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MEASURING AND EVALUATING TECHNICAL EFFICIENCY OF A LIBYAN CONSTRUCTION COMPANIES THROUGH DATA ENVELOPMENT ANALYSIS

Abdullah Ahmad A. Eltaief
Universiti Teknologi MARA, Malaysia

Saadiah Mohamad
Universiti Teknologi MARA, Malaysia

Badrul Hisham Kamaruddin
Universiti Teknologi MARA, Malaysia

Abstract

This paper attempts to investigate this claim through measuring the technical efficiency for 26 companies surveyed in 1995-2005 in Libyan construction industry. In measuring technical efficiency data envelopment analysis (DEA) will be adopted. Further, this paper looks at determine the level of technical efficiency where as the input variables comprise assets, equity and number of employees. The output variables used were revenue and profit. The results from this study show that the majority of the Libya companies are operating inefficiency. The overall (pooled) technical efficiency (TE) estimate was 0.807. Whereas 69 percent of the firms were operate above the average, and 31 percent below it. Only 2 firms scored full efficiency (TE = 1.00) while 24 others were inefficient. Detailed analysis showed that majority of firms suffer over employment of workers, overstatement of assets and equity and using obsolete technology. The results also showed that larger firms are more efficient than the smaller firms, and technical efficiency is not a consequence of firm's age, and that change of government policy has a strong effect on technical efficiency. That is, after the government implemented the open door policy, technical efficiency scores gradually increase.
Keywords: Libya; Technical efficiency; Data envelopment analysis, Construction firms; Scale of production; Optimal.

Introduction

The strong contribution of the construction industry to the Libyan economy is undeniable. Libya is a resourceful country with raw-material and natural resource primarily relying on oil and natural gas as the main source of income. This prompted the investigation into the construction industry in order to increase production of its member firms to support GDP growth. Libyan economic policy reveals that after 1978, Libya applied socialist system. Moreover, the United Nations also imposed sanctions on Libya in 1992. When the United Nations suspended its sanctions regime in 1999, Libya began to introduce socioeconomic reforms and moved from the socialist system to the open market system. In 1978 Libya had fully transformed itself into a socialist system and that has lasted for more than three decades John (2008). The change to the socialist system offers the new Libyan economic system a balanced relationship between worker and owners, and also contributes to solving problems at work and wages Qadhafi (1981).

The suspension of the UN sanctions occurred at a time when global demand for petroleum product was increasing, and oil prices were improving. As a result, Libya's hydrocarbon-based revenues increased sharply 1999-2003, contributing about 50 percent to GDP, 97 percent to exports, and 75 percent to government revenue; private investment's contribution to GDP was only 2 percent. Hence, Libya is heavily dependent on the oil and gas sector. Nevertheless, the economy remained largely state-controlled. In March 2004, the Central Bank established that 75 percent of employment remained with the public sector.

In that way the construction industry is important to support of economic growth, not less than important of banking sector. Although, upon review of the literature of construction industry did not find any study to introduce this vital sector, despite, this sector has contributes about 5 percent to GDP and employs about 20 percent of the 1.6 million of the whole manpower, This demonstrates the low level of efficiency in this sector, this study seeks to identify the causes of low efficiency And thereby achieve to fill the gap in literature study in Libya Central Bank of Libya (2004). Construction firms, like other firms, are owned by the government which may explain the reason behind the low efficiency due to low competition Central Libyan Bank (2004). The Libyan economy also faced mounting employment problem, compounded by high rate of population growth and a low rate of job creation and low efficiency. Consequently, in 2003, Libya shifted from public ownership to open market and invited foreign and local investors to invest in all active economic corners John (2008). Hence, the issue that is raised in this study is that whether the government policy of open market has increased efficiency or productivity of the construction companies.

The low efficiency in the construction industry could be explained by some factors that affect performance. Inabilities of the firms to take advantage of scale economies, difficulties in getting some resources in terms of qualified human capital and skills, and the industry's dependency on government fund might possibly be some of the reasons for low efficiency. Also, it appears that almost all the firms, particularly the ones that have been long in the business, adopt weak technology, and the majority of workers have low level of education and knowledge. An important cause could be the weak system of incentive and salary which Libya applies based on the old system of salary, unchanged since 1981.

