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Full Length Research Paper

An investigation of cost, revenue and profit efficiency: The case of Iranian companies

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Using data envelopment analysis technique, this research firstly investigated cost, revenue and profit efficiency of automobile and parts industry of companies listed in Tehran stock exchange during the years 2006 to 2009. Secondly, it explored potential relationships between a few variables including size, operating costs, profitability, asset turnover ratio and different efficiency measures calculated in the first stage. The empirical results indicated that average cost, revenue and profit efficiency of surveyed companies over the given period were 0.51, 0.57 and 0.27, respectively. In this context, inefficient companies, using efficiency frontier concept and considering benchmark units, could approach efficient levels, as it was treated in this paper. Moreover, the findings arrived from exploring potential determinants of efficiency revealed that there was a significant positive relationship between return on equity, sales to fixed assets and cost efficiency between sales to fixed assets, log. total assets, sales to total assets and revenue efficiency and finally between sales to fixed assets, log. total assets and profit efficiency. These results implied that the more a company was large, the more it was revenue and profit efficient. Also, they highlight effective role of fixed assets in firms operations and generating profits.

Key words: Data envelopment analysis, cost efficiency, revenue efficiency, profit efficiency and Iranian companies.

INTRODUCTION

Performance measurement and evaluation are fundamental to management planning and control activities, and accordingly, have received considerable attention by both management practitioners and theorists (Toloo et al., 2008).

According to the neo-classical microeconomic theory, the firm behavior is usually characterized by profit maximization. Therefore, it is generally interesting to test if the empirical production data are consistent with the profit maximization hypothesis (Afriat, 1972; Hanoch and Rothschild, 1972; Varian, 1984). If profit maximization fails empirically, one may proceed to estimate the resulting loss. The notion of profit efficiency was first introduced by Nerlove (1965) in the context of parametric estimation of production functions. The nonparametric estimation of profit inefficiency can rely on the same well-established theoretical principles and axioms (Banker and Maindiratta, 1988; Färe and Grosskopf, 1995). In the recent years, the measurement and analysis of profit efficiency has attracted increasing attention in the operational research literature (Kuosmanen et al., 2010).

Generally stated, each efficiency concept provides distinct valuable information with which management can trace the sources of inefficiency. Such analysis helps management enhances their likelihood of survival in competitive markets (Isik and Hassan, 2002). Examining efficiency using a profit function allows us to capture inefficiencies that result from choosing a suboptimal output level or mix in addition to choosing a suboptimal input level or mix. Efficiency should be examined from both perspectives to provide a true depiction of the level

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of efficiency present in the market (Anderson et al., 2000).

In other words, the objective of maximising profits does not only require that goods and services be produced at a minimum cost. It also demands the maximising of revenues (Maudos et al., 2002). It is true that cost efficiency is a wider concept than technical efficiency, since it refers to both technical and allocative efficiency, but profit efficiency is an even wider concept as it combines both costs and revenues in the measurement of efficiency (Pasiouras et al., 2009). Computing profit efficiency, therefore, constitutes a more important source of information for management than the partial vision offered by analyzing cost efficiency. In fact, the limited evidence available now shows that there are higher levels of profit inefficiency than of cost inefficiency. This result supports the importance of inefficiencies on the revenue side, either due to the wrong choice of output or to the mispricing of output (Maudos et al., 2002).

As a supporting evidence for the above-mentioned claim, the study by Berger and Mester (1997) in financial institutions, for example, shows that, contrary to initial expectations, profit efficiency is not positively correlated with cost efficiency, suggesting the possibility that cost and revenue inefficiencies may be negatively correlated. This result indicates that a bank with higher costs may compensate this apparent inefficiency by achieving higher revenues than its competitors, either using a different composition of its vector of production or by benefiting from greater market power in pricing derived from its specialization. Thus, a measurement of cost inefficiency may be contaminated by the composition of output, so that an output vector of higher quality could be more costly but not necessarily inefficient. The estimation of a frontier profit function instead can capture productive specialization, allowing the higher revenues received by banks that produce differentiated or higher quality outputs to compensate for the higher costs incurred.

In this paper, using DEA, cost, revenue and profit efficiency of a sample consisting of companies listed in Tehran stock exchange during 2006 to 2009 have been examined. The paper also examines several proposed sources of the differences in measured efficiency, including size, operating costs, profitability and asset turnover ratio.

The reminder of this paper is structured as follows: relevant literatures relating to different efficiency measures and determinants; methodology and models used to estimate efficiency levels; Input, output and other variables used are described; empirical results; and finally some concluding remarks will be summarized.

