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Efficiency evaluation of accounting firm partnerships from the perspective of operating difficulties, strategies, and practices in Mainland China

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Abstract

Purpose – The purpose of this paper is to explore the operating efficiency of accounting firm partnerships.
Design/methodology/approach – An empirical analysis is performed with a three-stage research method: data envelopment analysis (DEA), univariate testing and regression analysis.
Findings – The results indicate that large firms are not necessarily the most efficient. Efficient accounting firms see an average 50 percent contribution from total practice revenues and a 50 percent contribution from the number of cases. The percentage of senior managers is higher for firms with poor operating efficiency than for firms with good operating efficiency. This implies that firms with poor operating efficiency have a higher expenditure in human capital. Both efficient and inefficient firms find intense market competition to be the main challenge, followed by the challenge of market recessions. Appropriate educational training should be provided to upgrade the professional expertise and competency of staff. Response to peer competition and assistance to local accountant practices are the main reasons for setting up practice in Mainland China. The main operating mode in Mainland China is bringing personnel from Taiwan.
Originality/value – Using DEA, univariate testing and regression analysis, this paper aims to help the operators of accounting firms in dealing with business difficulties, finding their own core competencies, and making up for their operating disadvantages. The findings can provide references to reviewing whether their human resource allocation is appropriate and which operational type should be adopted by the accounting firms. Hence, the accounting firms can formulate their future operational strategies.

Keywords Data envelopment analysis, Regression, Accounting firms, Operating efficiency

Paper type Research paper

1. Introduction

According to the Survey Report on the Business of the Accounting Firms published by the Financial Supervisory Commission (FSC) (2009) in March, the number of accounting firms increased from 736 in 2004 to 854 in 2007. The number of accounting firm branches also grew from 916 to 1,024 during the same period. The number 1,024 represents the total number of major practice premises and branches. The number of accounting firms increased by 47 (5.8 percent) from the end of 2006, and the number of practice premises and branches increased by 53 (5.5 percent) in 2007. The survey also indicates that at the end of 2007, 607 sole ownership firms (71.1 percent) were established by accountants, and 247 partnership firms (28.9 percent) were established by two or more accountants. These numbers increased by 34 (5.9 percent) and 13 (5.6 percent), respectively, from the levels at the end of 2006. It is hardly surprising that the competition is intensifying given the increasing number of accounting firms. It is imperative for accounting firms to seek optimal business modes.

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Services provided by accounting firms consist of auditing, taxation, management consulting and accounting services. The growing interaction between companies and accounting firms over recent years signifies an increasing reliance of companies on accounting firms. Therefore, accounting firms are paying more and more attention to their service quality. This quality has a direct impact on the reputations of accounting firms and the trust of their clients.

Taiwanese companies are moving toward internationalization, particularly with regard to outward investments in Mainland China. To meet the needs of clients, some accounting firms have set up practices in Mainland China, providing services in auditing, inspecting and consulting (FSC, 2009). Some firms also expatriate staffs to branches in Mainland China to assist in operations and provide business support. To respond to such changes in operations and client demand, accounting firms have had to adjust their business modes. Accounting firms are increasingly important to companies as they provide expertise in business diagnosis. In addition, corporate clients are asking accounting firms to provide diverse services outside the traditional scope of auditing.

According to a FSC (2009), 34 accounting firms established practices in Mainland China, 4 percent of the total of 854 firms. Among these 34 firms, 26 were partnership firms and only 8 were sole ownership firms. In terms of the number of employees, 9 firms had fewer than 20 employees, and 25 firms had more than 20 employees. In terms of revenue, 5 firms reported annual revenues of NTD1~10m, 12 firms in the range of NTD10~50m, 5 firms in the range of NTD50~100m and 11 firms above NTD100m. These numbers show that most companies with operations in Mainland China are partnership firms rather than sole ownership firms. The larger the firms, the more likely they are to have established practices in Mainland China.

With a view to the abovementioned major changes in business environments and policies, this paper intends to examine the operating efficiency of accounting firms in three stages. The focus is on partnership firms with two or more practicing accountants. The data envelopment analysis (DEA) method is applied during the first stage in order to assess the operating efficiency of the partnership accounting firms, identify the reasons for inefficiency and gauge the room for improvement (i.e. percentage and magnitude) in input and output. An analysis is performed to evaluate the effects of input and output items on operating efficiency. It is hoped that the list of critical input and output items can serve as a reference for accounting firms to improve their operating efficiency. Firms with good operating efficiency can provide a benchmark or target for firms with poor efficiency.

Accounting firms are a sector of the service industry known for their intense use of human capital. The caliber of human resources determines the service quality. Hence, human capital is a key input element for accounting firms. It is necessary for accounting firms to decide on appropriate manpower allocations. Although a large number of practice premises can serve more clients and expand clientele, a corresponding investment in branches is also required. The branches may also have different operating types. The analyses in the second stage focus on the human capital structures of firms with good operating efficiency and firms with poor operating efficiency. Relevant factors include the percentage of accountants possessing Certified Public Accountant (CPA) qualifications and senior managers, and the characteristics of the branch operating types. Are there any variances in human capital allocations and branch operating types? Are there any significant differences in the operating efficiency of branches operating different operating types? What are the major operating challenges for firms with both good and poor operating efficiency? What are the future strategic focuses? All of these issues are addressed in the second stage empirical analysis.

During the third stage, this paper develops regression models to assess the effects of practices in Mainland China on operating efficiency. There are four dimensions for analysis: the percentage of revenues from Mainland China, the reasons for setting up practice in

Mainland China, the percentage of each project executed in Mainland China and the operating modes in Mainland China. In order to assist accounting firms in their strategies in Mainland China, it is critical to identify the key factors making positive contributions to operating efficiency.

The remainder of this paper is organized as follows. Section 2 reviews the related DEA literatures. Section 3 introduces the DEA models, data sources and choice of decision-making units (DMUs), the definitions of output and input items, and also constructs empirical regression models. Section 4 conducts the related empirical analysis and discusses the results. Conclusions and managerial implications are presented in Section 5.

2. Literature review

The DEA method is widely used in many domains in the evaluation of operating performance. These domains include: banks (e.g. Bonin *et al.*, 2005; Camanho and Dyson, 1999; Chen *et al.*, 2013; Chen and Lei, 2016; Cook *et al.*, 2004; Garden and Ralston, 1999; Grace and Timme, 1992; Grifell-Tatjé and Lovell, 1996; Lin *et al.*, 2009; Miller and Noulas, 1996; Noulas, 1997; Paradi *et al.*, 2011; Portela *et al.*, 2004; Staub *et al.*, 2010; Yang, 2009; Yang and Hsiao, 2013; Yeh, 1996), insurance companies (e.g. Audibert *et al.*, 2016; Bates *et al.*, 2010; Chen, 2013; Jeng *et al.*, 2017; Lee and Chen, 2017; Noulas *et al.*, 2001; Wu *et al.*, 2007), human development (e.g. Despotis, 2005), human resource practices (e.g. Huang and Chen, 2015; Tseng and Lee, 2009), the high-tech industry (e.g. Chou *et al.*, 2013; Fang *et al.*, 2014; Kozmetsky and Yue, 1998; Kuo and Chen, 2014; Wang *et al.*, 2016), the information services industry (e.g. Lee and Huang, 2015), public services (e.g. Cooper and Ray, 2008; Smith and Street, 2005), the medical industry (e.g. Banker *et al.*, 1986; Chian *et al.*, 2016; Kinyanjui *et al.*, 2015; Lu *et al.*, 2015; Pulina *et al.*, 2010; Shimshak *et al.*, 2009; Valdmanis, 1990; Yeh *et al.*, 2015), schools (e.g. Anderson *et al.*, 1998; Kirjavainen and Loikkanent, 1998; Lai *et al.*, 2015; Palocsay and Wood, 2014), teaching and learning performance analysis (Montoneri *et al.*, 2011; Montoneri *et al.*, 2012; Montoneri *et al.*, 2013), hotels (e.g. Anderson *et al.*, 2000; Morey and Dittman, 2003; Sigala *et al.*, 2005), internal auditing (e.g. Sueyoshi *et al.*, 2009), the accounting industry (e.g. Banker *et al.*, 2005; Banker *et al.*, 2007; Chen and Lin, 2007; Cheng *et al.*, 2000; Dopuch *et al.*, 2003; Lee, 2009, 2014; Lin and Cho, 2014; Shih and Chung, 2014; Shih and Tsai, 2014), etc.