The objective of this study is to evaluate technical efficiency levels of Libya construction industry, and examine the impact of open market on efficient firms by using data collected for the period 1995-2005. Technical efficiency (TE) examines how efficiently firms use the available inputs to produce outputs and estimation the slack input and the target to reach fully efficiency. In other words, we see that there are two possible definitions of efficiency depending on the purpose of evaluation. According to Wonsik (2003), one might be interested in possible reduction of inputs (in DEA, called the input-orientation) or augmentation of outputs (the output- orientation) to achieve TE. Improved TE is important as it supports the GDP growth and contributes to diversification of income as well as reduces the dependence on oil for Libya.

This paper is organized into five sections. The next section discusses the relevant literature followed by the methodology explanations, empirical results, and conclusion and suggestions for future research.

Literature review

There is abundance of literature on firm-level frontier efficiency studies. However, the bulk of studies go to analyze firms in developed countries and financial institutions, particularly banks. There are limited studies investigating the other types of industries such as manufacturing, construction and agricultural; and the public sectors such as schools and hospitals.

In a Malaysian study, Rahmah & Noorasiah (2007) investigated the claim through measuring TE for 264 Malaysian manufacturing firms surveyed for the period 2001-2002 using DEA. Factors that improve efficiency were identified to be research and development, training and level of technology. The results showed that the majority of Malaysian firms are operating inefficiently and have an efficiency score index of less than 0.50. moreover another study done by Mohd Noor & Ismail (2004) used technical efficiency and its determinants for 138 manufacturing firms. They found that only 6.3% firms were fully efficient at CRS estimates, and 92.6% firms were not efficient with less than 0.5 efficiency score. The estimation at VRS increases the percentage of firms that efficient and reduces tremendously its percentage with less than 0.5 efficiency score. Further this study found that level of mechanization and firm size significantly positively determine the level of technical efficiency

Studies of technical efficiency (TE) in the long run usually aimed to look at its contribution to productivity and efficiency growth. This kind of studies uses time series or panel data in computing TE. A study by Wu (2000) in all APEC countries using the stochastic frontier approach found that technical progress was a dominant contribution of TFPG, while the technical efficiency even though positive but very small. In Singapore, there were few studies on technical efficiency using stochastic frontier approach Mahadevan (2000) and Tay (1992). Measuring TE for the individual enterprises is more meaningful because of micro data and further analysis on factors that influenced TE can be investigated. Firms' data is also considered as more efficient than the aggregated time series data since the former will have the advantage of overcoming some of the measurement problems and aggregation bias associated with aggregate industry data. Many studies of TE are conducted at firms' level (see for example Danlin et al. (2001) and Wu (2003) and Yao & Zhang (2001). Many empirical studies on farms' efficiency have been undertaken using non-parametric approach Byrnes et al. (1987), Chavas & Aliber (1993), Featherstone et al. (1997), Kalaitzandonakes et al. (1992) and Weersink et al. (1990).

Byrnes et al. (1987) found that the major source of technical inefficiency in the Illinois grain farms was scale inefficiency. Weersink et al. (1990) found that the source of efficiency in the Ontario diary farms was pure technical allocation and non-optimal scale of production. Whereas in other studies efficiency was related to farm size, financial structure and degree of specialization (see for example Chavas & Aliber (1993) and Featherstone et al. (1997) and Kalaitzandonakes et al. (1992). In China enterprises efficiency was affected by incentive, location, wage system, vintage capital, FDI and R&D investment Wu (2003) and Yao & Zhang (2001). A study by Wu (2003) found that efficiency best performers were transport machinery and sugar processing, whereas the worst performers were consumer electronic and telecommunication and equipment repair. Wu (2003) showed that 45% of firms in the sugar beets industry were efficient.

Danlin et al. (2001) studied technical efficiency in cotton enterprises in the Soviet Union. They found that more man half of the enterprises have estimated rate of TE in excess of 94% and 90% of the firms were at least 84% technically efficient. They concluded that the normative methods employed by the Soviets to provide a reasonably effective mechanism for monitoring and controlling overt enterprises technical efficiency. Furthermore, the study conducted in Middle East in Egypt by Abdelati (2004) investigate in productivity growth in Egyptian manufacturing firms between 1966-1986 and variations in TE in the glass sub-sector of manufacturing using DEA model. One section analyzes the development of manufacturing before and after Infitah (open market), explores the impact of the Infitah liberalization policies that began in 1974, the finding refer the mean firm efficiency lies between 78 percent and 95 percent depending on the estimation method. There was no evidence of improvement over time. The firm characteristics most significantly associated with these rankings were the age and size of the firm. Larger firms, most of which were public, outperformed the medium and small private firms. Lower education level of the manager, higher replacement cost of capital, and more complete book-keeping records also helped explain variations in productive efficiency.