LITERATURE REVIEW

Most of the existing literatures concerning the cost and profit efficiency concentrated specially on the financial institutions and banks efficiencies using parametric or nonparametric approaches. Moreover, these studies usually investigated some potential factors proposed to affect measured efficiency levels such as the effect of size, ownership type, corporate control and governance, macroeconomic factors, profitability, risk profile, environmental changes and so on. With respect to the size and its relationship to the efficiency, results seem controversial, that is, considering cost efficiency, some studies concluded a negative relationship (Isik and Hassan, 2002) and a few studies indicated a positive one (Delis et al., 2008; Srairi, 2010; Ray and Das, 2010). In addition, from a profit efficiency perspective, there is also a negative relationship (Isik and Hassan, 2002; Delis et al. 2008) or a positive one (Akhigbe and McNulty, 2005; Das and Ghosh, 2009; Srairi, 2010; Ray and Das, 2010). One interesting result obtained from few studies recognized a U-shape relationship between these two variables, in which the smaller and larger banks are less efficient than mid-size banks (Ariff and Can, 2008; Margono et al., 2010).

On the relationship between bank ownership type and efficiency, a large number of studies have compared efficiency of public-owned banks with that of private-owned banks and/or foreign banks with domestic banks. Some studies revealed public-owned banks in comparison to private-ones were less cost and profit efficient (Isik and Hassan, 2002; Ariff and Can, 2008), more cost and profit efficient (Ray and Das, 2010), more cost efficient (Delis et al., 2008), less cost efficient (Margono et al., 2010), more profit efficient (Das and Ghosh, 2009) and less profit efficient (Delis et al., 2008). Concerning the comparison of foreign and domestic banks, Isik and Hassan (2002) concluded that foreign banks were more cost and profit efficient. Tahir et al. (2010) showed that foreign banks were less cost efficient but more profit efficient, and finally Margono et al. (2010) illustrated that foreign banks were more cost efficient.

Previous studies have also explored the relationship between banks' profitability, operating costs and efficiency. For example, Srairi (2010) and Ariff and Can (2008) both recognized a positive relationship between profitability and efficiency and a negative one between operating costs and efficiency.

Finally, a few researchers have also examined the correlation between some variables such as corporate control and governance, macroeconomic factors, risk profile and environmental changes with efficiency. In brief, Isik and Hassan (2002) found that the efficiency of banks whose CEO and chairman of the board is the same person is significantly lower than that possessed by banks without a similar governance structure. They also found that banks, whose shares are publicly traded in the Stock Exchange, are more cost efficient. Fitzpatrick and McQuinn (2005) reported that an increase in the GDP growth rate for a particular country decreases the profit inefficiency of a credit institution. Conversely, an increase in the unemployment rate in a country increases the level of inefficiency. Turning to the impact of risk and environmental changes, Ariff and Can (2008) indicated that banks which have a higher ratio of loans to assets tend to incur higher credit risk, and thus, higher loan-loss provisions, and are less efficient. Also there is significantly positive correlation between China's WTO accession and bank efficiency.

Unfortunately, there are very scarce studies examining efficiency scores among companies. As a few studies concerning this field of study, we can refer to the Goto and Tsutsui (1998), Kozmetsky and Yue (1998) and Shao and Lin (2002). For example, Goto and Tsutsui (1998) using data envelopment analysis (DEA) measured both overall cost efficiency and technical efficiency to compare bilaterally between Japanese and US electric utilities in the periods from 1984 to 1993. 9 Japanese and 14 US vertically integrated investor-owned electric utilities were examined in the study. The main empirical results include: (1) the overall cost efficiency of Japanese electric utilities was consistently higher than that of US electric utilities from 1984 to 1993; (2) Japanese utilities were more efficient than US utilities in terms of technical, allocative and scale efficiency; (3) allocative inefficiency was a main source of overall cost inefficiency for the Japanese utilities.

Kozmetsky and Yue (1998) presented a performance evaluation for the global semiconductor industry over the periods from 1982 to 1994. The evaluation is conducted via a series of comparative analyses based upon company-level variables. It includes the comparisons of market share and economic growth, employment and labor productivity, cost efficiency measured by the DEA approach (inputs: cost of goods sold; selling, general and administrative expenses; total assets and outputs: net sales), profit margin, R and D expenditure ratio, and growth trend of company's market value. The paper shows that U.S., Japanese, and emerging South Korean and Taiwanese semiconductor companies have become the major competitors in the global semiconductor industry. These companies hold different comparative strengths in terms of the multiple evaluation criteria employed in this paper.

Shao and Lin (2002) presented an approach to investigating the effects of information technology (IT) on technical efficiency in a firm's production process through a two-stage analytical study with a firm-level data set. In the first stage, a nonparametric frontier method of data envelopment analysis is employed to measure technical efficiency scores for the firms. The second stage then utilizes the Tobit model to regress the efficiency scores upon the corresponding IT investments of the firms. Strong statistical evidence is presented to confirm that IT exerts a significant favorable impact on technical efficiency and in turn, gives rise to the productivity growth that was claimed by recent studies of IT economic value.