In terms of research on the performance evaluation of accounting firms, Cheng *et al.* (2000) apply DEA to the performance evaluations of accounting firms by sampling firms in Taiwan in 1994. They examine the technical efficiencies of these accounting firms and find that there is 27.8 percent room for improvement in terms of input reduction. This suggests relatively poor technical efficiency for most accounting firms in Taiwan. Dopuch *et al.* (2003) introduce quantitative techniques, such as DEA and the stochastic parametric frontier method (SFA) into research on the auditing market, in order to investigate production efficiency and audit service pricing of accounting firms. Banker *et al.* (2005) sample 64 out of the top 100 accounting firms in the USA in 1995–1999 and analyze the revenues and human resources data by applying the Malmquist productivity index. Their purpose is to examine changes in productivity, technical advances and corresponding changes in efficiency, using the DEA method.

Banker *et al.* (2007) use revenue and personnel data for the top US public accounting firms during 1995–1998. The results indicate the existence of statistically significant allocative inefficiency in the public accounting industry. Chen and Lin (2007) indicate that Taiwan's audit firms experienced a productivity growth of 27 percent and a technical progress of 31 percent but a 5 percent decline of relative efficiency during the sample period. They also report a positive relationship between technical efficiency of the firms and human capital embodied in partnerships. Lee (2009) uses DEA to evaluate the operational efficiency of 173 Taiwanese medium-sized audit firms in 2005. The results indicate that there are

24 audit firms with an overall technical efficiency value of 1. The average scale efficiency of all samples is higher than the average in terms of pure technical efficiency. Most medium-sized audit firms are in the stage of decreasing returns to scale. In addition, Lee (2009) finds that the larger the scale, the higher the operational efficiency.

For internal auditing, Sueyoshi *et al.* (2009) use case studies to develop a multi-criteria decision making aid that can identify the most critical business units within a corporation. They explore the potential of DEA and analytic hierarchy process (AHP) for determining business units that need auditing. The proposed combined model incorporates a much wider range of quantitative and qualitative criteria, and provides a more detailed and thorough study. Sueyoshi *et al.* (2009) also point out that the proposed evaluation framework is comprehensive and flexible and shows great potential for internal audit prioritization and resource allocation.

Lee (2014) explores the operating efficiency of CPA firms from the perspective of industry-specific client groups. The operating revenues from the transport and storage, manufacturing, lodging, food and beverages industries in the efficient firms are ranked as the top three. It is recommended that the operators of efficient firms focus on development of the three industry-specific client groups and manage client relationships better, in order to increase operating efficiency. The client group plays a significant role in the maintenance of a CPA firm's operation and the increase in operating revenue. Regardless of whether a firm is efficient or inefficient, labor cost plays a vital role in a CPA firm's operation, and it is an indispensable factor in service quality. Lin and Cho (2014) measure operating efficiency by applying DEA, and find that firms which are involved in mergers have significantly higher productivity growth than their peers.

Shih and Chung (2014) find that the overall technical inefficiency of the public accounting industry in Taiwan results mainly from scale inefficiency. Most of the efficiency test results do not significantly support the hypothesis that the increase of audit service supply imposes a negative effect on the industry's efficiency. Shih and Tsai (2014) explore the impact of intellectual capital on the operating efficiency of group practice accounting firms in Taiwan. The operating efficiency value (i.e. the technical efficiency, which is composed of pure technical efficiency and scale efficiency) of the Big X accounting firms is significantly higher than that of the non-Big X firms. The overall technical inefficiencies of group practice accounting firms mainly result from scale inefficiencies. In addition, the Tobit regression results show that human capital, innovation capital and process capital are significantly positively related to operating efficiency value.

Lee and Chen (2016) show that when an accounting firm has higher employee education concentration, higher human capital leverage, and better employee benefits, its operating performance will be better. In addition, lower business client concentration, longer firm age and larger firm size will result in better operating performance. Lee and Tung (2017) analyze factors affecting the decision making on the provision of business services by Taiwanese accounting firms in Mainland China, finding that when an accounting firm establishes a management consulting firm, has a higher percentage of employees with high educational levels, has a higher percentage of young employees, has a higher percentage of management consulting personnel and has a higher percentage of financial auditing business revenue, the probability of providing business services in Mainland China will be higher.

3. Methodology and data resource

This paper performs a three-stage empirical analysis. During the first stage, a DEA model is used to derive the efficiency values of individual accounting firms, in order to determine operating efficiency. An analysis of inputs and outputs aims to highlight the room for improvement and their respective contributions to operating efficiency. During the second stage, this paper analyzes the relationships among human capital, branch operating types,

operating difficulties and future strategies for improving operating efficiency. During the third stage, an analysis is conducted to examine the effect of practices on operating efficiency in Mainland China. Four empirical models are established for regression analyses. Below are the details of the DEA model and the regression models.

3.1 Charnes–Cooper–Rhodes' (CCR) model of DEA

Seiford and Zhu (2003), Cook and Zhu (2006) and Cook *et al.* (2010) indicate that the DEA is a mathematical approach for measuring the relative efficiency of peer DMUs. The measurement of efficiency starts with the efficiency measurement model developed by Farrell (1957). The model assumes that given only two inputs and one output, constant returns to scale (CRS) relationships exist between outputs and inputs. The CRS concept means that output directly reflects input (i.e. double inputs produce exactly double outputs). Farrell (1957) is the first scholar to suggest the use of production frontiers in the evaluation of efficiency levels. Charnes *et al.* (1978) apply the concept proposed by Farrell (1957) and expands the efficiency measurement model with multiple inputs and multiple outputs on the same CRS assumption. They utilize linear combinations to convert it to a single virtual input and output, and estimate the efficiency frontier from the ratio of two linear combinations (Lee, 2009; Lin *et al.*, 2009); it is called DEA, and is generally grouped into the CCR model. The efficiency value of the CCR model is the overall technical efficiency of the evaluated unit. If the efficiency value equals 1, the evaluated unit is efficient; if the efficiency value is less than 1, the evaluated unit is inefficient.

Charnes *et al.* (1978, p. 430) propose a measure of any DMU's efficiency that can be obtained as the maximum of a ratio of weighted outputs to weighted inputs, subject to the condition that similar ratios for every DMU are less than or equal to unity. In a more precise form, it is:

$$\max h_0 = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}, \tag{1}$$

subject to:

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leqslant 1; \quad j = 1, \ldots, n,$$

$$u_r, v_i \geqslant 0; \quad r = 1, \ldots, s; \quad i = 1, \ldots, m.$$

Here, y_{rj}, x_{ij} (all positive) are the known outputs and inputs of the jth DMU, and $u_r, v_i \geq 0$ are the variable weights to be determined by the solution of this problem, e.g. by the data on all the DMUs that are being used as a reference set. The efficiency of one member of the reference set of $j = 1, \ldots, n$ DMUs is rated relative to the others. It is, thus, represented in the function for optimization, as well as in the constraints, and is further distinguished by assigning it the subscript "0" in the function (but preserving its original subscript in the constraints). The indicated maximization then accords this DMU the most favorable weighting that the constraints allow (Charnes *et al.*, 1978, p. 430). Details are shown in the original paper of Charnes *et al.* (1978).

3.2 Data sources and choice of DMUs

This paper sources data from the Survey Report Database on the Business of the Accounting Firms in 2007. This database establishes the increasing importance of service industries in Taiwan's economy. As part of government efforts to promote the development of service industries and the modernization of commerce, the Ministry of Finance started

this annual survey of accounting firms under the auspices of the Executive Yuan in 1990. The purpose of this survey is to gather information regarding businesses and operating targets of accounting firms, provide a reference for the government in the formation of policies and assist accounting firms in their business development. The governance of accounting firms was transferred to the FSC in July 2003, and the FSC took over responsibility for the survey (FSC, 2009).

This paper selects 220 accounting firm partnerships with two or more practicing accountants from the 2007 survey as DMUs. Given the criteria required by the DEA method for input/output items and the restrictions of Frontier Analyst in execution, this paper selects only input and output items with positive values. No zero value or negative values have been allowed.

