2%. The last window indicates a slight drop in efficiency with a TE score of 89.2%, PTE score of 95.7% and SE score of 93.2%. However, during the early part of the period from 1992 to 1997, a sharp drop in the TE was experienced by Yemen banks3. This may be due to the combined effect of the entry of new banks, (as Islamic banks), the investment in the adoption of technology, and competition with new entrants such as unit trusts, leasing firms, and other specialized financial services—all competing for market share.

Furthermore, developments in financial markets, especially in the Yemen share Exchange, may have affected the financial services in the Yemen banking industry.

Table 5.4 is a summary of the descriptive statistics and statistical tests of significance for all banks in the sample. On average, there is a considerable level of inefficiency in banks investigated in this study. Another way of interpreting this result is to suggest that these banks have not been using the resources efficiently to produce the same outputs. Therefore, the levels of inefficiency are 7.64, 2.77 and 4.71, percent, respectively in producing the outputs4.

Hence, the same outputs could have been produced by fewer inputs. These results mean that the average bank has actually used only 97.3 percent of the resources to produce the same level of output. In other words, the average bank has wasted 2.77 percent of its inputs, or it could have saved 2.77 percent of its inputs to produce the same level of outputs. Hence, there is substantial room for significant cost savings as pure-technical efficiency for these banks if they employed their inputs more efficiently. However, it is noted that, on the average, banks are more efficient in using their resources compared to all score efficiency; the average efficient bank could only reach 92.9 percent of technical efficiency it is expected to generate. Thus, there is a slack of 7.64 percent, meaning that the average efficient bank lost an opportunity to receive 7.64 percent more revenue, given the same amount of resources. Clearly, the highest level of inefficiency is on the technical efficiency side, followed by the scale efficiency. Similarly, the average bank could be 95.5 percent of what is available and lost the opportunity to make 4.71 percent more scale efficiency.

Table 5.4: Descriptive Statistics: TE, PUR-TE, and SC of Commercial, Islamic and All Banks

	score efficiency in all banks			
banks category	Descriptive statistics	TECHNICAL EFFICIENCY	PUR-TECHINCAL EFFICIENCY	SCALE EFFICIENCY
all banks	N	14	14	14
	Mean	0.929	0.973	0.955
	Std. Deviation	0.042	0.023	0.029
	Maximum	0.982	0.999	0.983
	Minimum	0.826	0.916	0.885
commercial banks	N	10	10	10
	Mean	0.938	0.974	0.963
	Std. Deviation	0.043	0.023	0.031
	Maximum	0.984	0.999	0.999
	Minimum	0.826	0.916	0.885

[3] See appendix 1and 2.

[4] The relationship between efficiency (E) and inefficiency (IE) is IE= (1-E)/E. Thus, the 92.9 percent efficiency implies 7.64 percent inefficiency, not 7.1 percent (or not 1-0.929). See Isik and Hassan (2002).

	N	4	4	4
	Mean	0.936	0.980	0.954
	Std. Deviation	0.063	0.026	0.048
	Maximum	1.000	1.000	1.000
Islamic banks	Minimum	0.793	0.921	0.838
Mann-WhitneyTest	Asymp. Sig. (2-tailed)	605	555	505

['Z' scores are given in parentheses.'**' indicates that test scores are significant under 5]

