

# A Frontier Analysis Approach to Measuring Profitability and Marketability of Stock-traded Companies in Saudi Arabia

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## SUMMARY

*Economists believe that a healthy economy is a result of a well-established and developed stock market. Companies listed in the stock market have to operate at a high level of efficiency and, hence, having a good management is very essential to the performance of these companies. Saudi stock-traded companies are currently challenged with rapid technological changes as well as increasing competition in the local markets from both the new established local companies and the opening of the local markets to multinational companies. Such challenges should compel Saudi companies to make an effort to reduce its levels of inefficiencies, not only on the profitability side, but also on the marketability side.*

*Investors, like managers, are always in need for information concerning the performance of companies they are willing to invest in. In this context, this paper purports to measure and analyze the efficiency of 48 stock-traded companies in Saudi Arabia using a nonparametric frontier technique called Data Envelopment Analysis (DEA). These companies represent about 70% of all companies listed in the stock market and are classified into three major sectors which are: the banking sector, the industrial sector and the service sector. The proposed model is divided into two different stages and utilizes nine performance measures that serve as inputs and outputs. The first stage is devoted to measure profitability of a DMU as seen by shareholders using three inputs: assets, labor force and shareholders' equity that produce outputs revenue and profit. The second stage measures marketability of a DMU as seen by stock investors using two inputs revenue and profit that produce four outputs: earning per share, market value, return on equity and return on assets.*

*Frontier Analyst Professional® software is used to compute DEA efficiency scores and sensitivity analysis for each DMU using actual input-output data for the year 2002 for a set of 48 companies including financial institutions. The results show that only four companies out of 48 companies are efficient in both stages and a considerable number of companies have very low efficiency scores. This result indicates that many stock-traded companies in Saudi Arabia are operating inefficiently due to bad management and, hence, exposing shareholders' equity and stock investors to a high level of risk. Therefore, government regulators should supervise closely current practices in the private sector and interfere, if necessary, in order to improve the performance of inefficient companies.*

**Key words:** data envelopment analysis (DEA), efficiency analysis, financial ratios, reference sets

## 1. Introduction

It is a well-known fact that a stock market of a country plays a major role in that country's economic development process. In fact, a healthy economy is a result of a well-established and developed stock market. A stock-traded company has to operate at a high level of efficiency. However, a high quality management is not easily found.

In the foreseeable future, Saudi stock-traded companies are faced with rapid technological change, the joining of the World Trade Organization (WTO), increasing competition from multinational companies, increasing number of new established and privatized companies, renewal interest in the local stock market from both local and regional investors. No doubt, such factors will compel all Saudi stock-traded companies to make an effort to reduce its levels of inefficiency, not only on the profitability side, but also on the marketability side. The reduction of profits due to bad management make the reduction of all types of technical inefficiency a very important potential source of gains in a highly competitive and tiny market such as Saudi markets.

In this context, the article purports to measure and analyze the efficiency of large Saudi stock-traded companies using a nonparametric frontier technique called Data Envelopment Analysis (DEA, thereafter). The DEA adopted because not only it allows for inefficiency and disaggregating of input and output factors, it also reduces specification bias by avoiding multicollinearity problem as well as imposition of a specific functional form.

The remaining structure of this article is organized as follows: Section 2 sets out the most important differences between efficiency analysis and financial analysis. Section 3 describes a typical production process of a decision making unit (DMU, thereafter) and its corresponding production factors (inputs and outputs) and the data used. Section 4 lays out the methodology proposed for measuring profitability and marketability and reviews the existing literature on performance evaluation. Section 5 reports the empirical results and discussion of the efficiency analysis. Finally, section 6 concludes the paper along with directions for future research.

## **2. Efficiency Versus Financial Analysis**

Although, ratio analysis is the heart of financial analysis, it is based on implicit assumptions that do not always apply. Computations and comparisons of ratio analysis are further confounded by inappropriate use of benchmarks to indicate optimal levels, the timing of transactions, negative numbers, and differences in accounting and reporting methods. Furthermore, ratio analysis fails to take into account the value of management's actions and investment decisions that will affect the future prosperity of a DMU; it aggregates many aspects of performance such as operations, marketing and financing (Sherman and Gold 1985). Disadvantages of ratio analysis can also arise when management starts to focus either on one ratio or on few ratios with resultant discord and confusion about their relative importance. Inability to take into account some important uncontrollable factors such as customer satisfaction and service (or product) equality, will always put a limit on the reliability and creditability of ratio analysis as the main source of information about a DMU's performance.

Efficiency analysis, on the other hand, addresses these difficulties by using both controlled and uncontrolled factors to determine mathematically *relative* performance efficiency as opposed to *absolute* performance efficiency. Efficiency analysis characterizes the relationships among multiple inputs and multiple outputs and is measured by estimating best practice efficient frontiers based on a relevant sample of firms. Firms on the frontier are seen as the best performers in the sense that their performance is at least as good as that of other firms with similar characteristics. The efficiencies of all other firms in the industry are then measured in comparison to the efficient frontier.

In practice, efficiency analysis uses more factors as inputs and outputs to measure actual performance against a known attainable rather than a theoretical standard generating less controversy and therefore can be used with greater confidence.