To the best of our knowledge, there is no study investigating companies from a special industry using cost, revenue and profit efficiency measures altogether. Therefore, this study is new in some reasons: firstly, it investigates company-level efficiency measures in a special industry among companies accepted in Tehran stock exchange. Secondly, it takes into account all of cost, revenue and profit efficiency, not one or some of these efficiency measures. And finally, it explorers most probable determinants of efficiency proposed to affect different efficiency measures.

Non-parametric techniques in cost, revenue and profit efficiency estimation

Most literature relating to efficiency measurements has based its analysis either on parametric or non- parametric methods. The choice of estimation technique has attracted debate since no method is strictly preferable over one (Murillo-Zamorano, 2004). This paper uses the non-parametric DEA-based technique to analyze cost and profit efficiency of Iranian companies due to the following reasons. This is the first study of Iranian company's efficiency to consider all of cost, revenue and profit efficiency using a non-parametric method. DEA is a linear programming-based technique proposed by Charnes et al. (1978), which can be used to determine the efficiency of a group of decision-making units (DMUs) relative to an envelope (efficient frontier) by optimally weighting inputs and outputs. Additionally, DEA provides a single indicator of efficiency irrespective of the number of inputs and outputs. DEA has been applied in a number of fields, including education institution, healthcare, banking and high-tech manufacturing. A number of studies have used DEA as an evaluation technique, some of them have evaluated the efficiency of high-technology firms from various perspectives, including manpower (Reitsperger et al., 1993; Thore et al., 1996; Cooper et al., 2001; Despotis, 2005), cost (Kozmetsky and Yue, 1998; Kauffmann et al., 2000), technology (Linton and Cook, 1998; SubbaNarasimha et al., 2003), R and D (Oral et al., 1991; Linton et al., 2002; Verma and Sinha, 2002) and profits (Shao and Lin, 2002; Verma and Sinha, 2002).

The most important advantage of DEA is the capability of comparison between several DMUs with respect to the several criteria. Among other advantages of this non-parametric technique over the parametric methods, we can point to the no necessity of the functional form estimation. Using all of the existing information is another advantage of this method while the parametric methods lack this capability and analyze the data in a sample (Halkos and Salamouris, 2004).

Considering aforementioned advantages relating to DEA, simplicity of using this method in measuring efficiency and also widespread use of it in previous studies such as Isik and Hassan (2002), Ariff and Can (2008) and Ray and Das (2010), this paper employs this method in order to measure cost and profit efficiency of

DMUs.

Here, we present three non-parametric models: the well-known and widely used model for calculating cost and revenue efficiency, the model developed by Färe and Grosskopf (1997), Färe et al. (2004) and Zhu (2002) for calculating standard profit efficiency and a new model for calculating alternative profit efficiency.

Cost efficiency (CE)

To illustrate the non-parametric methodology for calculating cost efficiency, let us suppose that there exists N firms (i = 1,…,N) that produce a vector of q outputs yi = (yi1,…,yiq) ∈Rq++ that they sell at prices ri=(ri1,…,riq) ∈ Rq++ using a vector of p inputs xi=(xi1,…,xip) ∈Rp++ for which they pay prices wi=(wi1,…,wip) ∈Rp++. The cost efficiency for the case of firm j can be calculated by solving the following problem of linear programming (model 1):

$$\begin{aligned} &\text{Min} \sum_{p} w_{jp} x_{jp} \\ &\text{s.t.} \sum_{i} \lambda_i y_{iq} \geq y_{jq} \quad \forall q \\ &\sum_{i} \lambda_i x_{ip} \leq x_{jp} \quad \forall p \\ &\sum_{i} \lambda_i = 1;\ \lambda_i \geq 0; i = 1, \dots, N \end{aligned} \qquad (1)$$

The solution to which, x*j = (x*j1,…, x*jp) corresponds to the input demand vector which minimizes the costs with the given prices of inputs, and is obtained from a linear combination of firms that produces at least as much of each of the outputs using the same or less amount of inputs. If this hypothetical firm had the same input price vector as firm j would have a cost C*j =Σwpj·x*pj which, by definition, will be less than or equal to that of firm j (Cj =Σwpj·xpj).

Having obtained the solution to the problem, the cost efficiency for firm j (CEj) can be calculated as follows (model 2):

$$CE_j = \frac{\sum_p w_{jp} x_{ip}^*}{\sum_p w_{jp} x_{jp}} \qquad (2)$$

where CEj ≤1 represents the ratio between the minimum costs (C*j), associated with the use of the input vector (x*j) that minimizes costs, and the observed costs (Cj) for firm j.