3.3 Definitions of output and input items

Lee (2009) uses four output items: attestation revenues, tax business revenues, management consultancy revenues and corporate registration and other business services. Lee's four input items include number of branches, number of total employees, number of partners and total expenditures of the auditing firm. This paper uses the total practice revenues (based on Lee's (2009) output points) to represent the overall operating results of accounting firms; the database also provides information regarding the number of cases from business practices. The service charges depend on the nature of services and the relationship with clients. Sometimes, the total practice revenues from a large number of cases are not necessarily higher than the total practice revenues from a small number of cases. Therefore, this paper involves indices, total practice revenues and number of cases to present a complete picture of the overall operating results. Based on Lee's (2009) input points, this paper also includes number of employees as one of the input items. Finally, this paper incorporates the area of space in use to represent the size of premises. Table I provides detailed definitions of two output items and two input items.

According to the DEA method, the selection of inputs and outputs takes into account the effects of these items on efficiency and isotonicity (i.e. no output declines in the event of an increase in inputs). All inputs and outputs should be highly and positively correlated. The Pearson coefficients in Table II suggest that there is a significantly positive correlation between inputs and outputs. All of the coefficients are above 0.4. It is inferred that the inputs and outputs selected by this paper meet the requirement for isotonicity in the DEA method. The VIF tests on the relationship between input and input items, as well as on the

Item	Name	Definition
Outputs	Total practice revenues (O1) (Unit: NTD)	Including the sub-business revenues from auditing for publicly issued firms, auditing for financing projects, auditing for other financial requirements, auditing for income tax reporting, tax planning, taxation and administrative remedies, other taxation services, management consulting, business registrations and other service practices
	Number of cases (O2)	Including the sub-business cases from auditing for publicly issued firms, auditing for financing projects, auditing for other financial requirements, auditing for income tax reporting, tax planning, taxation and administrative remedies, other taxation services, management consulting, business registrations and other service practices
Inputs	Number of employees (I1)	Including the number of accountants, managers, senior auditors, assistants and other employees
	Area of space in use (I2) (Unit: square feet)	Including the area of space owned, rented and provided by accountants

Table I. Definitions of input and output items

relationship between output and output items, indicate that all of the VIF values are smaller than 10. Hence, no serious collinearity exists among the items, and it is possible to proceed with further DEA steps.

3.4 Empirical regression models

During the third stage of the empirical analysis, this paper examines four dimensions: the percentage of revenues from Mainland China, the reasons for setting up practice in Mainland China, the percentage of each project executed in Mainland China and operating modes in Mainland China. The purpose is to validate whether practices in Mainland China improve operating efficiency, and whether the strategies in Mainland China are beneficial. The 220 CCR efficiency values derived in the first-stage DEA method are the dependent variables in the empirical model during the third stage. The factors associated with the practices in Mainland China are the independent variables. The range of efficiency values calculated by Frontier Analyst 4.1.0 software is 0–100 points. This paper runs the ordinary least squares approach (OLS) regression models and develops four relational models 1 to 4 concerning the relationships between the practices in Mainland China and the operating efficiency of accounting firms. These four models are established using the factors of the abovementioned four dimensions. The four models are listed as follows:

(1) Dimension of the percentage of revenues from Mainland China

Model 1: the relation between percentage of revenues from Mainland China and operating efficiency:

$$\mathrm{OE} = a_0 + a_1 \mathrm{TR} + e_1, \tag{2}$$

where OE is the operating efficiency derived from the CCR model with the DEA method; TR is the percentage of revenues from Mainland China; a_0 is the intercept of the regression model; a_1 is the parameter of the regression model; e_1 is the error term of the regression model.

(2) Dimension of the reasons for setting up practice in Mainland China

Model 2: the relation between reasons for setting up practice in Mainland China and operating efficiency:

$$\mathrm{OE} = b_0 + b_1 S_1 + b_2 S_2 + b_3 S_3 + b_4 S_4 + e_2, \tag{3}$$

where OE is the operating efficiency derived from the CCR model with the DEA method; S_1 is whether practices in Mainland China are established to address the needs of clients. This is a dummy variable; if the answer is "Yes," it is set as 1; if the answer is "No," it is set as 0; S_2 is whether practices in Mainland China are established to extend business markets. This is a dummy variable; if the answer is "Yes," it is set as 1; if the answer is "No," it is set as 0; S_3 is whether practices in Mainland China are established to compete with peers. This is a dummy variable; if the answer is "Yes," it is set as 1; if the answer is "No," it is set as 0; S_4 is whether practices in Mainland China are established for other reasons. This is a dummy variable; if the answer is "Yes," it is set as 1; if the answer is "No," it is set as 0; b_0 is

Table II.
Pearson correlation coefficients between input and output items

	Total practice revenues (O1)	Number of cases (O2)
Number of employees (I1)	0.987*** (0.000)	0.906*** (0.000)
Area of space in use (I2)	0.558*** (0.000)	0.405*** (0.000)

Note: ***Significant at 1 percent level

the intercept of the regression model; b_1, b_2, b_3, b_4 are the parameters of the regression model; e_2 is the error term of the regression model.

(3) Dimension of the percentage of each project executed in Mainland China

Model 3: the relation between percentage of each project executed in Mainland China and operating efficiency:

$$OE = c_0 + c_1R_1 + c_2R_2 + c_3R_3 + c_4R_4 + c_5R_5 + c_6R_6 + c_7R_7 + c_8R_8 + e_3, \quad (4)$$

where OE is the operating efficiency derived from the CCR model with the DEA method; R_1 is the percentage of projects in Mainland China – the auditing of the accounts for Taiwanese transfers to investment companies; R_2 is the percentage of projects in Mainland China – the auditing of financial reports for appointed companies; R_3 is the percentage of projects in Mainland China – the evaluation of investment projects and consultation; R_4 is the percentage of projects in Mainland China – the implementation of statutory audit practices; R_5 is the percentage of projects in Mainland China – the assistance in training the personnel of local accounting firms; R_6 is the percentage of projects in Mainland China – the inspection of financial reports of local companies; R_7 is the percentage of projects in Mainland China – the assistance to local accountants' practices; R_8 is the percentage of projects in Mainland China – others; c_0 is the intercept of the regression model; c_1, c_2, c_3, c_4, c_5, c_6, c_7, c_8 are the parameters of the regression model; e_3 is the error term of the regression model.

(4) Dimension of the operating modes in Mainland China

Model 4: the relation between operating modes in Mainland China and operating efficiency:

$$OE = d_0 + d_1M_1 + d_2M_2 + e_4, \quad (5)$$

where OE is the operating efficiency derived from the CCR model with the DEA method; M_1 is whether operating modes in Mainland China are personnel sent from Taiwan. This is a dummy variable; if the answer is "Yes," it is set as 1; if the answer is "No," it is set as 0; M_2 is whether operating modes in Mainland China are cooperating with local firms in Mainland China and the training of local professionals. This is a dummy variable; if the answer is "Yes," it is set as 1; if the answer is "No," it is set as 0; d_0 is the intercept of the regression model; d_1, d_2 are the parameters of the regression model; e_4 is the error term of the regression model.

4. Empirical results and discussions

4.1 Results for accounting firms with better operating efficiency

4.1.1 Analysis of operating efficiency. This paper refers to efficiency values calculated with Frontier Analyst 4.1.0 software and rates these values in the range of 0–100 points. The efficiency scores are the measure for operating efficiency. The efficiency scores of all 220 firms are shown in the Table AI. Panel A in Table III indicates that four DMUs report an efficiency score of 100 in the CCR model, implying that these firms have optimized their allocations of input and output items. DMU28 is referenced 214 times, the highest count among all four efficient firms. The number of references indicates the number of times the efficient firm is referred to as a benchmark by inefficient firms. DMU201, the second highest in ranking, is referenced 205 times. The third highest in ranking, DMU200, is referenced 33 times. DMU12, the fourth in ranking, is referenced four times. DMU28, DMU201 and DMU200 are the learning benchmarks for all of the accounting firms.