### **3. The Production Process**

Saudi stock-traded and non stock-traded companies are yearly evaluated to form the list of 'Top 100' by a local specialized business local newspaper called Aleqtisadiah. Companies are evaluated based only on one factor that is total revenue (or sales). Likewise, Fortune magazine in forming its 'Global 500 Rank' for best performers, uses factors such as revenues, profits, return on revenues, return on assets, and number of employees. The problem with using several performance measures is that they produce conflicting and misleading reports and, hence, it is difficult to determine which DMU achieves a better overall performance.

Instead of relying on single measures to perform an efficiency analysis, the present approach utilizes multiple performance measures (inputs and outputs) that operate simultaneously with each other to determine relative efficiency of a finite number of DMUs. Figure 1 shows how a production process of a DMU utilizes nine performance measures which are used to construct DEA efficiency frontiers. The production process is divided into two separate stages with the nine performance measures serving as inputs and outputs for each stage (Seiford and Zhu 1999). Table 1 presents financial measures used as inputs and outputs and their corresponding definitions. Stage 1 is devoted to measure profitability of a DMU as seen by management. In fact, this stage evaluates the quality of the DMU's management using three input measures which are: assets, labor force and stockholders' equity to produce outputs revenues and profits. Stage 2 measures marketability of a DMU (stock performance) as seen by stock investors using two input measures revenues and profits to produce four outputs *EPS*, *MV*, *ROE* and *ROA*. It should be noted that there is no systematic interaction between the two stages of the DEA model except that the two measures revenues and profits will serve as intermediate measures in the sense that they are outputs from the first stage and inputs to the second stage

The purpose of dividing the DEA model into two stages is to gain valuable insights about the performance of both the stock and the management of a DMU and to use this information to improve current practice.

### **4. The Frontier Efficiency Technique**

In his seminal paper on measuring economic efficiency, Farrell (1957) laid the foundation for the application of nonparametric methods. Farrell's proposed approach to frontier estimation was not given much detailed empirical attention for about two decades, until it was extended and operationalized by Charnes *et al.* (1978, 1989). These authors developed nonparametric measures of total efficiency called data envelopment analysis, which is a mathematical programming approach for the construction of production frontiers and the measurement of efficiency relative to the constructed frontiers. In DEA terminology all firms are decision making units (DMUs). The DEA frontier, called the efficient frontier, is formed as the piecewise linear combination that connects the set of 'best practice' (efficient) DMUs contained in the sample under consideration. DMUs, which construct the frontier, are termed efficient and those, which lie below the frontier, are termed inefficient. The distance between efficient and inefficient DMUs provides a measure of efficiency or inefficiency. DEA has been widely applied to the efficiency measurement of various organizations in public and private sectors (for surveys, see Forsund *et al.*, 1980; Seiford