Another study which also adopted DEA to measure TE in the manufacturing sector was conducted by Ilker & Birdogan (2007) evaluated TE for a Turkish Glass Company located in Istanbul. While labor, machinery, and raw material were taken as inputs, and smooth glass and rough glass were treated as output for efficiency analysis in this research, the results reveal that 4 out of 7 workshops are inefficient and their efficiency scores were between 0.80 and 0.90. The results also identified that the company needed some modification in terms of labor as this is a potential input factor. Only 3 workshops scored full efficiency of 1.00. In another study conducted in China by Yu-Feng Ma & Yeoung-Jai Goo (2005) on China's high-and new-technology industry development zones covering the period 1996-2002 involving manufacturing firms in 53 zones using DEA reveals that average TE of zones is related to firm size, exports and R&D expenditure, but showed no significant relationship with location. Efficiency scores estimated were less than 1.00, but greater than 0.90.

Roberto Alvarez & Crespi (2003) also evaluated the TE of small manufacturing firms in Chile using survey data and the DEA. They found that TE is positively associated with the experience of workers, modernization of physical capital and innovation in products. In contrast, other variables such as outward orientation, owner education and participation in some public programs do not affect the efficiency of the firms, and they found that the average efficiency of the sample was 65 percent and the efficiency score was between 91 percent and 34 percent. another study by Saba Vahid & Taraneh Sowlati (2007) on the Canadian wood-product manufacturing for the period 1993-2003 using DEA, they found that all subsections had improved their TE during the study period and the average efficiency score for all subsections was 0.53. As this short survey has been made clear, there is still considerable uncertainty about the nature of the relationship between corporate governance system and TE, particularly in developing countries. Another aim of this study is to provide new evidence in this regard by relying on TE as a measure of performance, and by simultaneously controlling for three sets of potentially relevant corporate governance variables: change of government policy, size of firm and age of firm.

Methods

The level of technical efficiency in a particular firm is characterized by the relationship of observed production and some ideal or potential production. The measurement of firm specific technical efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a firm's actual production point lies on the frontier, it is perfectly efficient; otherwise, it lies below the frontier that is technically inefficient, with the ratio of the actual potential production defining the level of efficiency of the individual firm McCombie (1998).

Farrell (1957) definition of TE led to the development of methods for estimating the relative TE of firms. The common feature of these estimation techniques is that information is extracted from extreme observations from a body of data to determine the best practice of production frontier. Despite this similarity, the approaches for estimating TE can be generally categorized under the distinctly opposing techniques of parametric and non-parametric methods Seiford & Thrall (1990). Charnes et al. (1978) used the DEA as an alternative method to analyze technical efficiency, allocative efficiency and economic efficiency.

At the outset, to understand this approach more clearly, we can assume there are N numbers of firms; each firm has a number of producing M outputs by using K inputs. Within the typical of non-parametric approach that has the advantage of examining decision making units (DMUs or firms) operating multi-inputs and multi-outputs (e.g., banks); those inputs and outputs are often reduced to a single virtual inputs and virtual outputs Aly Hassan et al. (1990) and Shunxiang et al. (2003). The definition of technical efficiency which is the firm’s ability to minimize its inputs was utilized to produce a given bundle of outputs. In other words, TE (x, y) represents the radial contraction in inputs for a firm to produce a given output vector y, if it is operated on the production frontier. That represents fully efficient firms lying on the production frontier and having efficiency score index of 1.00. On the other hand, we can say full (100 percent) efficiency is attained by any DMU if and only if none of its inputs or outputs can be improved without worsening some of its other inputs or outputs.