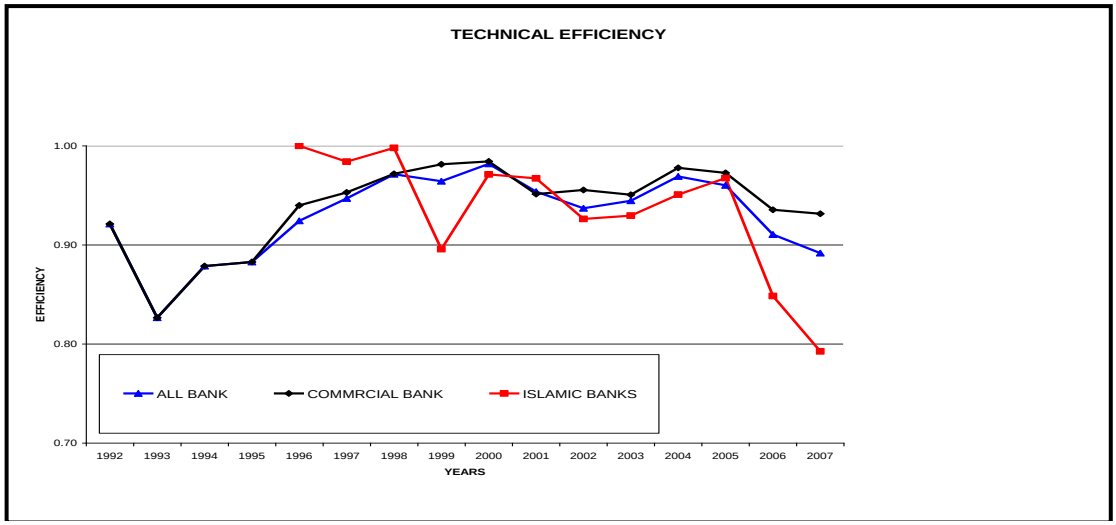

Figure 5.1: technical efficiency

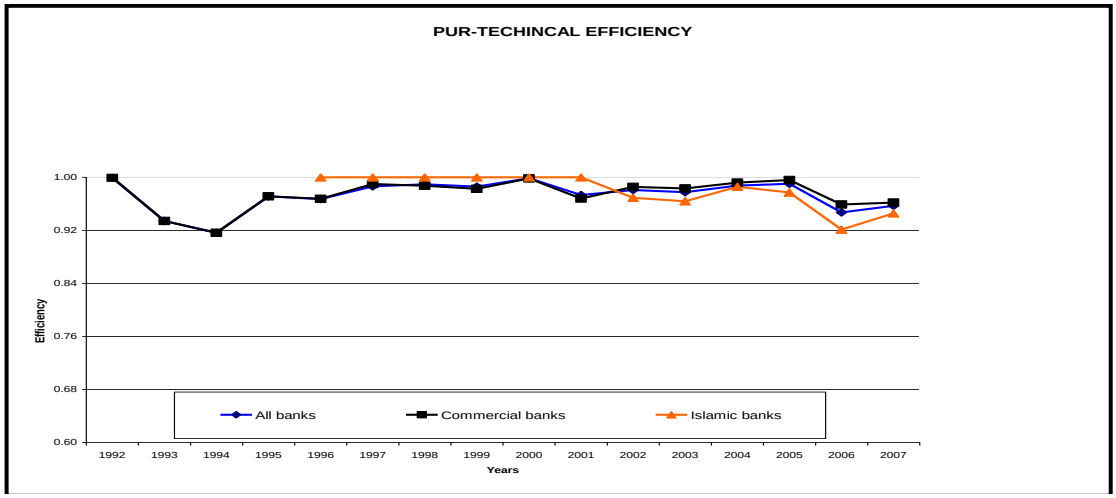

Figure 5.2: pur- technical efficiency

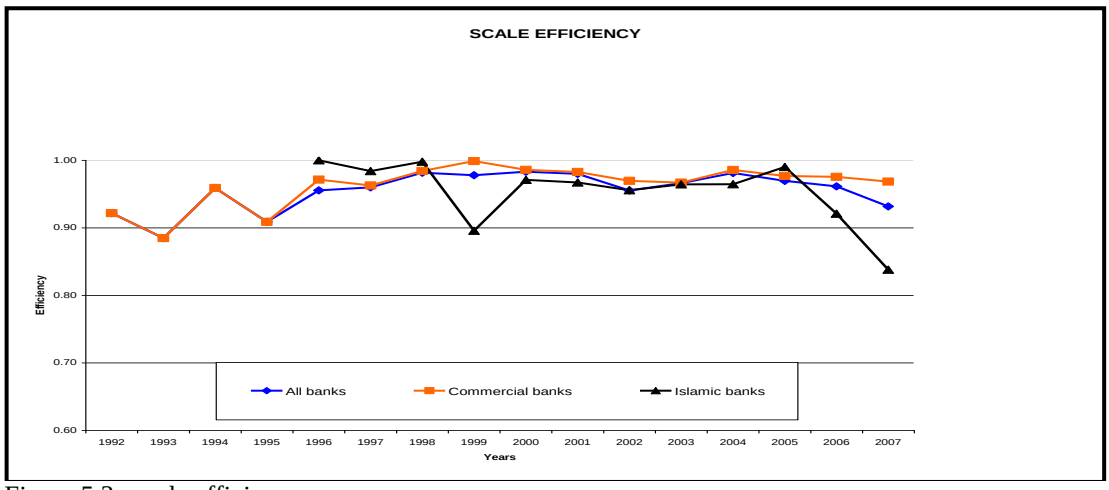

Figure 5.3: scale efficiency;

Table 5.4 also presents the summary statistics of the efficiency measures calculated relative to separate frontiers for both banking streams for the years 1992-2007. It compares the technical efficiency, pure-technical efficiency, and scale efficiency of commercial versus Islamic banks. It is noteworthy that all the inefficiency levels in both banking streams are in the same order as the averages in all banks, i.e. both banking systems are better in utilizing inputs more than generating optimal outputs. Perhaps, this is due to the ability of banks' management to better control the usage of their internal resources rather than controlling the outcomes which is normally influenced by external factors such as competition, regulations, GDP, and other macroeconomic factors. The Mann-Whitney U test is a relevant test for two independent sample coming from data having the same distribution.The test statistics summarized in table 5.5 ' indicates that test scores are significant under 5% level of commercial vs. Islamic banks especially with scale efficiency; all Z values are greater than the standard level at 5 percent.