Revenue efficiency (RE)

Zhu (2002) summaries the revenue efficiency model as (model 3):

$$\begin{aligned} &\text{Max} \sum_{q} r_j y_{jq} \\ &\text{s.t.} \sum_{i} \lambda_i y_{iq} \geq y_{jq} \quad \forall q \\ &\sum_{i} \lambda_i x_{ip} \leq x_{jp} \quad \forall p \\ &\sum_{i} \lambda_i = 1;\ \lambda_i \geq 0; i = 1, \dots, N \end{aligned} \qquad (3)$$

Like cost efficiency calculations, revenue efficiency is also calculated by using following model (model 4) after solving model 3 and obtaining vector of outputs.

$$RE_j = \frac{\sum_q r_j y_{jq}}{\sum_q r_j y_{iq}^*} \qquad (4)$$

Profit efficiency (PE)

Profit efficiency includes more extensive concept than cost efficiency because it investigates the effect of production vector on both cost and revenue. Profit efficiency is calculated by dividing observed profit of each DMU by maximum profit that can be obtained with respect to the other efficient DMUs. Model 5 presents the linear programming model related to the calculation of profit efficiency as follow: like cost efficiency, the calculation of standard profit efficiency can be done for the case of firm j, by solving the following problem (model 5) of linear programming proposed by Färe and Grosskopf (1997) and Färe et al. (2004):

$$\begin{aligned} &(\text{Max} \textstyle\sum_q r_j y_{jq} - \sum_p w_{jp} x_{jp} \\ &\text{s.t.} \sum_{i} \lambda_i y_{iq} \geq y_{jq} \ \forall q \\ &\sum_{i} \lambda_i x_{ip} \leq x_{jp} \ \forall p \\ &\sum_{i} \lambda_i = 1;\ \lambda_i \geq 0; i = 1, \dots, N \end{aligned} \qquad (5)$$

The solution to which corresponds to the vector of outputs y*j = (y*j1,…,y*jq) and the input demand vector x*j=(x*j1,…, x*jp) which maximise the profits with the given prices of outputs (r) and of inputs (w). This solution is obtained from a linear combination of firms that produces at least as much of each of the outputs using the same or less amount of inputs. If this hypothetical firm were subject to the same input and output prices as those faced by firm j it would have a profit P*j=Σrqj·y*qj-Σwpj·x*pj which, by definition, will be higher than or equal to that of firm j Pj = Σrqj·yqj-Σwpj·xpj. Having solved the model 5, standard profit efficiency (SPEj) is then calculated as (model 6):

$$PE_j = \frac{\sum_q r_j y_{jq} - \sum_p w_{jp} x_{jp}}{\sum_q r_j y_{iq}^* - \sum_p w_{jp} x_{ip}^*} \qquad (6)$$

where PEj represents the ratio between the observed profits (Pj) and the maximum profits (SP*j) associated with the production of the output vector y*j and with demand for inputs x*j which maximize profits for firm j.

It can be inferred from model 6 that if a DMU has a loss, the efficiency score will be negative. Therefore, it can be concluded that the efficiency score might be between 1 and -∞.

VARIABLES AND SAMPLE USED

The sample consists of 23 companies among those listed in Tehran stock exchange. In order to increase reliability and comparability, all of the companies have been selected among a same industry namely automobile and parts industry for a four-year period (2006 to 2009). Considering the objectives of this research, that are measuring cost, revenue and profit efficiency and investigating its relationship to the size, operating costs, profitability and assets turnover of the DMUs, the research variables have been categorized into two groups: the first group consists of input and output variables of DMUs aiming at the measurement of cost, revenue and profit efficiency that are summarized in Table 1. The second group also consists of independent variables including size, operating costs, profitability and assets turnover used to determine the relationship between them and cost, revenue and profit efficiency as dependent variables. Table 2 presents how the independent variables used in the second stage of the research are calculated.

EMPIRICAL RESULTS

First stage: analysis of the efficiency estimates

At the first stage of this research, using efficiency frontier concept, cost, revenue and profit efficiency have been calculated (Table 3). According to the obtained results, the average cost, revenue and profit efficiency of 23 examined companies over the four-year period are 0.51, 0.57 and 0.27, respectively. These results also imply that the examined companies are, on average, 0.49, 0.43 and 0.73 inefficient in terms of cost, revenue and profit efficiency. In fact, they have wasted 49% of their resources, or considering the same resources used, they have lost 43% of revenues they could and have to earn, or they are 0.73 inefficient in using resources and earning revenue collectively. It is of vital importance to note that these companies' managers have to raise their efforts toward increasing efficiency and improvement in using their resources. Inefficient companies, using efficiency frontier concept, can approach more efficient levels. The benchmarks are selected among efficient units, as shown in Table 4. For example, DMU12 and DMU19 are benchmarks for DMU2 and in order to approach cost efficiency frontier, its costs should be equal to 191% of DMU12's. considering revenue efficiency, its revenues should be equal to 311% of DMU12' and 78% of DMU19'. The similar calculations can be done for profit efficiency.