The inefficient firms have efficiency scores between 0 and 1, and 1 – TE (x, y) is the inefficiency due to not adopting the best production technology. Here we can use the vector that represents the virtual input and output to identify the target and slacks needed to get fully efficiency. Specifically, λ is a vector describing the percentages of other producers used to construct the virtual producer. λX and λY are the input and output vectors respectively for the observed producer. In other words, X and Y describe the virtual inputs and outputs, respectively. The value of θ is the producer's efficiency optimal target. Additionally, Farrell’s technical efficiency can be measured with respect

to production frontiers characterized by constant returns to scale (CRS)Aly Hassan et al. (1990). The linear programs of the Charnes, Cooper and Rhodes (1978, 1981) (or CCR model) are used to analyze technical efficiency (TE) as follows:
CRS technical efficiency for firm j_0 is:

$$TE_{CRS}(x,y) \quad \theta^* = Min\ \theta_{CRS}$$
$$Subject \quad to$$
$$\sum_{j=1}^{N} \lambda_j y_{ij} \geq Y_{ij0} \qquad i = 1.......m \tag{1}$$
$$\sum_{j=1}^{N} \lambda_j x_{rj} \leq X_{ij0} \qquad r = 1......K$$
$$\lambda_J \geq 0 \qquad j = 1........N$$

Where DMU_0 represents one of the n DMUs under evaluation, and X_{ij} and Y_{ij} are the ith input and rth output for DMU_0 reprehensively. Since $\theta = 1$ is a feasible solution to (1), the optimal value to (1), $\theta \leq 1$.is $\theta^* = 1$, then the current input level cannot be reduced (proportionally), indicated by the frontier. θ^* represents the (input-oriented) efficiency scores of DMU_0. The input reduction or output increasing is called slack, so after calculating the model in Equation 1, slack value may exist in input or output. So imposing s is the slack in Equation 2,

$$s_i^- = \theta^* x_{i0} - \sum_{j=1}^{n} \lambda_j x_{ij} \qquad i = 1,2,......., m$$
$$s_r^+ = \sum_{j=1}^{n} \lambda_j y_{rj} - y_{r0} \qquad r = 1,2,.......s \tag{2}$$

where s_i^- and s_i^+ represent input and output slacks, respectively, an alternate optimal of $\theta^* = 1$ and $\lambda_j^* = 1$ exist when we calculate model 1, if we obtain $\theta^* = 1$ and $\lambda_j^* = 1$, then we have zero slack, as we will more explain later in benchmark.

We use the CCR model which has constant return to scale (CRS) characteristic. Returns to scale refers to a technical property of production that examines changes in outputs subsequent to a promotional change in all inputs (where all inputs increase by a constant factor). If output increases by that same proportional change then constant returns to scale (CRS) exists for the firm or DMU. Sometimes, it is referred simply as returns to scale. If output increases by less than that proportional change, there is decreasing returns to scale (DRS). If output increases by more than that proportional, there is increasing returns to scale (IRS). The model of CCR aims to minimize the inputs while satisfying at least the given output level. This is called the input-oriented model. There is another type of model called the output-oriented model that attempts to maximize the output requiring more of any observed input values. This study uses the input-oriented model. For the input-oriented DEA estimation model, we use 3 inputs (asset, equity and employees) and 2 outputs (revenue and profits). Table 1 shows the efficiency scores of the 26 DMUs with their ranks and the reference set benchmarked for each firm. The reference set (benchmarked) is defined as follows:

For an inefficient DMUo , (i.e., DMU on observation) from n DMUs, we define its reference set E_o , by

$$E_o = \{ j \mid \lambda_j > 0\}, \quad (j \varepsilon \{1,....,n\}) \tag{3}$$

DMUo is fully efficient when (1) we have the efficiency score $(\theta^* = 1)$ and (2) all input and output slacks are zero. This efficiency is CCR-efficient (both technical efficiency and mix or allocative efficiency). If $\theta^* = 1$, but at least one of the slacks is not zero then we call this DMU weakly efficient. In this case, $\theta^* = 1$ is referred to as technical efficiency, but the second condition (i.e., at least one non zero slack) refers to mix efficiency. In this case, if at least one of the slacks is not zero, we have both technical and mix inefficiency, which is also CCR-inefficient. Whenever we have mix inefficiency the input slack (S^-) shows the exceeded amount of input that cause inefficiency in comparison to the related reference to that DMU. The output slack (S^+) shows the shortfall amount of output that cause inefficiency. In order to make an observed DMUo efficient, we should decrease its inputs (Xo) to Xo^* which are the optimal input to make DMUo efficient and its output (Yo) also should increase to Yo^* :

$$\begin{aligned} X_o^* &= \theta^* X_o - S^- \\ Y_o^* &= \theta^* Y_o + S^+ \end{aligned} \tag{4}$$

The score column shows the CCR efficiency. As can be seen, there are seven firms which have full efficiency or CCR efficiency (i.e., firms 1,4,6,11,13, 17 and 25) and for these seven DMUo, $\theta^* = 1$ and all input and output slacks are zero.