Table 5.5: Mann-Whitney test between Islamic and commercial banks

Test Statistics[b]

	TE	PTE	SE
Mann-Whitney U	121.500	96.000	114.500
Wilcoxon W	257.500	232.000	250.500
Z	-.245	-1.220	-.509
Asymp. Sig. (2-tailed)	.806	.223	.611
Exact Sig. [2*(1-tailed Sig.)]	.809[a]	.239[a]	.616[a]

a. Not corrected for ties.

b. Grouping Variable: bank

5.2 Analysis of Productivity Changes

This section presents the results of the assessment of productivity changes in the intermediation processes. The respective productivity indices are estimated using DEA-based MPI. Tables 5.6 report geometric means5 of the MPIs aggregated into sub-groups based on different types of banks, together with decomposition into the constituent components of productivity changes: the catch-up or technical efficiency changes (TECH) and frontier shift (FRN). Those indices are calculated on the basis of individual banks' data for the period 1992 to 2007 using an adjacent period method. If a recorded value of an index is greater than one it indicates productivity progress. If a recorded value of an index is lower than one it indicates deterioration regress of productivity of that bank. An index value equal to one indicates that there is neither progress nor

5 Reported geometric means are subject to errors resulted on aggregation. It may not satisfy the basic property which says that the total productivity change (MPI) is equal to the product of efficiency change (CAT) and frontier shift (FRN).

regression in productivity. This model show, a 3.8% (geometric means of all banks' productivity) total productivity improvement has been recorded in intermediation (see Table 5.6). Decomposition of the productivity change shows that the recorded gain has, for the most part, mainly resulted from FRN (by 5.3%). During the period, a small productivity regress has been recorded from TECH (-1.3%). This finding suggests that some Yemen banks have improved their technologies in intermediation during the study period.

Further, the above findings suggest that banks in Yemen have recorded relatively higher productivity in the intermediation process during the study period. Additionally, the result indicates that protective regulations related to interest rate determinations, lack of external and internal competition and a highly collusive environment in the banking industry may have forced Yemen banks to adhere to non-price competition. Geometric means of all banks' productivity indices (intermediation) show eight increases (in the periods 1992-93, 1993-94, 1995-96, 1996-97, 1999-2000, 2000-01, 2003-04 and 2006-07) from FRN and four increases (in the periods of 1998-99, 2000-01, 2004-05, and 2005-06) from TECH, confirming that the main contributor to productivity improvements in intermediation is the FRN which resulted from the advancement of technologies used. resulting in eight increases in total productivity (in the periods 1992-93, 1993-94, 1995-96, 1999-2000, 2000-01, 2003-04 and 2006-07) out of 15 comparisons made during the period 1992 to 2007.

Tables (5.6) report geometric means of the Malmqust Productivity Index(MPIs)

	Average			commercial banks			Islamic banks		
Years	MPI*	TECH	FRN	MPI	TECH	FRN	MPI	TECH	FRN
1992-1993	1.001	0.967	1.035	1.001	0.967	1.035	N.a	N.a	N.a
1993-1994	1.450	0.981	1.478	1.450	0.981	1.478	N.a	N.a	N.a
1994-1995	0.813	0.964	0.844	0.813	0.964	0.844	N.a	N.a	N.a
1995-1996	1.146	0.935	1.225	1.146	0.935	1.225	N.a	N.a	N.a
1996-1997	0.998	0.969	1.030	0.952	0.980	0.972	0.790	1.000	0.790
1997-1998	0.924	0.970	0.953	0.912	0.980	0.930	1.462	1.000	1.462
1998-1999	1.008	1.008	1.000	0.993	0.991	1.002	0.988	1.000	0.988
1999-2000	1.086	0.972	1.117	1.101	0.989	1.113	1.105	1.000	1.105
2000-2001	1.125	1.032	1.090	1.164	1.040	1.119	0.745	1.000	0.745
2001-2002	0.949	0.998	0.951	0.927	0.994	0.932	0.942	1.000	0.942
2002-2003	0.983	0.990	0.992	0.966	1.002	0.963	1.118	0.983	1.137
2003-2004	1.070	0.973	1.100	1.094	0.965	1.133	1.000	0.980	1.021
2004-2005	0.986	1.010	0.976	0.998	1.005	0.992	1.078	1.000	1.078
2005-2006	0.896	1.065	0.841	0.916	1.042	0.879	0.660	1.099	0.601
2006-2007	1.128	0.966	1.167	0.821	1.006	0.816	0.892	0.910	0.981
Mean	1.038	0.987	1.053	1.017	0.989	1.029	0.980	0.997	0.986