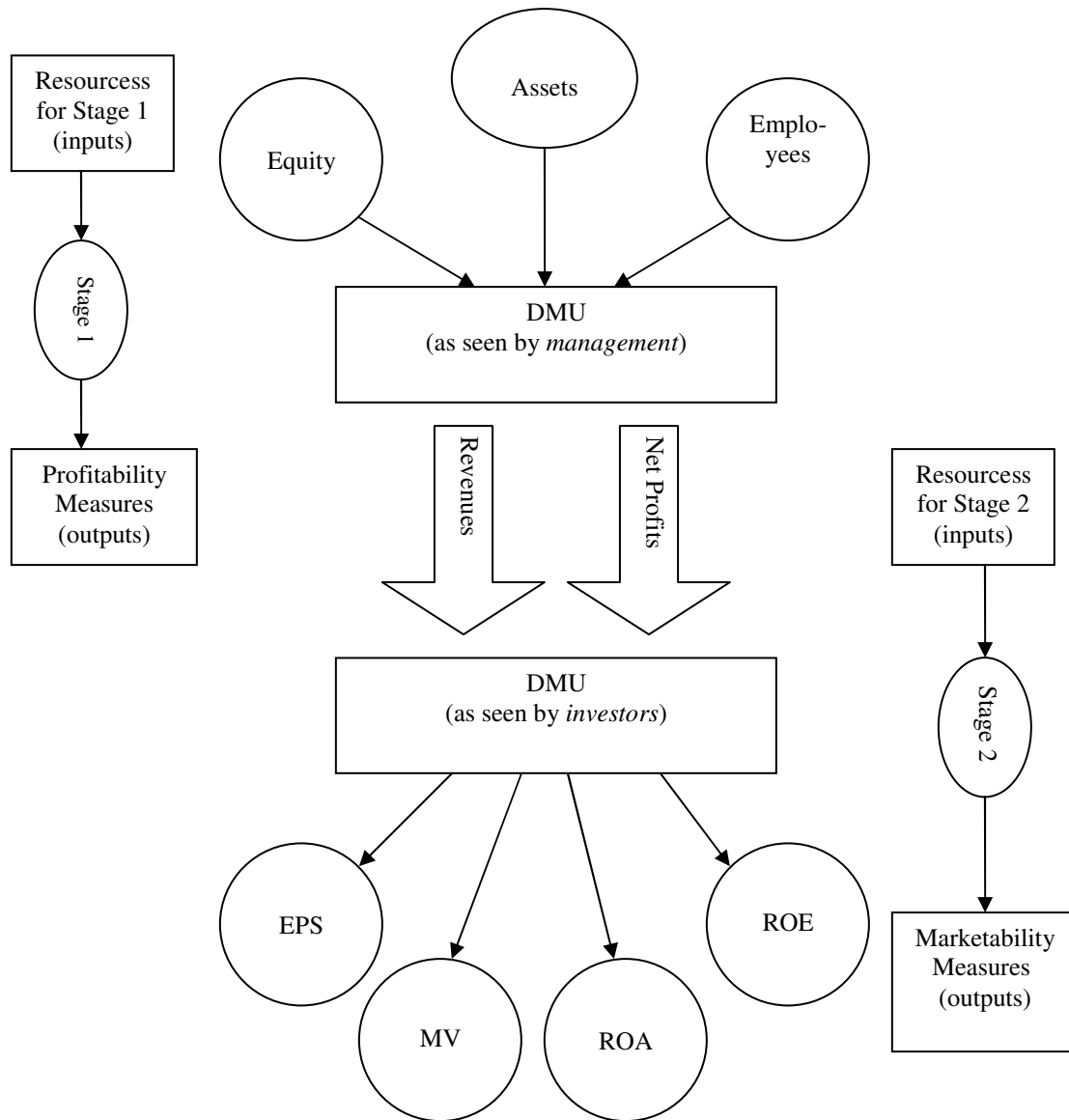


Figure 1: The DMU's two-stage production model for benchmarking efficiency using both profitability and marketability measures of efficiency

and Thrall, 1990; Lovell, 1993; Bauer *et al.*, 1993; Ali and Seiford, 1993; Seiford, 1996; Berger and Humphrey, 1997; Cooper *et al.*, 1999; Emrouznjad *et al.*, 2002 and Emrouznjad, 2003).

Charnes *et al.* (1978) proposed a model that had an input or output orientation and assumed constant return to scale (CRS). In the input-oriented model, the DEA approach seeks to identify technical inefficiency as a proportional reduction in input usage. While the output-oriented model, on the other hand, measures technical inefficiency as a proportional increase in output production. Although up-to-date theoretical literature is inconclusive orientation of measurement, it should be noted that both orientations would construct exactly the same frontier and, hence, identify the same set of efficient DMUs as long as the assumption of CRS is assumed (Casu and Molyneux 2003). Following Charnes *et al.* (1978) and Seiford and Zhu (1999) the so called output-oriented (CCR) DEA approach is adapted in this study to empirically measure the relative

Input/output	Financial Variable	Definition
Input 11	<i>ASSETS</i>	Refers to all types of assets: current, noncurrent and other assets at the company's year-end.
Input 21	<i>EQUITY</i>	Consists of capital stock, paid-in capital, reserves and retained earnings at the company's year-end.
Input 31	<i>Emp</i>	Total number of all employees hired by the company at the company's year-end.
Output 11/ Input 12	<i>NP</i>	Net Profits which are total income (revenues) after general and administrative expenses, after provision of doubtful debts and after zakat and taxes at the company's year-end.
Output 21/ Input 22	<i>Rev</i>	Revenue which is all types of income from a company's regular activity as shown at the end of the year.
Ouput 12	<i>MV</i>	Market Value of a company is obtained by multiplying the number of common shares outstanding by the closed share price as of December 31, 2001.
Ouput 22	<i>EPS</i>	Earning Per Share is the division of net profits by the number of common shares outstanding at the company's year-end.
Ouput 32	<i>ROE</i>	Return on Equity is the company's net profits expressed as a percentage of its equity capital at the company's year-end.
Output 42	<i>ROA</i>	Return on Assets is the company's net profits expressed as a percentage of its total assets at the company's year-end.

Table 1: Definitions of financial variables used as inputs and outputs

technical efficiency (*RTE*) of profitability and marketability of 48 stock-traded companies listed in the Saudi stock market. Mathematically, for  $n$  DMUs using  $m$  inputs (denoted by X's) to produce  $s$  outputs (denoted by Y's) DEA maximizes for  $DMU_k$ ,

$$\begin{aligned}
RTE_k & \phi_k^g + \varepsilon \left( \sum_{i=1}^m s_i^- + \sum_{r=1}^s s_r^+ \right) & g = 1, 2 . \\
s.t. \quad & \phi_k^g y_{ro} - \sum_{j=1}^n \lambda_j y_{rj} + s_r^+ = 0, & r = 1, 2, \dots, s, \\
& \sum_{j=1}^n \lambda_j x_{ij} + s_i^- = x_{io}, & r = 1, 2, \dots, m, \\
& \lambda_j, s_i^-, s_r^+ \geq 0,
\end{aligned}$$

where  $\phi_k^1$  and  $\phi_k^2$  are the efficiency scores of  $DMU_k$  in stage 1 and stage 2, respectively,  $x_{ij}$  is the quantity of  $i$  th input for  $j$  th DMU,  $y_{ij}$  is the quantity of  $r$  th output for  $j$  th DMU,  $\lambda_j$  is the proportion of  $j$  th DMU in reference unit for  $k$  th DMU,  $s_i^-$  and  $s_r^+$  are input and output slacks, respectively.

The solution to the objective function will be  $RTE_j = \phi_o^s \leq 1$  ( $j=1,2,\dots,n$ ) for stage 1 and stage 2 models. DMUs with  $\phi_k^1 = 1$  and zero input/output slacks define the efficient frontier for stage 1 model and such DMUs are said to be CCR-efficient in profitability. Likewise, if  $\phi_k^2 = 1$  and all input/output slacks are zero, then, efficient DMUs define the efficient frontier for stage 2 model and are said to be CCR-efficient in marketability. Efficient DMUs will serve as reference or benchmarks in rating the relatively inefficient DMUs.