Source of data

Data for this study were obtained from secondary sources relating to 26 Libyan construction firms for the period 1995-2005. They are located in all states and operating at different sizes - small and large. The sample consists of 6 types of enterprises, namely, iron and steel; cement; bricks; glass; paint; and pipes. The variables used to analyze cost efficiency are three inputs (labor, physical capital and financial capital) and two outputs (revenue and profits).

The labor expense is proxied by wages and benefits. The physical capital expense consists of building and equipment depreciation. The financial capital is total equity. The price of labor is calculated by dividing total personnel expenses on wages and fringe benefits by total number of employees. The price of physical capital input is computed by dividing total capital expenses by total assets (Tsu-Tan et al., 2008). The price of financial capital input is computed by dividing total equity by total tax expense. All the companies are state-owned and hence do not have shareholders. Therefore, in consideration for the capital funds that they received from the state government, the firms pay income taxes.

Empirical results

This section focuses on the results of technical efficiency by using Equation 1 model to analyze the data. Technical efficiency estimations are made using the nonparametric DEA program excel solver version 2003 by Zhu Joe Zhu (2003) which was adapted from the former form by Coelli T J (1996) which employed input oriented. This method will produce results at constant returns to scale (or CRS). The best performance will be determined through their ability in producing output with the minimal use of resources (inputs). The efficiency score of technical efficiency stated that the optimal input should be used in order to produce certain level of output, and the slack input or output should decrease input to reach full efficiency of 1.00.

DEA measures TE of Decision Making Units (DMUs) and provides a basis for comparing the TE of each unit with the other units. This study applies the DEA model to firms in the Libyan construction industry with full efficiency indicated by 1.00 and that which is less than 1.00 is inefficient. Table 1 refers to the efficiency scores of firms in the sample covering the period 1995-2005 and also the ranking of these firms from the highest to the lowest, with the average efficiency score being 0.895. The number of firms which have efficiency score greater than the average was 17 DMUs representing 65 percent and 9 DMUs scored less than the average which represents 35 percent. The number of firms that scored full efficiency in 1995 was only 7 and this represents 27 percent and 19 firms are inefficient. The reasons for low level of efficiency, is a sanction imposed on Libya that effect to obsolescence of machinery, and high cost of imported spare parts. Over the period 1995-2005, the lowest efficiency score is 0.417 and the highest efficiency score is 1.00 with an average efficiency score efficiency of 0.807 that indicates most firms are operating inefficiently. Furthermore, we have 15 firms operating more than 0.807 or 69.23 percent and 30.77 percent are operating less than the average, and only two companies have full efficiency scores which represent 7.69 percent and 24 are inefficient representing 92.31 percent. The results reflect that the majority of the firms are operating inefficiently and should increase their outputs by using the same level of inputs; hence producing at the low frontier stage of production.

The estimation of technical efficiency using CRS approach produces higher number of firms that are inefficient. In Table 2, analysis by types of enterprise shows that the first seven are operating at the highest level of efficiency score, that is, equal to 1. In the CRS model, this means that the seven firms are operating at constant returns to scale. Table 2 shows that there are 9 companies operating at decreasing returns to scale and the remainder at increasing returns to scale. Hence, based on these principles, the results from this study show that the majority of the companies are operating at an inefficient level which represents the DRS, and technically inefficient due to not adopting the best production technology.