Table III.
Analysis of efficient DMUs with an efficiency value of 100

Panel A: operating efficiency

Code of DMU	Efficiency score	RTS	No. of references	DEA rankings	Rankings by the total practice revenues	Rankings by the number of cases	Input and output contribution (%) O1	O2	I1	I2
12	100	CRTS	4	4	14	8	0	100	0	100
28	100	CRTS	214	1	1	1	100	0	100	0
200	100	CRTS	33	3	33	45	100	0	50	50
201	100	CRTS	205	2	190	7	0	100	2.2	97.8
Average							50	50	38.05	61.95

Panel B: operating difficulties and future strategies

		Allocations of human capital			Operating types of branches				Major operating difficulties			Future strategies		
Code of DMU	Efficiency Score	% of possessing CPA qualifications	% of partners and managers	No. of branches	Permanently stationed by practicing accountants	Regularly stationed by practicing accountants	Permanently stationed by full-time staff	Only as a contact window	1st	2nd	3rd	1st	2nd	3rd
12	100	0.10	0.15	3	Yes	No	No	No	1	6	4	1	6	3
28	100	0.19	0.30	2	Yes	No	No	No	1	7	4	1	3	6
200	100	0.17	0.23	0	No	No	No	No	1	2	0	1	6	0
201	100	0.40	0.40	0	No	No	No	No	0	0	0	0	0	0
Average		0.22	0.27	1.25										

Notes: (1) Major operating difficulties: 0: none; 1: fierce competition; 2: market recessions; 3: many practitioners without licenses or simply renting licenses; 4: high costs in human capital, 5: a lack of skilled professionals; 6: unhealthy commissioning system; 7: high turnover of professional personnel; 8: others. (2) Future strategies: 0: none; 1: improvement of service quality; 2: recruiting more assistants; 3: training of staff; 4: maintenance of status quo; 5: recruiting more accountants; 6: IT systems in sales and management; 7: relocation of accountants to Mainland China; 8: merger with other accounting firms; 9: establishment of a management consulting firm; 10: addition of branches; 11: others. (3) CRTS represents the constant returns to scale

DMU28 ranks top in the league for both total practice revenues and number of cases. This is consistent with the rankings based on DEA results. However, the rankings of the other three accounting firms differ from those on the list ranking the DEA results. The DEA method takes into account the relationship between inputs and outputs. The total practice revenues and the number of cases are also representative of firm size. Generally, a larger firm has higher total practice revenues and a larger number of cases. Based on these two metrics, the other three accounting firms are small and medium size in scale. This also means that not all large firms are efficient; it all depends on whether the allocations of input and output items are optimal and whether the invested resources can generate maximum benefits.

In terms of input and output contributions, the efficiency value of the highest-ranking DMU28 is mainly subject to the contribution of total practice revenues (O1; 100 percent) and the number of employees (I1; 100 percent). Both contributions are 100 percent. In other words, the operating efficiency of DMU28 is a result of the efforts to expand revenues and the high caliber of employees. However, in the case of the second-highest ranking DMU201, the highest contributing factor is the number of cases (O2; 100 percent). There is no contribution from total practice revenues (O1; 0 percent). As far as input items are concerned, the contribution of the number of employees (I1; 2.2 percent) is significantly lower than that for the area of space in use (I2; 97.8 percent). This accounting firm focuses on the effective utilization of its space. On average, the four accounting firms with an efficiency value of 100 see an average of 50 percent contribution from total practice revenues (O1; 50 percent) and 50 percent contribution from the number of cases (O2; 50 percent). The average contribution to operating efficiency from the number of employees (I1; 38.05 percent) is lower than that from the area of space in use (I2; 61.95 percent). This means that firm sizes and spatial arrangements are key input factors.

4.1.2 Analysis of human capital, operating types of branches, major operating difficulties and future strategies. Panel B in Table III shows the allocation of human capital. DMU28 is the highest in ranking and largest in scale, with a total of 2,674 employees, 19 percent of them being CPA qualified accountants. Partners and managers account for 30 percent of the total, a very high percentage. The DMU201, the second highest in ranking, is much smaller in scale; it has only five employees. On average, 22 percent of the employees of the four accounting firms with an efficiency value of 100 are CPA qualified accountants, and 27 percent are partners and managers.

Both DMU12 and DMU28 have branches with practicing accountants on a permanent basis; DMU200 and DMU201 have no branches. Practicing accountants of DMU28 often visit branches to look after business, and their operating efficiency is superior. In terms of major operating difficulties, three out of the four firms quote fierce competition as the major challenge, followed by market recessions, an unhealthy commissioning system, high turnover of professional personnel and high costs in human capital. It is critical to maintain competitive advantages in highly competitive markets. The focus of future strategic endeavors is on the improvement of service quality. This is followed by the training of staff and IT systems in sales and management. Given the high homogeneity of the service items, accounting firms are advised to prioritize service quality for both auditing and non-auditing services. They should step up efforts in the development of management consulting services in order to gain the trust and loyalty of customers and maintain long-term and collaborative relationships.

4.2 Results for accounting firms with poor operating efficiency

4.2.1 Analysis of operating efficiency. As shown in Panel A in Table IV, 216 accounting firms report efficiency values smaller than 100 under the CCR model. Only 1 DMU reports an efficiency value in the 90–100 range. Three DMUs report efficiency values of 80–90 and 189 DMUs report efficiency values below 60. In other words, the operating efficiency of most

Table IV.
Analysis of inefficient DMUs with an efficiency value below 100

Panel A: operating efficiency

Efficiency score range (No. of DMUs)	Average efficiency score	Improvement percentages (%)				Improvement space				Input and output contribution (%)			
		O1	O2	I1	I2	O1	O2	I1	I2	O1	O2	I1	I2
90 ⩽ E < 100(1)	99.5	0.5	82.3	0.00	0.00	139,990	272	0.00	0.00	100	0.00	88.3	11.7
80 ⩽ E < 90(3)	83.62	19.67	85.33	0.00	0.00	314,671,424.86	9,067.34	0.00	0.00	96.27	3.73	49.20	50.80
70 ⩽ E < 80(8)	73.44	36.34	55.40	0.00	−54.91	156,177,699.70	2,782.34	0.00	−762.69	93.24	6.76	87.35	12.65
60 ⩽ E < 70(15)	63.60	57.53	57.53	0.00	−65.29	18,705,292.47	380.92	0.00	−98.78	92.27	7.73	90.72	9.28
0 ⩽ E < 60(189)	35.78	248.49	619.70	0.00	−59.18	37,112,529.00	738.36	0.00	−69.68	94.11	5.89	93.86	6.14
Average (216)	40.06	223.05	549.85	0.00	−58.35	43,927,885.32	902.76	0.00	−96.08	94.01	5.99	92.75	7.25

Panel B: operating difficulties and future strategies

Efficiency score range (No. of DMUs)	Average efficiency score	Allocations of human capital		Operating types of branches						
		% of possessing CPA qualifications	% of partners and managers	No. of branches	Permanently stationed by practicing accountants	Regularly stationed by practicing accountants	Permanently stationed by full-time staff	Only as a contact window	Major operating difficulties	Future strategies
90 ⩽ E < 100(1)	99.5	0.12	0.24	0	No	No	No	No	1,2,4	1,6,2
80 ⩽ E < 90(3)	83.62	0.13	0.22	1.33	3	No	No	No	1,5,8	1,11
70 ⩽ E < 80(8)	73.44	0.24	0.36	0.75	1	1	2	No	1,2	1,2,3
60 ⩽ E < 70(15)	63.60	0.26	0.33	0.27	3	No	No	No	1,2	1,3,4
0 ⩽ E < 60(189)	35.78	0.21	0.29	0.58	59	14	18	7	1,2,3,4,5	1,3
Average (216)	40.06	0.21	0.30	0.57						

Notes: (1) Major operating difficulties: 0: none; 1: fierce competition; 2: market recessions; 3: many practitioners without licenses or simply renting licenses; 4: high costs in human capital; 5: a lack of skilled professionals; 6: unhealthy commissioning system; 7: high turnover of professional personnel; 8: others. (2) Future strategies: 0: none; 1: improvement of service quality; 2: recruiting more assistants; 3: training of staff; 4: maintenance of status quo; 5: recruiting more accountants; 6: IT systems in sales and management; 7: relocation of accountants to Mainland China; 8: merger with other accounting firms; 9: establishment of a management consulting firm; 10: addition of branches; 11: others

accounting firms is poor. The average efficiency value of the sampled 216 firms is 40.06. In terms of improvement percentages and space, total practice revenues (O1) should increase by 223.05 percent (or NTD 43,927,885.32) and the number of cases (O2) should increase by 549.85 percent (or 902.76 cases). There is no need for any improvement in the number of employees (I1). The area of space in use (I2) should be reduced by 58.35 percent (or 96.08 square feet). Overall, the priority in increasing outputs is to increase the number of cases (O2) and reduce the area of space in use (I2). This means that accounting firms may not fully utilize their space or may have excess space.

In terms of input and output contributions, the average contribution from total practice revenues (O1; 94.01 percent) of the sampled 216 firms is significantly higher than the number of cases (O2; 5.99 percent). The average contribution of the number of employees (I1; 92.75 percent) is also significantly larger than for the area of space in use (I2; 7.25 percent). This indicates that the major performance contributors for inefficient firms are practice revenues and human resources.