Figures 1, 2, and 3 present cost, revenue and profit efficiency trends over the given period and also on an average basis. It is clear that DMU12 in comparison to other companies is more cost, revenue and profit efficient. The average efficiency scores of this company are 93, 100 and 100%, respectively that are more than any other company's scores. Then, it is selected as a benchmark for majority of inefficient companies.

Second stage: Potential determinants of efficiency

Here, the impact of proposed independent variables, namely size, operating costs, profitability and assets turnover on the measured efficiency levels calculated in the previous section are examined. Therefore, multiple regression analysis is employed as it is used in Srairi (2010) and the resulted outcomes are presented in Table 5. The results revealed a significant positive correlation between ROE, STFA and cost efficiency. In addition, there is a significant positive relationship between variables STFA, LOG.A, STTA and revenue efficiency and also between STFA, LOG.A and profit efficiency. In general, it simply can be concluded that assets turnover (STFA) affects every efficiency level, which is, cost, revenue and profit efficiency. A reason for this result might be found in effective role of fixed assets in firms operations especially in examined firms. Moreover, the variable LOG.A has also a positive effect on both revenue and profit efficiency, that is, larger firms (firms with larger amount of assets) are more successful in earnings revenue and profit. This later result is consistent with Das and Ghosh (2009) and Ray and Das (2010), although, they studied efficiency level in banking industry.

Conclusion

Considering ever-increasing competition in businesses and vital importance of optimum allocation of existent resources, this research is organized to investigate cost, revenue and profit efficiency of 23 automobile and parts industry companies listed in Tehran stock exchange. Examining business efficiency is essentially important, because it provides an appropriate basis for comparability and improvement. Moreover, investigating potential relationships between some proposed variables including size, operating costs, profitability, assets

Table 1. Variables used in the cost, revenue and profit efficiency estimation: mean and standard deviations for 2006 to 2009 (standard deviations in parentheses).

Symbol	Definition	2006	2007	2008	2009
x_1	Number of employees	2899.70 (6058.67)	3044.13 (6263.31)	3097.39 (6439.13)	3100.65 (6531.77)
x_2	Physical capital = book value of fixed assets	823058.96 (1882965.43)	903829.22 (2117360.67)	956010.35 (2319028.48)	973818.30 (2621617.15)
Y	Cost of goods sold (COGS)	2646408.00 (5934633.58)	3062599.48 (7527125.12)	3392643.04 (8338301.14)	4216403.26 (10145067.35)
w_1	Price of labour = personnel expenses/ x1	80.76 (20.15)	91.79 (21.13)	114.44 (30.69)	139.99 (41.50)
w_2	Price of physical capital = other operating expenses include direct material cost, overhead cost and selling, general and administrative expenses (except for labour cost)/x^2	3.24 (1.53)	3.34 (1.60)	3.81 (1.81)	5.03 (3.17)
r	Price of COGS = operating revenues / y	1.29 (0.12)	1.30 (0.13)	1.27 (0.12)	1.21 (0.09)
C	Total costs = operating costs	2832941.78 (6372572.83)	3306140.40 (8150349.01)	3702482.50 (9100162.38)	4534878.96 (11010347.60)
P	Operating profit = operating revenue - operating costs	730281.04 (2009950.96)	804071.30 (2334108.67)	715218.87 (2071613.82)	774835.30 (2177621.23)

Table 2. Description of multiple regression variables: means and standard deviations for 2006 to 2009 (standard deviations in parentheses).

Name and symbol	Definition	2006	2007	2008	2009
Size (Log. A)	Natural logarithm of total assets	5.94 (0.72)	5.99 (0.72)	6.06 (0.74)	6.09 (0.73)
Operating costs (CTI)	Cost to income	0.88 (24.36)	8.34 (12.99)	8.83 (7.67)	13.68 (20.97)
Profitability (ROA, ROE, ROS)	Operating profit to average total assets (ROA)	0.18 (0.15)	0.16 (0.08)	0.13 (0.06)	0.12 (0.05)
	Operating profit to average equity (ROE)	0.69 (0.39)	0.49 (0.19)	0.43 (0.17)	0.46 (0.28)
	Operating profit to sales (ROS)	0.16 (0.07)	0.16 (0.06)	0.14 (0.06)	0.11 0.05
Asset turnover ratio (STTA, STFA)	Sales to average total assets (STTA)	1.14 (0.86)	1.05 (0.49)	1.01 (0.46)	1.08 (0.35)
	Sales to average fixed assets (STFA)	4.55 (2.09)	4.70 (2.15)	5.32 (2.45)	6.71 (3.79)

Table 3. Cost, revenue and profit efficiency scores.