## 5. Empirical Analysis

The DEA model in the preceding section is implemented by using actual data for inputs and outputs for a set of 48 (out of 69) stock-traded companies for the year 2002. The rest of companies are excluded from the present study due to either incompleteness of data or the reporting of negative values for the selected measures at the end of the year 2002. Data are obtained from Saudi Listed Companies Book (SLCB) published by TADAWUL, 2002 edition. The efficiency analysis software package used for the experiment is known as Frontier Analyst Professional® from *Banxia software Ltd.* This software computes different efficiency scores depending on the selected model (additive, input, output, variable return to scale (VRS), CRS). This package allows the user to easily input the data, choose the structure of the model and specify active inputs and outputs through a friendly user interface. In addition, the package enables the user to view and copy different aspects of the analysis including graphical representation of results and sensitivity analysis.

This study uses an output-oriented DEA model to evaluate all DMUs. *RTE* scores of stage 1 and stage 2 models in all sectors are summarized in Tables 2a-c, along with DMUs' efficiency rank and input/output potential improvements. Table 2a reports efficiency results of the banking sector. Five out of ten banks, namely, DMU3 (Estthmar), DMU4 (Holandi), DMU8 (Samba), DMU9 (Rajhi) and DMU10 (Ahli), are 100 percent efficient in profitability. Likewise, three banks, namely, DMU2 (Jazira), DMU4 (Holandi) and DMU9 (Rajhi), are 100 percent efficient in marketability. Only Rajhi and Holandi banks in this sector exhibit 'best practice' in both dimensions. In the industrial sector, only nine and five DMUs are found to be 100 percent efficient in profitability and marketability, respectively, and only DMU19 (Motatawera) and DMU25 (NAMA) are consistently efficient in both stages as it appears in Table 2b. In the service sector, only DMUs in each stage are fully efficient, however, none of the DMUs in this sector demonstrates 'best practice' in both models as shown in Table 2c.

Tables 2a-c provide valuable information for inefficient DMUs to improve performance to become efficient DMUs. Taking Jazira bank, as an example of 'worst practice' DMU in stage 1 with an efficiency score of 87.80%, this bank can improve its performance by reallocating its resources. Table 2a shows how much, in percentage terms, Jazira bank's use of its inputs or production of outputs needs to change by in order to become an efficient bank. Thus, Jazira bank should reduce its resource of shareholders' equity by 20.10%, while maintaining the same level of production; or increase its net profits and revenues by 88.69% and 13.89%, respectively. The same analysis is applied to all other inefficient DMUs.

Overall, the number of efficient DMUs is very small as shown, in percentage terms, in Table 3. A graphical representation of the distribution of (in)efficient DMUs in all sectors can be obtained from the Frontier Analyst software as presented in Figures 2a-f.

<i>Profitability (Stage 1)</i>								
DMU No.	DMU Name	Efficiency Score (%)	Efficiency Rank	Assets (%)	Equity (%)	Emp (%)	NP (%)	Rev (%)
1	Riyad	96.320	7	00.00	-19.70	00.00	3.820	3.820
2	Jazira	87.800	10	00.00	-20.10	00.00	88.69	13.89
3	Estthmar	100.00	01	00.00	00.00	00.00	00.00	00.00
4	Holandi	100.00	01	00.00	00.00	00.00	00.00	00.00
5	Fransi	97.200	06	-1.97	00.00	00.00	2.880	2.880
6	Brittani	96.150	08	00.00	00.00	-11.98	4.000	4.000
7	Arabi	95.890	09	-6.45	00.00	-9.760	46.41	4.280
8	Samba	100.00	01	00.00	00.00	00.00	00.00	00.00
9	Rajhi	100.00	01	00.00	00.00	00.00	00.00	00.00
10	Ahli	100.00	01	00.00	00.00	00.00	00.00	00.00

<i>Marketability (Stage 2)</i>									
				NP (%)	Rev (%)	MV (%)	EPS (%)	ROE (%)	ROA (%)
1	Riyad	77.620	10	00.00	00.00	28.83	126.63	110.22	119.77
2	Jazira	100.00	1	00.00	00.00	00.00	00.00	00.000	00.000
3	Estthmar	95.100	5	-9.520	00.00	5.150	5.150	7.9200	5.1500
4	Holandi	100.00	1	00.00	00.00	00.00	00.00	00.000	00.000
5	Fransi	92.950	6	-12.98	00.00	7.590	7.590	8.0800	7.5900
6	Brittani	82.380	9	-6.820	00.00	21.39	21.39	21.390	61.330
7	Arabi	83.080	7	00.00	00.00	20.36	148.63	291.23	512.06
8	Samba	83.050	8	-6.010	00.00	20.41	74.52	20.410	40.050
9	Rajhi	100.00	1	00.00	00.00	00.00	00.00	00.000	00.000
10	Ahli	98.190	4	-23.13	00.00	1.850	8.270	1.8500	64.730

Table 2a: Efficient and inefficient DMUs and input/output potential improvements (banking sector)

When DMUs are sorted by assets, it is apparent that larger DMUs are better at generating profits (good management), while the smaller DMUs are more accurately valued (good investment) as shown in Table 4. Moreover, it is clear that DMUs of both sizes in the banking sector outperform all DMUs in other sectors in both stages. Likewise, DMUs of both sizes in the industrial sector outperform DMUs in the service sector in both dimensions except for smaller DMUs in stage 2. Overall, DMUs in the banking sector achieved better performance than other DMUs in the other two sectors whereas DMUs in the industrial sector performed better than DMUs in the service sector which reflects weak performance in the present study.