4.2.2 Analysis of human capital, operating types of branches, major operating difficulties and future strategies. Panel B in Table IV summarizes the allocations of human capital. On average, 21 percent of the employees in all the sampled 216 firms are CPA qualified accountants, very close to the 22 percent for the four efficient firms. The percentage of partners and managers is 30 percent for all the inefficient firms, slightly higher than the 27 percent for the four efficient firms. The results indicate that the percentage of senior managers is slightly higher in inefficient firms. It may also increase the payment of human cost in inefficient firms. Too high of a percentage of senior managers does not necessarily mean that such manpower allocation is poor; however, the appointment of suitable talents is required. If the appropriate functions cannot be given to the staff to play their functions, it may certainly increase the burden of accounting firms, causing idle talents and waste, which is not beneficial for accounting firms. Thus, this paper suggests that inefficient firms should refer to the percentage of manpower allocation in efficient firms and suitably reduce the percentage of senior managers to achieve efficient management.

The average number of branches is less than 1. As many as 66 firms have practicing accountants stationed permanently at branches; 15 firms have practicing accountants stationed regularly; 20 firms have dedicated staff stationed permanently and 7 firms using branches as contact windows only. The firms with efficient values of 90–100 do not have branches. In the case of firms with efficiency values below 60, 73 have practicing accountants permanently or regularly stationed at branches. This could be one of the reasons for their inefficiency. This implies that in addition to headquarters affairs, practicing accountants should also take care of branch businesses. This would allow them to stay on top of operations of all operating units; however, it may also cause them to lose focus on main operations.

To compete with efficient firms, inefficient firms should endeavor to maintain their competitive advantages. They should strive to secure and maintain existing clients and develop new customers to combat recessions. Moreover, they should provide appropriate training to enhance the professional knowledge and skills of employees, in order to be able to meet client needs and cope with various situations. Accounting firms are a human capital intensive industry. Only with high-caliber professionals can accounting firms survive recessions and thrive in competitive markets.

Future strategies are the same for both inefficient firms and efficient firms. The top priority is the improvement of service quality, followed by training of staff, recruiting more assistants and utilizing IT systems in sales and management. Given the high homogeneity of the service items, accounting firms are advised to prioritize service quality. They should enhance the intelligence and skills of professionals in order to gain the trust and loyalty of customers for firm business services. This can secure the operations of accounting firms.

4.3 Analysis of operating difficulties and the effects of branch operating type on operating efficiency

Table V summarizes the operating difficulties quoted by the sampled 220 firms. The most quoted operating difficulties are fierce competition (93 firms) and market recessions (66 firms), followed by fierce competition (48 firms), market recessions (57 firms) and high costs in human capital (33 firms). The third most quoted operating difficulties are high costs in human capital (35 firms) and high turnovers of professional personnel (28 firms).

Table VI shows the variances in operating efficiency for different operating types of branches. The independent sample *t*-test shows no significant difference in the means of both sampled groups. It does not seem to matter whether practicing accountants are permanently or regularly stationed at branches, or whether dedicated personnel are permanently stationed at branches. It also does not seem to matter whether or not the branches are anything more than contact windows. This means that the operating type of a branch makes no significant difference on the operating efficiency of the accounting firm.

4.4 Effects of practices in Mainland China on operating efficiency

The operating difficulties shown in Tables III and IV are mainly fierce competition, followed by market recessions, and then high costs in human capital and a lack of skilled professionals.

Table V.
Operating difficulties for the accounting firm partnerships

	The first		The second		The third	
	No. of DMUs	Average efficiency score	No. of DMUs	Average efficiency score	No. of DMUs	Average efficiency score
0: none	13	46.683	23	47.083	49	44.080
1: fierce competition	93	44.010	48	39.647	26	36.070
2: market recessions	66	38.482	57	43.529	19	40.933
3: many practitioners without licenses or simply renting licenses	11	30.678	11	37.132	26	38.967
4: high costs in human capital	9	40.412	33	37.147	35	48.261
5: a lack of skilled professionals	12	45.690	18	38.343	17	45.759
6: unhealthy commissioning system	6	23.360	19	36.610	17	39.576
7: high turnover of professional personnel	7	36.464	11	51.528	28	34.519
8: others	3	56.493	–	–	3	19.680
Sum of DMUs/average efficiency score	220	41.155	220	41.155	220	41.155

Table VI.
Difference in operating efficiency of different operating types of branches

Yes/No	No. of DMUs	Average efficiency score	Average difference	*t*-value	*p*-value (one-tailed)
Branch type – permanently stationed by practicing accountants					
Yes	68	42.712	2.254	0.822	0.206
No	152	40.458			
Branch type – regularly stationed by practicing accountants					
Yes	15	43.309	2.312	0.660	0.259
No	205	40.997			
Branch type – permanently stationed by full-time staff					
Yes	22	41.897	0.825	0.195	0.423
No	198	41.072			
Branch type – only as a contact window					
Yes	7	45.043	4.016	0.556	0.289
No	213	41.027			

The first two are external factors; the third an internal factor, which is within the control of accounting firms. Although external factors are beyond the control of accounting firms, it is still necessary to resolve the problems they present. Many companies in Taiwan have shifted most of their operations or sales locations to Mainland China. As a result, accounting firms also need to adjust their strategies and meet the demand by setting up practice in Mainland China. This paper summarizes the findings on the related factors of the four dimensions, namely, the percentage of revenues from Mainland China, the reasons for setting up practice in Mainland China, the percentage of each project executed in Mainland China, and the operating modes in Mainland China, as well as their relationships with operating efficiencies.

Table VII shows the percentage of revenues from Mainland China in Model 1. There is a significant and positive correlation between TR and OE. In other words, the higher the percentage of revenues from Mainland China, the better the operating efficiency of the accounting firms; practice in Mainland China makes positive contributions. According to Model 2, in regard to the reasons for setting up practice in Mainland China is the significant and positive correlation between S_1 and S_3 (two variables) and OE. This means that accounting firms have extended their footprint to Mainland China in order to address the needs of clients (S_1) and to respond to competition from their peers (S_3). This is consistent with the major operating difficulties listed in Tables III and IV. The offering of services in Mainland China to meet the demands of customers in a highly competitive market can indeed boost the operating efficiency of accounting firms.

According to the percentage of each project executed in Mainland China in Model 3, there is a significant and positive correlation between R_1, R_5, R_7 and R_8 (four variables) and OE. The higher the number of projects in the auditing of the accounts for Taiwanese transfers to investment companies (R_1), the greater the assistance in training the personnel of local accounting firms (R_5), the more assistance to local accountants' practices (R_7) and businesses other than R_1~R_7 (R_8), the better the improvement to operating efficiency. The auditing of the accounts for Taiwanese transfers to investment companies (R_1) is a natural progression for accounting firms serving Taiwanese clients operating in Mainland China. Assistance in training the personnel of local accounting firms (R_5) and assistance to local accountants' practices (R_7) may also boost the operating efficiency of accounting firms.

According to the operating modes in Mainland China covered by Model 4, there is a significant and positive correlation between M_1 and OE. The dispatch of personnel from Taiwan to Mainland China boosts operating efficiency. However, cooperation with local firms in Mainland China and the training of local professionals (M_2) do not have any significant influence on operating efficiency. This means that Chinese practices still require support from operations in Taiwan. The visits of Taiwanese professionals to Mainland China to provide assistance involves, in essence, the mentoring and sharing of professional expertise. This saves the time required to formulate new operating modes and the costs needed to train local professionals in Mainland China. It is also a method of quickly applying the operating modes and intellectual capital of firms in Taiwan to practices in Mainland China, and shortening the learning curve for adjusting to new environments and familiarizing with relevant laws and regulations. Visiting Taiwanese personnel in Mainland China can also avoid barriers to sharing and communication between the employees in Taiwan and the employees in Mainland China. To sum up, the dispatching of personnel from Taiwan is beneficial to the operating efficiency of accounting firms.