DMU Name	Cost efficiency					Revenue efficiency					Profit efficiency				
	2006	2007	2008	2009	Mean	2006	2007	2008	2009	Mean	2006	2007	2008	2009	Mean
DMU1	0.91	1.00	1.00	0.51	0.86	0.95	1.00	1.00	0.54	0.87	0.81	1.00	1.00	0.16	0.74
DMU2	0.76	0.80	0.64	0.36	0.64	0.77	0.91	0.71	0.46	0.71	0.36	0.64	0.25	0.11	0.34
DMU3	0.63	0.69	0.78	0.45	0.64	0.68	0.72	0.84	0.51	0.69	0.29	0.31	0.38	0.01	0.25
DMU4	0.21	0.25	0.31	0.20	0.24	0.23	0.25	0.34	0.42	0.31	0.05	0.08	0.10	0.08	0.08
DMU5	0.77	0.75	0.81	0.38	0.68	0.79	0.78	0.87	0.41	0.71	0.34	0.28	0.34	0.04	0.25
DMU6	0.24	0.35	0.50	0.24	0.33	0.26	0.35	0.54	0.33	0.37	-0.003	0.09	0.13	0.03	0.06
DMU7	0.43	0.51	0.43	0.21	0.40	0.45	0.55	0.43	0.25	0.42	0.08	0.11	0.07	0.03	0.07
DMU8	0.20	0.19	0.23	0.24	0.22	0.24	0.21	0.23	0.34	0.26	0.04	0.04	0.05	0.04	0.04
DMU9	0.62	0.67	0.63	0.66	0.65	0.62	0.78	1.00	0.95	0.84	0.23	0.35	1.00	0.21	0.45
DMU10	0.57	0.56	0.78	0.39	0.58	0.58	0.56	0.80	0.39	0.58	0.26	0.27	0.48	0.11	0.28
DMU11	0.51	0.64	0.62	0.30	0.52	0.52	0.68	0.69	0.60	0.62	0.21	0.32	0.29	0.15	0.24
DMU12	1.00	0.86	0.87	1.00	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DMU13	0.75	0.79	0.81	0.41	0.69	0.76	0.89	1.00	0.75	0.85	0.14	0.10	1.00	0.04	0.32
DMU14	0.42	0.45	0.50	0.28	0.41	0.43	0.48	0.54	0.31	0.44	0.08	0.10	0.08	0.03	0.07
DMU15	0.19	0.22	0.26	0.17	0.21	0.20	0.23	0.26	0.25	0.24	0.03	0.04	0.03	0.04	0.03
DMU16	0.65	0.58	0.56	0.40	0.55	0.68	0.61	0.59	0.41	0.57	0.25	0.18	0.16	0.07	0.17
DMU17	0.44	0.42	0.34	0.22	0.35	0.47	0.44	0.34	0.27	0.38	0.15	0.11	0.08	0.05	0.10
DMU18	0.97	0.93	0.91	0.33	0.78	1.00	0.96	0.98	0.37	0.83	1.00	0.54	0.44	0.04	0.51
DMU19	0.51	0.43	0.80	0.48	0.56	0.53	0.46	1.00	1.00	0.75	0.26	0.20	1.00	1.00	0.61
DMU20	0.23	0.29	0.26	0.15	0.23	0.30	0.31	0.29	0.18	0.27	0.09	0.10	0.11	0.04	0.09
DMU21	0.36	0.38	0.35	0.16	0.31	0.36	0.38	0.38	0.30	0.36	0.07	0.08	0.07	0.02	0.06
DMU22	0.79	0.75	0.86	0.34	0.68	0.79	0.76	0.91	0.37	0.71	0.35	0.34	0.51	0.10	0.32
DMU23	0.33	0.38	0.41	0.16	0.32	0.37	0.38	0.43	0.17	0.34	0.06	0.07	0.09	0.03	0.06
Mean	0.54	0.56	0.59	0.35	0.51	0.56	0.60	0.66	0.46	0.57	0.27	0.28	0.38	0.15	0.27
S.D	0.25	0.23	0.23	0.19	_	0.24	0.25	0.27	0.24	_	0.28	0.27	0.36	0.27	_

turnover ratio and cost, revenue and profit efficiency is another objective of this research.

This study is divided into two parts. In the first part, cost, revenue and profit efficiency of sample companies, using DEA, is calculated. The results indicate that, on average, DMU12 is most cost-revenue and profit-efficient among other companies over the given period. Another contribution of this study to the inefficient companies is to find a way of approaching efficiency frontier. In fact, DEA technique recognizes benchmarks among efficient units in order to help inefficient ones to attain optimum cost, revenue and profit level. Information obtained in this section can assist management in setting strategies. Indeed, managers of inefficient companies using related benchmarks can calculate their companies' optimum cost, revenue and profit levels and also develop appropriate way of achieving those optimum figures. For example, managers of inefficient companies in order to achieve relative, optimum cost level, can utilize cost management techniques such as activity-based costing, target costing, etc.

Table 4. Benchmarking.