It should be noted that an efficiency study merely provides a guide to improvement potential because it is not always possible for a DMU to match 100 percent efficient DMUs. A set of reference sets of efficient DMUs is constructed by DEA models and it is used to help an inefficient DMU realize why it is under-performing and show clearly the areas in which it is weak. Table 5 documents all reference sets for all inefficient banks in the banking sector (reference sets of DMUs in the other two sectors are not shown). Jazira bank's reference set, for instance, consists of two efficient banks, namely, Holandi and Rajhi banks. Jazira bank compares its usage of resources and its production of outputs with that of the reference bank (Rajhi or Holandi). The results of such a comparison, as shown in Figure 3, will enable policy makers to investigate why a reference DMU is able to achieve much greater outputs than an inefficient DMU does from its current level of inputs. As a reference DMU, Holandi bank has a predominant contribution over Rajhi bank in forming target values for Jazira bank's inputs and

<i>Profitability (Stage 1)</i>								
DMU No.	DMU Name	Efficiency Score (%)	Efficiency Rank	Assets (%)	Equity (%)	Emp (%)	NP (%)	Rev (%)
١١	SABIC	73.590	١٥	-19.56	00.000	00.000	35.890	35.890
١٢	SAFCO	33.010	٢٤	00.00	-28.27	00.000	250.50	202.93
١٣	Khazaf	47.070	٢١	00.00	00.000	-59.27	628.40	112.46
١٤	Savola	100.00	٠١	00.00	00.000	00.000	00.000	00.000
١٥	Attasnee	100.00	٠١	00.00	00.000	00.000	00.000	00.000
١٦	Addawaeya	92.500	١٣	00.00	-25.87	00.000	29.380	8.1100
١٧	GAZCO	56.160	١٩	00.00	00.000	-39.04	118.10	78.060
١٨	GYPSCO	93.900	١١	00.00	-6.970	-42.45	7.3700	6.5000
١٩	Motatawera	100.00	٠١	00.00	00.000	00.000	00.000	00.000
٢٠	ZOUJAJ	54.550	٢٠	00.00	-11.77	-16.73	155.70	83.310
٢١	Amiantit	100.00	٠١	00.00	00.000	00.000	00.000	00.000
٢٢	FIPCO	64.450	١٨	00.00	-9.710	-90.95	226.80	55.160
٢٣	SISCO	29.960	٢٥	00.00	00.000	00.000	1091.3	233.81
٢٤	PIPES	43.670	٢٣	00.00	00.000	00.000	896.50	128.98
٢٥	NAMA	100.00	٠١	00.00	00.000	00.000	00.000	00.000
٢٦	Chemical	100.00	٠١	00.00	00.000	00.000	00.000	00.000
٢٧	Azzamil	100.00	٠١	00.00	00.000	00.000	00.000	00.000
٢٨	Arabia	71.920	١٧	00.00	00.000	00.000	52.760	39.040
٢٩	Yamama	100.00	٠١	00.00	00.000	00.000	00.000	00.000
٣٠	Saudia	73.550	١٦	00.00	-16.40	-13.59	45.340	35.970
٣١	Qassim	100.00	٠١	00.00	00.000	00.000	00.000	00.000
٣٢	Janoubia	97.000	١٠	00.00	-1.690	00.000	3.0900	4.7400
٣٣	Yanbu	75.410	١٤	00.00	00.000	00.000	32.610	32.610
٣٤	Asharqyea	92.600	١٢	00.00	-2.920	00.000	18.690	7.9900
٣٥	Tabouk	46.470	٢٢	-8.230	00.000	00.000	115.18	115.18

<i>Marketability (Stage 2)</i>									
				NP (%)	Rev (%)	MV (%)	EPS (%)	ROE (%)	ROA (%)
١١	SABIC	34.060	٢٤	00.00	00.00	193.62	2316.9	4596.8	6680
١٢	SAFCO	100.00	٠١	00.00	00.00	00.000	00.000	00.000	00.00
١٣	Khazaf	55.310	١٧	00.00	00.00	80.810	80.810	142.26	123.2
١٤	Savola	33.800	٢٥	00.00	00.00	195.86	195.86	632.15	682.1
١٥	Attasnee	35.730	٢٣	00.00	00.00	179.85	179.85	197.08	593.5
١٦	Addawaeya	42.550	٢٢	00.00	00.00	135.03	135.03	306.83	294.1
١٧	GAZCO	43.520	٢١	-21.15	00.00	129.76	129.76	205.02	335.2
١٨	GYPSCO	82.430	٠٨	-13.74	00.00	21.310	21.310	83.990	139.6
١٩	Motatawera	100.00	٠١	00.00	00.00	00.000	00.000	00.000	00.00
٢٠	ZOUJAJ	52.910	١٨	00.00	00.00	89.010	89.010	91.640	118.1
٢١	Amiantit	49.660	١٩	00.00	00.00	101.37	101.37	109.39	277.6
٢٢	FIPCO	100.00	٠١	00.00	00.00	00.000	00.000	00.000	00.00
٢٣	SISCO	100.00	٠١	00.00	00.00	00.000	00.000	00.000	00.00
٢٤	PIPES	83.310	٠٧	00.00	00.00	20.030	20.030	20.400	68.65
٢٥	NAMA	100.00	٠١	00.00	00.00	00.000	00.000	00.000	00.00
٢٦	Chemical	55.310	١٦	00.00	00.00	80.810	80.810	142.26	123.2
٢٧	Azzamil	44.110	٢٠	00.00	00.00	126.73	126.73	197.79	326.3
٢٨	Arabia	62.190	١٥	-27.07	00.00	60.810	60.810	220.38	277.6
٢٩	Yamama	71.820	١٠	-28.88	00.00	39.230	39.230	217.45	342.9
٣٠	Saudia	63.550	١٤	-32.78	00.00	57.350	57.350	178.81	222.7
٣١	Qassim	75.570	٠٩	-33.31	00.00	32.320	32.320	216.34	237.6
٣٢	Janoubia	66.790	١١	-38.39	00.00	49.710	49.710	120.25	237.6
٣٣	Yanbu	63.810	13	-39.30	00.00	56.720	56.720	171.94	203.2
٣٤	Asharqyea	65.720	12	-30.56	00.00	52.170	52.170	212.33	226.4
٣٥	Tabouk	88.650	06	-32.06	00.00	12.800	12.800	28.230	85.33