Finally, this paper incorporates all 15 independent variables in the four models for stepwise regression analysis. Table VII screens out the three key factors determining the operating efficiency of accounting firms. Response to peer competition (S_3) is the main reason for setting up practice in Mainland China. The assistance to local accountants'

Table VII.
Regression results on relationships between practices in Mainland China and operating efficiency

Dimensions	Variables	Model 1	Model 2	Model 3	Model 4	Stepwise regression
	Intercept	40.264*** (31.422)	39.869*** (30.414)	40.130*** (30.773)	39.835*** (30.156)	39.859*** (30.689)
The percentage of revenues from Mainland China	TR	3.564*** (2.923)				
The reasons for setting up practice in Mainland China	S_1		9.594** (2.196)			
	S_2		−15.290 (−1.059)			
	S_3		32.890** (2.279)			25.128** (2.232)
	S_4		−0.243 (−0.013)			
The percentage of each project executed in Mainland China	R_1			0.083* (1.614)		
	R_2			−0.449 (−0.581)		
	R_3			7.868 (0.943)		
	R_4			−0.244 (−0.758)		
	R_5			1.934* (1.646)		
	R_6			−0.175 (−0.950)		
	R_7			7.318** (1.932)		7.506** (2.014)
	R_8			1.289** (2.070)		
The operating modes in Mainland China	M_1				11.322*** (2.720)	7.174** (1.681)
	M_2				4.635 (0.477)	
	Observations	220	220	220	220	220

Notes: The figures in parentheses are *t*-values. The variable VIFs are all less than 10, implying that no serious multi-collinearity exists among variables. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

$$\mathrm{OE} = a_0 + a_1 \mathrm{TR} + e_1 \tag{2}$$

$$\mathrm{OE} = b_0 + b_1 S_1 + b_2 S_2 + b_3 S_3 + b_4 S_4 + e_2 \tag{3}$$

$$\mathrm{OE} = c_0 + c_1 R_1 + c_2 R_2 + c_3 R_3 + c_4 R_4 + c_5 R_5 + c_6 R_6 + c_7 R_7 + c_8 R_8 + e_3 \tag{4}$$

$$\mathrm{OE} = d_0 + d_1 M_1 + d_2 M_2 + e_4 \tag{5}$$

practices (R_7) is the main factor in the percentage of each project executed in Mainland China. The major operating mode in Mainland China is sending personnel from Taiwan (M_1). All three key factors can enhance the operating efficiency of accounting firms.

5. Conclusions and managerial implications

Unlike past studies, this paper combines three research methods: DEA, univariate testing and regression analysis, to perform robust evaluations on the operating efficiency of accounting firm partnerships. During the first stage, this paper identifies reasons for inefficiency by using DEA to analyze accounting firm partnerships. The results can serve as a reference for managers in improving efficiency. During the second stage, this paper analyzes the allocation of human capital, the operating types of branches, their major operating difficulties and future strategies for accounting firm partnerships. During the third stage, this paper constructs regression models for evaluating the effects of practice strategies in Mainland China on operating efficiency, in order to identify key factors.

The findings in the first stage indicate that only 4 out of 220 firms have better operating efficiency. The remaining 216 firms are not efficient. DMU28, the highest ranking firm in terms of operating efficiency, reports an efficiency value of 100; it is referenced 214 times. In terms of total practice revenues and number of cases, DMU28 is the best performer. This is consistent with the rankings derived using the DEA method. The other three firms with an efficiency value of 100 are small and medium in size. Large firms are not necessarily efficient. The efficient accounting firms see an average of 50 percent contribution from total practice revenues and 50 percent contribution from the number of cases. Firm size and spatial arrangement are the key input factors. For inefficient firms, the main outputs are still dependent on total practice revenues. The contribution of major input is human capital.

The research in the second stage finds that the percentage of senior managers is higher for firms with poor operating efficiency than for firms with good operating efficiency. This implies that firms with poor operating efficiency may suffer from a high cost in human capital. If senior managers are not empowered, a high percentage of senior managers may be redundant and have a negative effect on operating efficiency. Practicing accountants from firms with good operating efficiency often visit branches to take care of business. Most of the branches of the firms with efficiency values below 60 have permanent or regularly stationed practicing accountants. This implies that in addition to headquarters affairs, practicing accountants should also take care of branch businesses. This would allow them to stay on top of operations of all operating units; however, it might also cause them to lose focus on main operations.

Both efficient and inefficient firms indicate that their biggest challenge is fierce competition, followed by market recessions. Accounting firms are advised to seek ways to maintain competitive advantages. To combat recessions, it is critical to maintain existing clients and develop new clients. Appropriate educational training should be provided to upgrade the professional expertise and competency of staff. Accounting firms belong to the highly labor-intensive and knowledge-intensive service industry, and only staff who are equipped with rich and professional knowledge and skills are qualified for the business services provided by these firms. Therefore, firms are advised to regularly hold related educational training to improve their staff's professional knowledge and ability in various aspects to respond to the diversified business nature and meet customer needs.

For both efficient and inefficient firms, the top priority should be the improvement of service quality, followed by staff training, recruiting more assistants and developing effective IT systems for sales and management. Therefore, accounting firms are advised to constantly strive for improvement of service quality and enhancement of staff competency in order to gain the trust and loyalty of their clients regarding the professional services

provided by accounting firms. In addition, for the operating types of branches, whether permanently or regularly stationed by practicing accountants or full-time staff or just used as contact windows, not to cause any significant differences in the operating efficiency of accounting firms.

The research in the third stage finds that, regarding the reasons for setting up practice in Mainland China, when the accounting firms set up practices in Mainland China to address customer needs and respond to intense competition from peers, they also shift their operational strategies to the Mainland China market. Providing services to businesses in Mainland China can enhance the operating efficiency of accounting firms. In terms of the percentage of each project executed in Mainland China, the higher the number audits of the accounts for Taiwanese transfers to investment companies, the greater the assistance in training the personnel of local accounting firms, the more assistance to local accountants' practices and businesses, and the better the improvement to operating efficiency will be. In terms of the operating modes in Mainland China, the dispatch of personnel from Taiwan to Mainland China will bring significant improvements to operating efficiency for accounting firms. It means that the dispatch of personnel from Taiwan to Mainland China can assist the relevant business to be executed, which can rapidly apply the operating modes and intelligent capital of firms in Taiwan to practices in Mainland China, and save the costs needed to train local professionals in Mainland China.

This paper screens out the three critical factors that influence the operating efficiency of accounting firm partnerships by performing a stepwise regression. Response to peer competition is the main reason for setting up practice in Mainland China. Assistance to local accountant practices is the main factor in the percentage of each project executed in Mainland China. The major operating mode in Mainland China is bringing personnel from Taiwan. These three key factors drive the improvement of operating efficiency.

These findings can serve as a reference and benchmark for accounting firms in regard to operating difficulties or poor efficiency, and assist accounting firms in identifying their core competences and enhancing their competitive advantages. The results can also help accounting firms in mapping out their future strategies and developing suitable operating modes. For practices in Mainland China, this paper developed four regression models. A stepwise regression analysis was also performed in order to identify the key factors of operating efficiency. Such efforts aim to assist accounting firms in developing business and expanding service scope so that they will no longer be limited by the traditional auditing and non-auditing markets in Taiwan. To survive in a highly competitive market, accounting firms should have broader perspectives in order to devise thorough business plans for future operating strategies.

By combining the three research methods of DEA, univariate testing and regression analysis, this paper breaks through bottleneck of previous researches, which mostly use a single research method to carry out operational performance evaluation. This research hopes that during the process of rigorous research and design, the objective application of multiple outputs and inputs can measure the operating efficiency of various firms, while meanwhile overcoming the limitation of the dependent variables in the regression model only allowing for one index. Moreover, DEA is combined with regression analysis to determine the key factors affecting operating efficiency. Research in the accountant industry is rare, and it is therefore the feature of the research and design in this paper. Past research works have discussed few relevant issues about the effect of practices in Mainland China on operating efficiency. This concept and research result can assist accounting firms in formulating strategies for practice in Mainland China; by referencing the key influence factors, the managers of firms can assist with and guide the formulation of guidelines for management to expand the business market in the future. This is also a research contribution of this paper.