Table 5 identifies how much reduction among the inputs or increment among the outputs needed to reach full efficiency, by using the reference set (benchmark) mode to identify the optimal product. Table 5 displays the analyzed data for 1995 and shows the level of input slack for assets, equity and employees. The manner in which the analysis is done is that the inputs of the observed DMU should be reduced to attain full efficiency while holding the same level of outputs. For instance, Libda Cement

Plant should reduce 4.37 percent of its assets, 4.37 percent of its equity, 10.39 percent of its employees, and increase its profits by 99.98 percent in order to attain full efficiency score. Another firm, Swany Baked Brick Plant, which has an efficiency score of 0.733, needs to reduce its inputs by as much as 26.70 percent for assets, 26.70 percent for equity and 41.34 percent for employees in order for its estimated efficiency score to reach the optimal level. Further, Tables 6, 7 and 8 refer to the slack of asset, equity and employees, respectively. The majority of companies are operating in weak efficiency because these companies required very large physical and financial capital as well as number of employees. These reasons drive them to incur high production cost and moreover the sanctions imposed on Libya previously had resulted in loans not been able to be provided to the people and for development projects. These are some of the reasons behind the low level of efficiency.

Table 9 and Figure 2 show the efficiency scores of firms for the period 1995-2005 based on firm size. There are several ways of classifying firms by size. Employment, sales and total assets are the most commonly used (Karl & George (2000). For the purpose of this paper, we used total assets. We divided the sample into two groups based on the value of total assets. 15 million LD or more is the big sized firm and the small sized firm has total assets less than the amount. Looking at the efficiency scores across years, the bigger size firms seem to be more efficient than small size firms.

Table 9 score TE related to the size firms over the period 1995-2005

Years	Big size	Small Size
1995	0.937536129	0.853388101
1996	0.922613865	0.80784113
1997	0.858693189	0.622943142
1998	0.915818985	0.733859199
1999	0.908013201	0.737412731
2000	0.915778178	0.795340589
2001	0.742792686	0.547028306
2002	0.869739473	0.786379661
2003	0.882295205	0.664486877
2004	0.927689532	0.714567234
2005	0.937124984	0.597856359

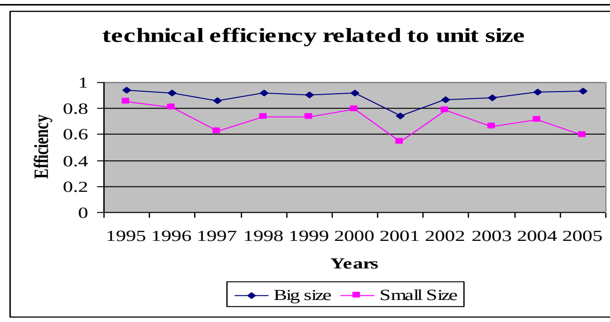

Figure 2-Average efficiency related to the size

Table 10 and Figure 3 show the efficiency scores of firms based on dates of their establishment. Again we divided the sample into two groups, old and new. The old was established before 1980 and the new was established after that. From the scores, we find that generally the technical efficiency scores of firms are not a consequence of age. That indicated that the date of establishment is not important.

The next controlling variable, change of government policy, is evidenced in Figure 1, whereby it shows that the number of firms which scored full efficiency across the period of study is mainly in the 2003-2005 period. The period 2000-2001 has the lowest number of firms' efficiency, and firms experiencing average efficiency are mainly in the 2003-2005 period. Up to 2005, the efficiency scores ascended from 0.782

to 0.821. The lowest rate was in the period 1995-2001 of which the efficiency scores declined from 0.895 to 0.660. All these were related to the change of the government policy to the open market and the United Nations suspending the sanctions which were impose on Libya from 1992 up to 2003.

Table 10 score TE related to age over the period 1995-2005

Years	Old	New
1995	0.89410208	0.89682215
1996	0.895300414	0.835154582
1997	0.741954297	0.739682034
1998	0.868165905	0.781512279
1999	0.848304988	0.810244057
2000	0.860343191	0.860040005
2001	0.670298985	0.649639604
2002	0.836337741	0.826193687
2003	0.811395826	0.752140743
2004	0.785185467	0.857071299
2005	0.770506584	0.764474758