Table 2b: Efficient and inefficient DMUs and input/output potential improvements (industrial sector)

<i>Profitability (Stage 1)</i>									
DMU No.	DMU Name	Efficiency Score (%)	Efficiency Rank	Assets (%)	Equity (%)	Emp (%)	NP (%)	Rev (%)	
٣٦	Fanadq	22.470	12	-11.67	00.00	-50.82	344.96	344.96	
٣٧	Akaria	28.680	11	00.000	-1.650	00.00	248.70	258.20	
٣٨	Bahri	100.00	01	00.000	00.00	00.00	00.000	00.000	
٣٩	SAPTCO	55.710	٠6	00.000	00.00	-80.50	305.35	79.510	
٤٠	SASCO	20.710	13	00.000	00.00	-56.59	626.25	382.84	
٤١	Taiba	100.00	01	00.000	00.00	00.00	00.000	00.000	
٤٢	Makka	100.00	01	00.000	00.00	00.00	00.000	00.000	
٤٣	Mubarad	33.270	09	00.000	00.00	-78.13	351.27	200.58	
٤٤	Assadrat	52.530	07	-3.610	00.00	00.00	90.360	90.360	
٤٥	Attameer	58.370	05	-8.300	00.00	00.00	71.320	71.320	
٤٦	Fitaihi	30.130	10	00.000	00.00	-40.48	2547.8	231.93	
٤٧	Kahraba	43.780	٠8	-21.76	00.00	00.00	447.48	128.42	
٤٨	Ettesalat	100.00	٠1	00.000	00.00	00.00	00.000	00.000	
<i>Marketability (Stage 2)</i>									
				NP (%)	Rev (%)	MV (%)	EPS (%)	ROE (%)	ROA (%)
٣٦	Fanadq	59.11	٠٨	00.000	00.000	69.170	72.060	69.170	108.6
٣٧	Akaria	100.00	٠١	00.000	00.000	00.000	00.000	00.000	00.00
٣٨	Bahri	29.83	١١	00.000	00.000	235.23	525.64	235.23	492.7
٣٩	SAPTCO	27.48	١٣	00.000	00.000	263.94	412.28	313.69	263.9
٤٠	SASCO	68.54	٠٥	-16.15	00.000	45.900	154.28	119.48	45.90
٤١	Taiba	61.75	٠٧	00.000	00.000	61.940	179.02	100.74	61.94
٤٢	Makka	36.58	٠٩	-28.53	00.000	173.37	173.37	554.88	350.7
٤٣	Mubarad	100.00	٠١	00.000	00.000	00.000	00.000	00.000	00.00
٤٤	Assadrat	100.00	٠١	00.000	00.000	00.000	00.000	00.000	00.00
٤٥	Attameer	61.91	٠٦	00.000	00.000	61.520	157.65	80.240	61.52
٤٦	Fitaihi	100.00	٠١	00.000	00.000	00.000	00.000	00.000	00.00
٤٧	Kahraba	29.45	١٢	00.000	00.000	239.56	12707	8308.4	١٣٩١
٤٨	Ettesalat	31.26	١٠	00.000	00.000	219.88	3156.2	2674.7	٣
									3696

Table 2c: Efficient and inefficient DMUs and input/output potential improvements (service sector)

	Profitability	Marketability
Banking Sector	50 %	30 %
Industrial Sector	36	20
Service Sector	30	30

Table 3: Percentage of efficient DMUs in stages 1 and 2 of all sectors

outputs as depicted in Figure 4, i.e., Holandi bank contributes by 62, 50, 42, 58 and 62 percent in forming new values of assets, equity, employees, net profits and revenues, respectively, for Jazira bank. Therefore, decision makers at Jazira bank should investigate the performance of the Holandi bank, especially if it is of a similar size, in order to understand the nature of the inefficiency present at Jazira bank.