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Appendix

Table AI. Efficiency scores of the all DMUs

Code of DMU	Efficiency score	No. of references	DEA rankings	Input and output contribution (%) O1	O2	I1	I2	Improvement percentages (%) O1	O2	I1	I2	Improvement space O1	O2	I1	I2
1	53.41	0	56	95.7	4.3	100	0	87.2	87.2	0	−29.3	8,829,736	178	0	−2.05
2	8.87	0	217	89.6	10.4	100	0	1027.4	1027.4	0	−81.8	7,191,970	370	0	−12.27
3	28.72	0	164	96.3	3.7	100	0	248.2	248.2	0	−53.1	31,737,433	539	0	−12.75
4	10.37	0	215	94.4	5.6	100	0	864.4	864.4	0	−65.4	5,588,077	147	0	−3.27
5	50.63	0	62	97.9	2.1	100	0	97.5	97.5	0	−91.6	2,127,400	20	0	−11.00
6	61.96	0	27	96.1	3.9	100	0	61.4	61.4	0	−50.4	8,849,485	160	0	−6.05
7	23.66	0	187	89.7	10.3	100	0	322.6	322.6	0	−81.9	60,313,674	3,068	0	−122.80
8	26.2	0	176	95.6	4.4	100	0	281.6	281.6	0	−81.6	7,766,726	158	0	−12.25
9	58.64	0	34	100	0	100	0	70.5	80.8	0	−93.2	24,161,436	201	0	−183.70
10	47.89	0	73	94.7	5.3	100	0	108.8	108.8	0	−83.5	60,790,781	1,527	0	−161.95
11	20.51	0	196	96.7	3.3	100	0	387.6	387.6	0	−88.1	33,825,378	519	0	−78.43
12	100	4	4	0	100	0	100	0	0	0	0	0	0	0	0.00
13	36.12	0	124	94.3	5.7	100	0	176.9	176.9	0	−79.7	18,571,795	495	0	−31.89
14	71.49	0	15	95.9	4.1	100	0	39.9	39.9	0	−58.2	13,837,773	266	0	−17.45
15	36.52	0	122	96.9	3.1	100	0	173.8	173.8	0	−97	23,022,056	325	0	−291.12
16	45.79	0	83	92.2	7.8	100	0	118.4	118.4	0	−97.1	15,401,049	580	0	−291.23
17	25.57	0	179	86.4	13.6	44.3	55.7	291.1	291.1	0	0	60,394,995	1,217	0	0.00
18	32.01	0	141	94.7	5.3	100	0	212.4	212.4	0	−93.6	85,008,363	2,129	0	−499.68
19	15.42	0	208	94.7	5.3	100	0	548.4	548.4	0	−54	58,165,376	1,453	0	−22.13
20	23.35	0	188	96.2	3.8	100	0	328.3	328.3	0	−28.1	32,450,936	575	0	−4.22
21	27.56	0	169	96.2	3.8	100	0	262.8	262.8	0	−83.8	27,599,287	489	0	−50.30
22	34.75	0	129	95.4	4.6	100	0	187.7	187.7	0	−54.9	93,118,449	2,018	0	−46.13
23	47.67	0	74	97.8	2.2	100	0	109.8	109.8	0	−69.4	31,554,813	310	0	−31.93
24	57.17	0	39	97.3	2.7	100	0	74.9	74.9	0	−54.2	112,842,785	1,388	0	−74.76
25	45.15	0	86	96.9	3.1	100	0	121.5	121.5	0	−53	10,531,687	148	0	−5.30
26	31.34	0	147	96.9	3.1	100	0	219	219	0	−90.2	21,953,110	318	0	−72.14
27	52.55	0	58	87.1	12.9	100	0	90.3	90.3	0	−45.9	10,004,046	660	0	−6.88
28	100	214	1	100	0	100	0	0	0	0	0	0	0	0	0.00
29	5.49	0	219	71.1	28.9	41.6	58.4	1,721.2	1,721.2	0	0	8,606,083	448	0	0.00
30	26.15	0	177	91.3	8.7	100	0	282.5	282.5	0	−93.3	14,833,298	633	0	−89.53
31	43.98	0	88	98.1	1.9	100	0	127.4	127.4	0	−80.3	30,244,222	259	0	−50.59

(*continued*)

Table AI.

Code of DMU	Efficiency score	No. of references	DEA rankings	Input and output contribution (%)				Improvement percentages (%)				Improvement space			
				O1	O2	I1	I2	O1	O2	I1	I2	O1	O2	I1	I2
32	64.84	0	21	62.2	37.8	60.9	39.1	54.2	54.2	0	0	18,531,491	1,128	0	0.00
33	37.25	0	119	96.8	3.2	100	0	168.4	168.4	0	−63.1	53,471,965	788	0	−35.98
34	18.72	0	199	95.8	4.2	100	0	434.1	434.1	0	−85.3	11,995,466	234	0	−22.17
35	28.42	0	166	95.6	4.4	100	0	251.9	251.9	0	−40.1	19,569,840	406	0	−4.82
36	62.58	0	25	83.4	16.6	52.7	47.3	59.8	59.8	0	0	2,182,251	44	0	0.00
37	71.24	0	16	96.6	3.4	100	0	40.4	40.4	0	−96.2	7,339,266	114	0	−158.65
38	81.22	0	8	88.8	11.2	61.6	38.4	23.1	23.1	0	0	12,983,717	210	0	0.00
39	49.44	0	65	97	3	100	0	102.3	102.3	0	−47.8	21,581,244	301	0	−9.57
40	43.63	0	90	97	3	100	0	129.2	129.2	0	−93.4	37,309,294	512	0	−227.86
41	53.44	0	55	85.3	14.7	46.1	53.9	87.1	87.1	0	0	3,672,970	81	0	0.00
42	36.64	0	121	95.3	4.7	100	0	173	173	0	−73.2	15,946,718	351	0	−18.30
43	41.09	0	99	95.9	4.1	100	0	143.4	143.4	0	−95.8	135,490,813	2,603	0	−1,360.50
44	58.67	0	33	86.8	13.2	51.7	48.3	70.4	70.4	0	0	22,210,258	431	0	0.00
45	20.86	0	194	93.2	6.8	100	0	379.3	379.3	0	−47.2	22,731,708	736	0	−7.55
46	63.28	0	24	95.7	4.3	100	0	58	58	0	−75.9	8,512,979	168	0	−18.97
47	10.35	0	216	86.8	13.2	100	0	866.4	866.4	0	−25.7	5,141,004	347	0	−0.77
48	61.24	0	28	96.7	3.3	100	0	63.3	63.3	0	−98.9	1,650,856	25	0	−97.95
49	22.87	0	190	89.6	10.4	50.7	49.3	337.2	337.2	0	0	17,451,173	260	0	0.00
50	37.77	0	114	97.4	2.6	100	0	164.8	164.8	0	−54.9	116,031,620	1,392	0	−54.39
51	32.1	0	140	96.6	3.4	100	0	211.5	211.5	0	−85.2	34,653,353	539	0	−73.30
52	11.53	0	212	91.7	8.3	100	0	767.4	767.4	0	−93.6	12,492,608	506	0	−65.53
53	37.53	0	116	94.2	5.8	100	0	166.5	166.5	0	−70.9	10,360,537	285	0	−11.34
54	54.04	0	54	95.8	4.2	100	0	85	85	0	−75.1	14,529,523	287	0	−24.78
55	40.46	0	101	92.1	7.9	100	0	147.1	147.1	0	−76	15,693,006	597	0	−25.84
56	33.79	0	133	96.7	3.3	100	0	196	196	0	−94.4	21,133,883	323	0	−134.08
57	30.88	0	149	92.1	7.9	100	0	223.8	223.8	0	−85	7,002,833	269	0	−17.85
58	31.73	0	144	95.9	4.1	100	0	215.2	215.2	0	−61.9	10,087,917	191	0	−6.19
59	39.29	0	105	96.9	3.1	100	0	154.5	154.5	0	−58.5	24,591,970	354	0	−14.05
60	85.07	0	6	100	0	42.9	57.1	17.6	150.3	0	0	544,481,017	17,750	0	0.00
61	39.08	0	109	100	0	100	0	155.9	200.1	0	−89.2	144,987,008	1,223	0	−445.82
62	41.72	0	96	96.9	3.1	100	0	139.7	139.7	0	−31.9	16,155,125	232	0	−3.19

(*continued*)