*Malmqust Productivity Index(MPIs), technical efficiency changes (TECH) and frontier shift (FRN)

Neither the Islamic banking sector banking sector recorded significant gains from mean productivity improvements (MPI) in intermediation. Further analysis of estimated productivity indices shows that both the Islamic (-2%) and the commercial banking (1.7%) sectors gained productivity improvements in intermediation from FRN during the study period. No productivity gain in intermediation has been made by the Islamic banking sectors. The commercial banking sector recorded the highest total productivity loss (-8.7%) in intermediation in 1994-1995 and the highest total productivity gain (16.4%) in 2000-01. The estimated productivity indices for individual periods show that most of the productivity gains in commercial banks originated from FRN. Further, changes in TECH have not significantly contributed to overall productivity gains, suggesting that the main aim of commercial banks was to seek improvements in productivity through the adoption of new technologies.

At the last, assessment of productivity change suggests that Yemen banks have been able to gain improvements in productivity in intermediation. Further, results show that most productivity gains have been achieved in the second year and latter part of the study. It also signifies that regulatory reforms may have

helped banks to improve their productivity in the long-term. Based on the results of productivity analysis, the following observations can be highlighted:

Productivity gains on intermediation have been recorded from FRN (advancement of technologies, rather than improvement of efficiency).

Banks in Yemen have recorded productivity gains in intermediation, indicating that banks have focused on gaining an advantage. On the other hand, estimated MPIs show that Yemen banks have recorded an improvement in productivity in intermediation. The intermediation process records total productivity gains mainly from the frontier shift. This finding suggests that banks in Yemen mainly focus on non-price competition.

6. Conclusion

Financial liberalization has resulted in a significant change in the infrastructure and operational environment of the Yemen banking industry. As discussed in Chapter Two, the financial services sector reform has widened the overall activities of the banking industry. Further, the analysis in the study finds that banks are not able to capitalize on the favorable environment created by financial reforms through efficiency and productivity improvements. The analysis of factors affecting the technical efficiency of banks in Yemen shows that the impacts of those factors on the different aspects of banking operations are not similar. The overall study findings suggest that policy reforms on their own may not be enough to improve the efficiency and productivity gains of the banking industry. The introduction of financial reforms may affect efficiency and productivity gains if individual banks are able to capture the opportunities created by such reforms and if the government is able to attain and sustain microeconomic stability in the country.

Appendix

Appendix 1 Mean estimated efficiency scores per-financial reforms

DMU	1992	1993	1994	1995	1996	Average	St.dev
TECHNICAL EFFICIENCY							
All Banks	0.921	0.826	0.879	0.883	0.924	0.887	0.035
commercial banks	0.921	0.826	0.879	0.883	0.940	0.890	0.039
Islamic	N.A.	N.A.	N.A.	N.A.	1.000	1.000	0.000
PUR-TECHINCAL EFFICIENCY							
All Banks	0.999	0.934	0.916	0.971	0.967	0.958	0.029
commercial banks	0.999	0.934	0.916	0.971	0.968	0.958	0.029
Islamic	N.A.	N.A.	N.A.	N.A.	1.000	1.000	0.000
SCALE EFFICIENCY							
All Banks	0.922	0.885	0.959	0.909	0.956	0.926	0.028
commercial banks	0.922	0.885	0.959	0.909	0.971	0.929	0.032
Islamic	N.A.	N.A.	N.A.	N.A.	1.000	1.000	0.000

Appendix 2: Mean estimated efficiency scores post-financial reforms

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average	St.dev
TECHNICAL EFFICIENCY												
All Banks	0.971	0.964	0.982	0.954	0.937	0.945	0.969	0.960	0.910	0.892	0.948	0.027
commercial banks	0.972	0.981	0.984	0.951	0.955	0.951	0.978	0.973	0.935	0.931	0.961	0.018
Islamic	0.998	0.896	0.971	0.967	0.926	0.930	0.951	0.967	0.848	0.793	0.925	0.060
PUR-TECHINCAL EFFICIENCY												
All Banks	0.989	0.986	0.999	0.973	0.981	0.978	0.988	0.990	0.947	0.957	0.979	0.015
commercial banks	0.987	0.983	0.998	0.968	0.986	0.983	0.992	0.996	0.959	0.962	0.981	0.013
Islamic	1.000	1.000	1.000	1.000	0.969	0.964	0.986	0.977	0.921	0.946	0.976	0.026
SCALE EFFICIENCY												
All Banks	0.982	0.978	0.983	0.980	0.955	0.966	0.981	0.970	0.961	0.932	0.969	0.015
commercial banks	0.984	0.999	0.986	0.983	0.970	0.967	0.986	0.977	0.976	0.968	0.979	0.009
Islamic	0.998	0.896	0.971	0.967	0.956	0.964	0.965	0.990	0.921	0.838	0.947	0.046

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