## 6. Summary and Conclusion

Frontier efficiency estimates constitute a new class of benchmarking techniques that have been applied to a wide variety of financial, governmental and industrial organizations worldwide. The frontier approach analyzes the performance of specific DMUs by comparing them to efficient

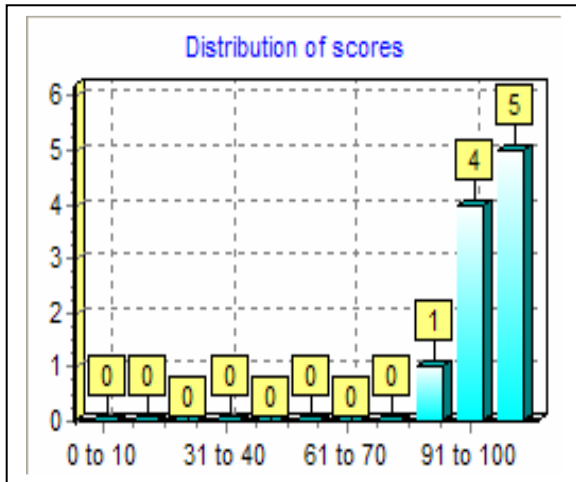


Figure 2a: CCR efficiency in stage1 (banks)

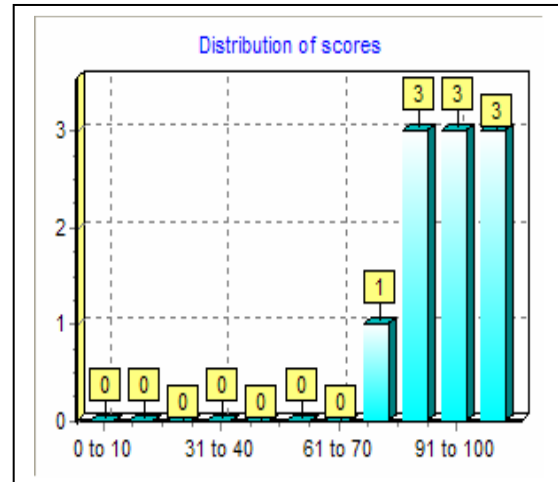


Figure 2b: CCR efficiency in stage 2 (banks)

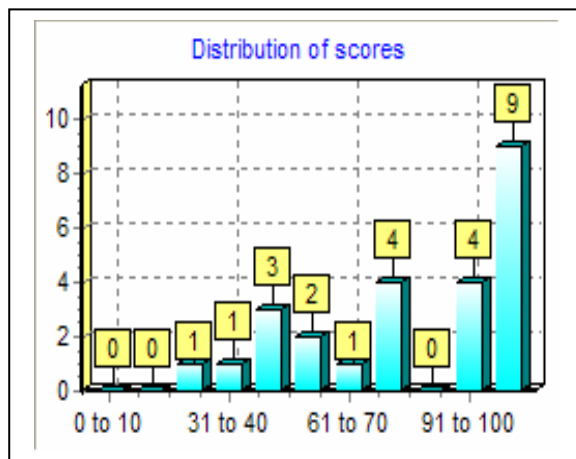


Figure 2c: CCR efficiency in stage1 (industry)

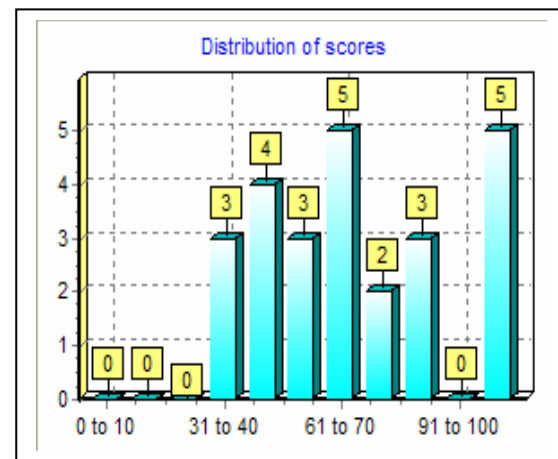


Figure 2d: CCR efficiency in stage 2 (industry)

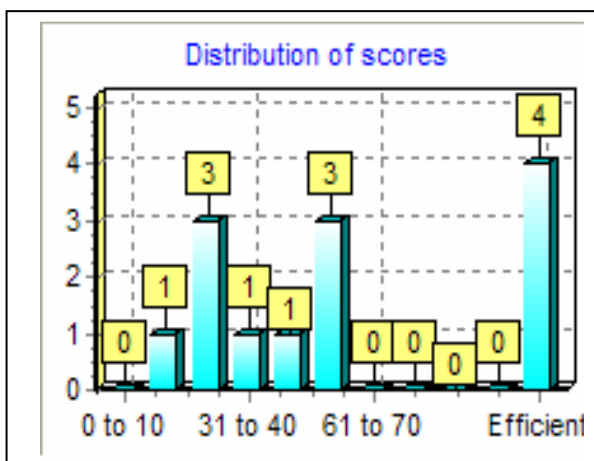


Figure 2e: CCR efficiency in stage1 (service)

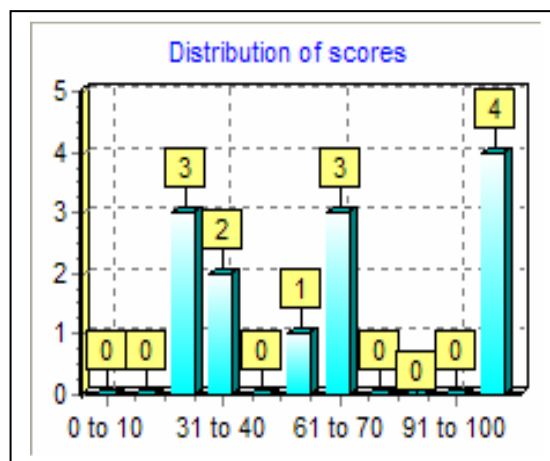


Figure 2f: CCR efficiency in stage 2 (service)