DMU Name	Cost efficiency		Revenue efficiency				Profit efficiency	
	Benchmarks		Benchmarks				Benchmarks	
DMU1	0.15	DMU12	0.28	DMU12			0.28	DMU12
DMU2	1.91	DMU12	3.11	DMU12	0.78	DMU19	4.02	DMU12
DMU3	0.07	DMU12	0.14	DMU12			0.14	DMU12
DMU4	1.36	DMU12	2.47	DMU19			2.88	DMU12
DMU5	0.16	DMU12	0.37	DMU12	0.02	DMU19	0.38	DMU12
DMU6	0.08	DMU12	0.16	DMU12	0.07	DMU19	0.24	DMU12
DMU7	0.13	DMU12	0.42	DMU12	0.07	DMU19	0.51	DMU12
DMU8	0.18	DMU12	0.32	DMU12	0.17	DMU19	0.51	DMU12
DMU9	1.04	DMU12	0.71	DMU12	0.30	DMU19	1.06	DMU12
DMU10	0.05	DMU12	0.12	DMU12			0.12	DMU12
DMU11	10.16	DMU12	13.11	DMU19			15.28	DMU12
DMU12	1.00	DMU12	1.00	DMU12			1.00	DMU12
DMU13	0.39	DMU12	0.16	DMU12	0.27	DMU19	0.47	DMU12
DMU14	0.40	DMU12	1.16	DMU12	0.11	DMU19	1.29	DMU12
DMU15	0.04	DMU12	0.08	DMU12	0.06	DMU19	0.14	DMU12
DMU16	0.53	DMU12	1.29	DMU12			1.29	DMU12
DMU17	0.04	DMU12	0.11	DMU12	0.03	DMU19	0.14	DMU12
DMU18	0.05	DMU12	0.14	DMU12			0.14	DMU12
DMU19	1.30	DMU12	1.00	DMU19			1.00	DMU19
DMU20	0.01	DMU12	0.06	DMU12			0.06	DMU12
DMU21	0.43	DMU12	1.09	DMU19			1.27	DMU12
DMU22	0.09	DMU12	0.24	DMU12			0.24	DMU12
DMU23	0.03	DMU12	0.18	DMU12			0.18	DMU12

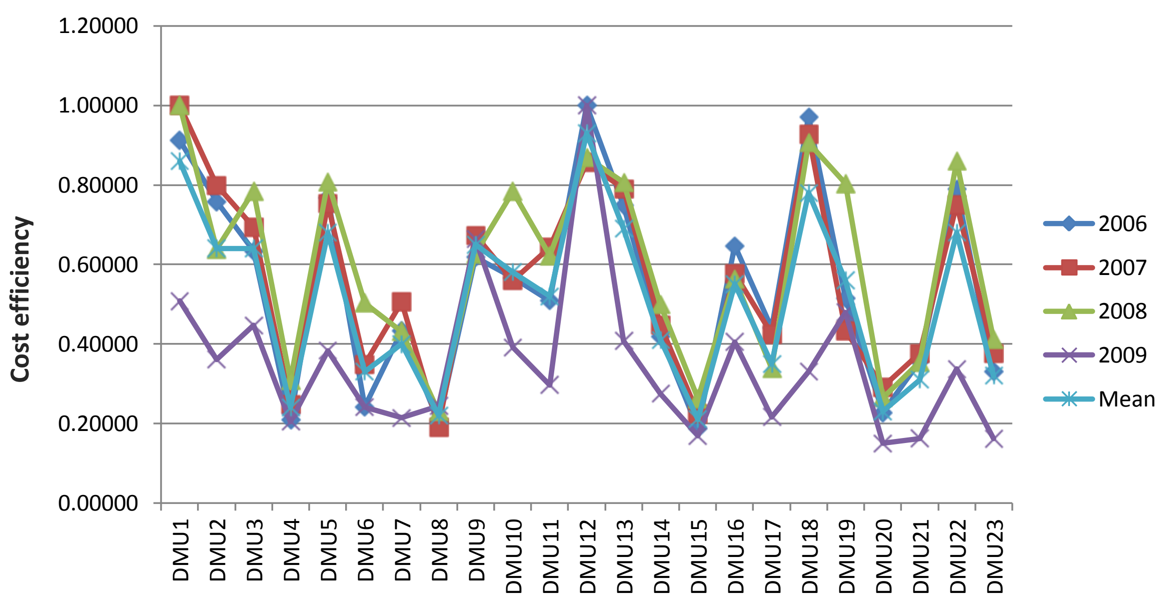

Figure 1. Cost efficiency.