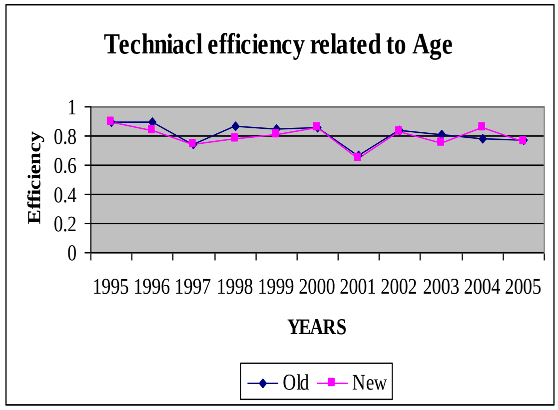

Figure 3 -Average efficiency related to the Age

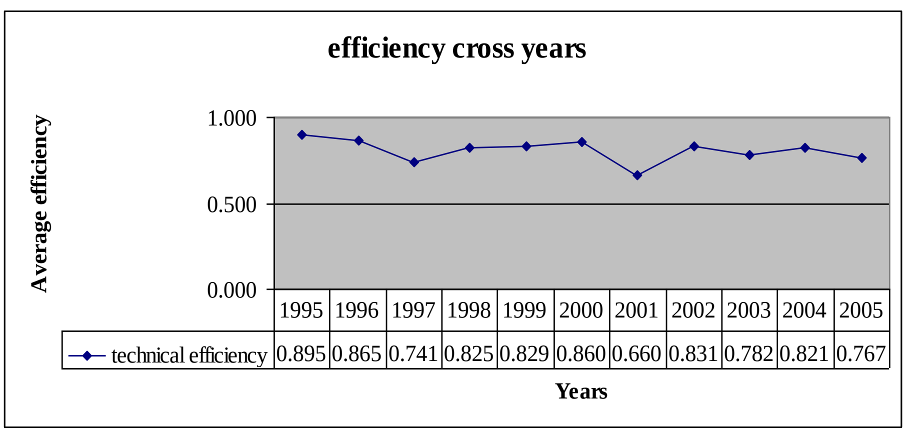

Figure 1 efficiency scores across over 1995-2005

This study suggests that Libyan firms should (slack) reduce their inputs in order to produce the same level of output or vis-à-vis they must increase their output with the same level of inputs identified in Table 3 for the input variables of assets, equity and employee. In order to attain full efficiency, firms should operate well enough to reach the target as depicted in Table 4. That shows the specified capacity that firms need to produce. Meanwhile, Tables 6, 7 and 8 specify the types of shortages that firms need to look into to attain full efficiency.

Conclusion and policy implication

Generally, the majority of firms in Libyan construction sector are operating inefficiently. AS depicted in Table 1, two companies namely, El-Fataiah Cement and Samaka Painting are operating in full efficiency, representing 7.69 percent of the sample, while 69.23 percent are operating above the average efficiency score of 0.807 and 30.77 percent are operating below this average score. The results also show that the bigger firms are more efficient than the smaller ones, technical efficiency scores are not a consequence of age, and change of government policy has strong effect on TE in that after opening the market, efficiency scores gradually increase.

Technical efficiency is crucial for companies to compete especially in the era of globalization and liberalization. This study shows that the majority of firms in Libya construction industry are operating inefficiently and some of the firms do not optimize the use of their resources that could contribute significantly to their efficiency level. This study also suggests that Libyan firms should (slack) reduce their inputs in order to produce the same level of output or vis-à-vis they must increase their output with the same level of inputs as outlined in Table 5 for the inputs: assets, equity and number of employees.

To increase the level of technology in Libya construction industry, firms must operate at a bigger scale. Besides easier adoption of advanced technology by bigger size firms, the advantage of operating at larger scale could also be viewed from economies of scale. When firms operate at large scale, they would gain from economies of scale that could reduce average cost of production; hence they will have comparative advantage in pricing by lowering price per unit output. Since the majority of inefficient firms are operating at increasing returns to scale, only 3 firms with full efficiency are operating in constant returns to scale and 7 firms are operating in decrease returns to scale. Those firms which work in IRS should increase using their resources to get CRS and the companies that operate in DRS should decrease inputs to reach CRS which refers to full efficiency. Additionally, in terms of size, the bigger firms are more efficient than smaller firms, and generally technical efficiency scores of firms are not a consequence of date of establishment or age of the firm.

The third controlling variable which is change of government policy reveal that the period of study 2003-2005 has high number of firms with full efficiency and the period 2000- 2001 has fewer number of firms with full efficiency. Firms that obtain average efficiency scores after the open market have scores gradually increased from 0.782 to 0.821, and the period 1995-2002 which has lower scores descends from 0.895 to 0.660. These are implications of the change of government policy to the open market policy, and the United Nations suspending the sanctions imposed on Libya from 1992 up to 2003.

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