	<b>Profitability (Stage 1)</b>	<b>Marketability (Stage 2)</b>
		<i>Banking Sector</i>
Large DMUs ( ≥ \$10 bil.)	97.94	88.18
Small DMUs ( < \$10 bil.)	95.93	98.37
		<i>Industrial Sector</i>
Large DMUs ( ≥ \$200 mil.)	83.07	58.64
Small DMUs ( < \$200 mil.)	66.70	84.25
		<i>Service Sector</i>
Large DMUs ( ≥ \$200 mil.)	67.67	48.60
Small DMUs ( < \$200 mil.)	34.16	92.14

Table 4: DMUs sorted by assets and average efficiency scores in stages 1 and 2

DMU No.	DMU Name	Efficiency Score (%)	Efficiency Rank	Reference DMUs		
<i>Profitability (Stage 1)</i>						
١	Riyad	96.320	٠7	Holandi	Samba	Rajhi
٢	Jazira	87.800	10	Holandi		Rajhi
٣	Estthmar	100.00	01			
٤	Holandi	100.00	01			
٥	Fransi	97.200	06	Holandi	Samba	Ahli
٦	Brittani	96.150	08	Holandi	Samba	Ahli
٧	Arabi	95.890	09	Holandi		
٨	Samba	100.00	01			
٩	Rajhi	100.00	01			
١٠	Ahli	100.00	01			
<i>Marketability (Stage 2)</i>						
١	Riyad	77.620	١٠		Jazira	Rajhi
٢	Jazira	100.00	٠١			
٣	Estthmar	95.100	٠٥	Holandi	Jazira	Rajhi
٤	Holandi	100.00	٠١			
٥	Fransi	92.950	٠٦	Holandi	Jazira	Rajhi
٦	Brittani	82.380	٠٩	Holandi	Jazira	Rajhi
٧	Arabi	83.080	٠٧		Jazira	Rajhi
٨	Samba	83.050	٠٨		Jazira	Rajhi
٩	Rajhi	100.00	٠١			

Table 5: Reference sets for inefficient DMUs (banking sector)

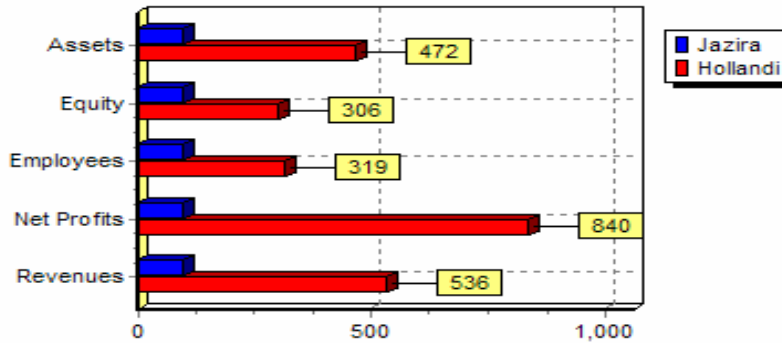


Figure 3 : Reference set of Jazira bank (Stage 1: profitability)

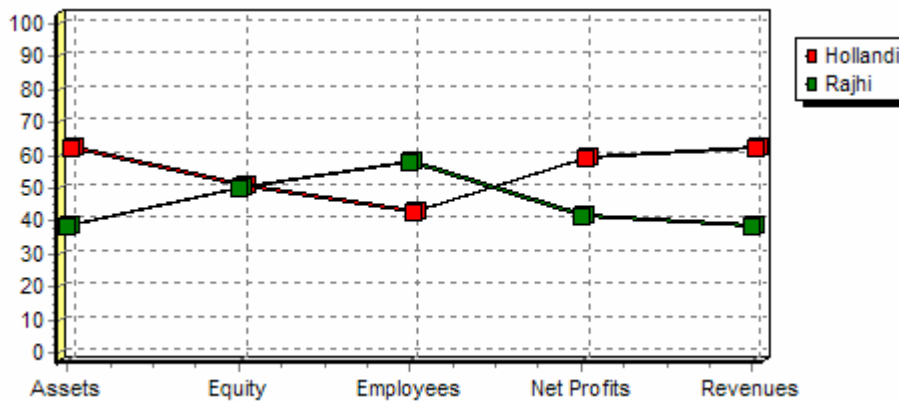


Figure 4 : Peer Contributions for Jazira bank (Stage 1: profitability)

frontiers consisting of 'best practice' DMUs in the same field. In this study, a two-stage output-oriented DEA approach is adapted to analyze the relative technical efficiency of 48 Saudi stock-traded companies. Surprisingly, only 30% of the companies analyzed in both models of all sectors are fully efficient. Most of the 'worst practice' companies are in the service sector. An important conclusion emerges from the present efficiency analysis that is banks show better performance over other companies in other sectors, suggesting that having a good management and a highly effective decision making process are essential to performance efficiency.

As Saudi markets will soon be widely open to international investors and bankers as an inevitable result of joining the World Trade Organization, strong competition in local markets will continue to increase in the years to come. Therefore, inefficient companies must improve their operating performance, merge with more efficient companies, or exit the market.

Additional research is needed to determine the relationship between company performance and its size. Also, the relationship between profitability and/or marketability and the company's size. Company scale efficiency also needs to be investigated.

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