The second-stage results showed that there is a significant positive relationship between ROE, STFA and cost efficiency, between STFA, LOG.A, STTA and revenue efficiency and finally between STFA, LOG.A and

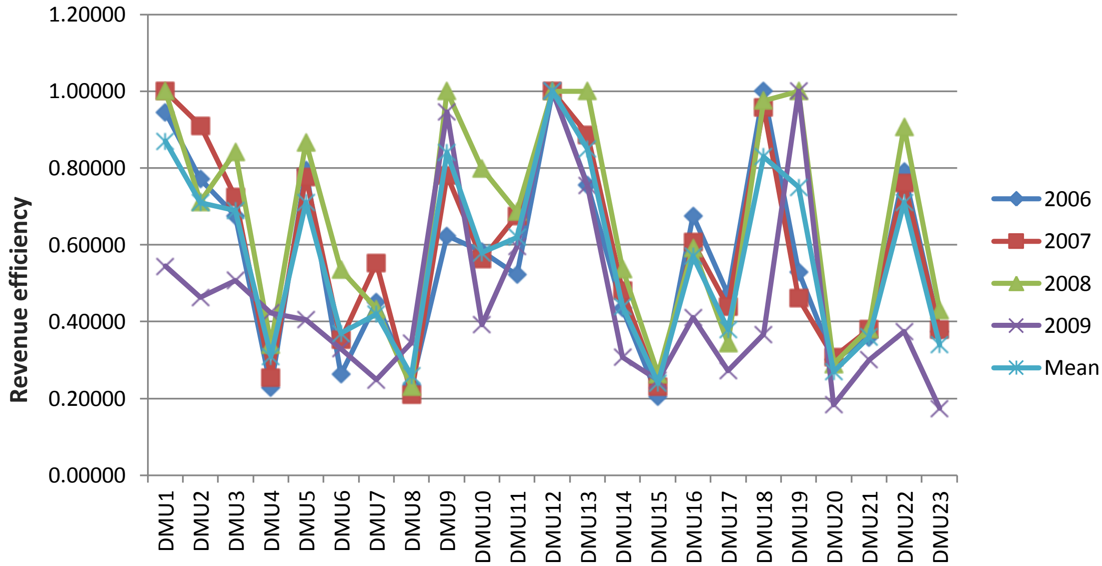

Figure 2. Revenue efficiency.

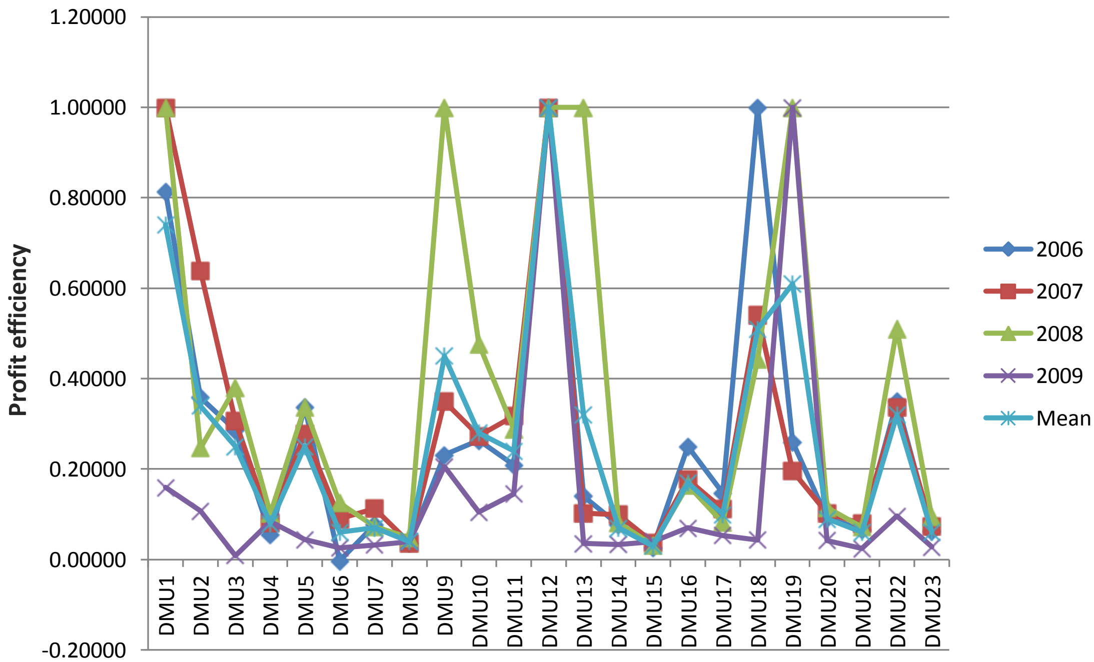

Figure 3. Profit efficiency.

Table 5. Results of regression analysis on the determinants of different efficiency measures.

Variable	Cost efficiency			Revenue efficiency			Profit efficiency		
	B	P-Value	R^2	B	P-Value	R^2	B	P-Value	R^2
ROE	0.19	0.01		_	_		_	_	
STFA	0.05	0.00		0.06	0.00		0.05	0.00	
LOG.A	_	_		0.09	0.00		0.09	0.02	
STTA	_	_		0.08	0.02		_	_	
R^2			0.72			0.74			0.63

profit efficiency.

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