Code of DMU	Efficiency score	No. of references	DEA rankings	Input and output contribution (%)				Improvement percentages (%)				Improvement space			
				O1	O2	I1	I2	O1	O2	I1	I2	O1	O2	I1	I2
63	21.46	0	192	94.9	5.1	100	0	365.9	365.9	0	−9.2	26,243,254	629	0	−0.92
64	29.3	0	159	85.9	14.1	54.1	45.9	241.3	241.3	0	0	65,897,736	1,382	0	0.00
65	26.23	0	175	93.5	6.5	100	0	281.2	281.2	0	−4.3	24,284,437	754	0	−0.43
66	64.29	0	22	96	4	100	0	55.6	55.6	0	−95.1	6,036,298	112	0	−84.66
67	37.84	0	113	96.1	3.9	100	0	164.3	164.3	0	−96.1	24,967,888	457	0	−253.71
68	28.55	0	165	97.3	2.7	100	0	250.3	250.3	0	−48.6	12,243,498	150	0	−3.89
69	58.14	0	36	90.6	9.4	100	0	72	72	0	−97.4	3,339,432	154	0	−97.36
70	71.96	0	13	96.2	3.8	100	0	39	39	0	−62.4	12,470,428	217	0	−18.71
71	54.54	0	51	89.4	10.6	59.7	40.3	83.3	83.3	0	0	27,600,279	420	0	0.00
72	59.89	0	32	100	0	100	0	67	19,210.5	0	−7.5	120,623,684	2,305	0	−5.54
73	30.59	0	150	95.8	4.2	100	0	226.9	226.9	0	−80.8	20,485,961	402	0	−32.33
74	55.12	0	48	97.9	2.1	100	0	81.4	81.4	0	−73.1	83,201,514	783	0	−116.95
75	30.32	0	153	92.9	7.1	100	0	229.9	229.9	0	−92.6	11,402,184	386	0	−61.12
76	35.57	0	125	88.7	11.3	50.6	49.4	181.2	181.2	0	0	169,960,388	2,772	0	0.00
77	37.72	0	115	95.3	4.7	100	0	165.1	165.1	0	−62.8	10,449,911	229	0	−7.53
78	65.37	0	20	97	3	100	0	53	53	0	−75.9	4,434,482	62	0	−9.87
79	26.96	0	173	94.4	5.6	100	0	270.9	270.9	0	−83.5	9,109,946	238	0	−17.54
80	12.4	0	211	93.4	6.6	100	0	706.3	706.3	0	−88	1,801,046	57	0	−4.40
81	68.7	0	18	96.8	3.2	100	0	45.6	45.6	0	−30.6	41,323,224	615	0	−14.38
82	43.51	0	91	95.1	4.9	100	0	129.9	129.9	0	−48.3	54,411,353	1,240	0	−24.15
83	40.28	0	102	94.5	5.5	100	0	148.2	148.2	0	−40.7	40,997,704	1,057	0	−13.02
84	47.66	0	75	97.6	2.4	100	0	109.8	109.8	0	−97.2	10,123,469	109	0	−160.44
85	84.56	0	7	100	0	43.1	56.9	18.3	82.6	0	0	386,549,540	9,241	0	0.00
86	58.56	0	35	100	0	49.4	50.6	70.8	50,497.8	0	0	21,062,946	505	0	0.00
87	55.36	0	46	98.2	1.8	100	0	80.6	80.6	0	−59.9	102,249,820	845	0	−78.51
88	37.42	0	117	85.4	14.6	56.2	43.8	167.3	167.3	0	0	30,402,648	667	0	0.00
89	49.28	0	67	96	4	100	0	102.9	102.9	0	−75.9	8,574,324	158	0	−13.66
90	28.42	0	167	93.6	6.4	100	0	251.8	251.8	0	−94.6	20,641,067	630	0	−146.66
91	63.49	0	23	94.7	5.3	100	0	57.5	57.5	0	−97.4	8,373,526	207	0	−230.72
92	33.83	0	132	96.9	3.1	100	0	195.6	195.6	0	−67.3	70,531,153	1,017	0	−53.80
93	34.65	0	130	94.6	5.4	100	0	188.6	188.6	0	−19.7	9,526,215	241	0	−0.99

(*continued*)

Table AI.

Table AI.

Code of DMU	Efficiency score	No. of references	DEA rankings	Input and output contribution (%)				Improvement percentages (%)				Improvement space			
				O1	O2	I1	I2	O1	O2	I1	I2	O1	O2	I1	I2
94	78.92	0	9	97.2	2.8	100	0	26.7	26.7	0	−89.2	2,255,002	29	0	−21.42
95	16.73	0	203	90.7	9.3	100	0	497.8	497.8	0	−50.6	14,962,894	682	0	−6.07
96	55.1	0	49	95.2	4.8	100	0	81.5	81.5	0	−68.4	134,492,117	3,033	0	−173.80
97	46.14	0	80	96.3	3.7	100	0	116.8	116.8	0	−96.1	19,417,064	328	0	−225.90
98	45.7	0	84	91.5	8.5	45.8	54.2	118.8	118.8	0	0	98,333,956	1,161	0	0.00
99	56.86	0	40	95.6	4.4	100	0	75.9	75.9	0	−71	18,163,029	368	0	−26.99
100	68.9	0	17	83.1	16.9	47.2	52.8	45.1	45.1	0	0	28,047,431	728	0	0.00
101	55.71	0	44	94.8	5.2	100	0	79.5	79.5	0	−63.5	46,188,212	1,136	0	−49.50
102	16.56	0	204	90.4	9.6	100	0	504	504	0	−85.9	11,621,659	549	0	−28.34
103	33.01	0	135	97.3	2.7	100	0	203	203	0	−94.9	21,516,036	268	0	−142.28
104	30.34	0	152	94.2	5.8	100	0	229.6	229.6	0	−47.7	50,528,920	1,393	0	−18.59
105	35.11	0	127	96	4	100	0	184.8	184.8	0	−55.8	30,165,027	558	0	−15.06
106	27.54	0	170	95.8	4.2	100	0	263.1	263.1	0	−81.1	13,756,711	266	0	−21.08
107	27.88	0	168	94.1	5.9	47.8	52.2	258.6	258.6	0	0	71,196,654	574	0	0.00
108	21.94	0	191	91.8	8.2	100	0	355.7	355.7	0	−68.3	7,886,777	313	0	−6.83
109	24.57	0	184	92.1	7.9	100	0	307	307	0	−94.5	16,820,501	642	0	−118.09
110	30.39	0	151	93.4	6.6	100	0	229.1	229.1	0	−80	2,863,583	89	0	−4.80
111	46.14	0	81	95.9	4.1	100	0	116.7	116.7	0	−61.6	13,645,534	258	0	−10.47
112	99.5	0	5	100	0	88.3	11.7	0.5	82.3	0	0	139,990	272	0	0.00
113	46.03	0	82	94.1	5.9	100	0	117.3	117.3	0	−46.5	48,060,622	1,344	0	−21.86
114	38.85	0	110	85.8	14.2	47.1	52.9	157.4	157.4	0	0	61,773,788	1,310	0	0.00
115	32.69	0	138	98.2	1.8	100	0	205.9	205.9	0	−19	26,178,977	216	0	−2.09
116	48.96	0	70	94.7	5.3	100	0	104.2	104.2	0	−12.3	21,285,380	525	0	−1.59
117	52.92	0	57	96.4	3.6	100	0	89	89	0	−74.3	12,986,414	216	0	−20.05
118	32.62	0	139	92.1	7.9	100	0	206.6	206.6	0	−98.2	13,655,850	523	0	−343.71
119	17.32	0	202	93	7	100	0	477.5	477.5	0	−17.6	142,182,329	4,756	0	−10.90
120	25.11	0	180	97.4	2.6	100	0	298.3	298.3	0	−61.5	134,825,342	1,620	0	−68.92
121	17.57	0	200	91.7	8.3	100	0	469.2	469.2	0	−87.5	14,968,869	605	0	−40.26
122	20.83	0	195	95.4	4.6	100	0	380	380	0	−79	28,264,208	604	0	−35.55
123	27.29	0	171	95.6	4.4	100	0	266.4	266.4	0	−21.6	41,299,029	850	0	−4.09
124	50.7	0	60	97.1	2.9	100	0	97.2	97.2	0	−42.1	40,045,549	529	0	−14.30

(*continued*)

Code of DMU	Efficiency score	No. of references	DEA rankings	Input and output contribution (%)				Improvement percentages (%)				Improvement space			
				O1	O2	I1	I2	O1	O2	I1	I2	O1	O2	I1	I2
125	5.47	0	220	78.9	21.1	54.1	45.9	1727.2	1727.2	0	0	16,191,149	553	0	0.00
126	65.98	0	19	96	4	100	0	51.6	51.6	0	−94.9	17,965,491	336	0	−252.41
127	29.13	0	161	95.3	4.7	100	0	243.3	243.3	0	−94.4	5,944,228	131	0	−37.76
128	55.9	0	43	93.3	6.7	100	0	78.9	78.9	0	−21.8	11,775,588	375	0	−2.18
129	32.89	0	137	95.8	4.2	100	0	204	204	0	−80.1	16,985,706	328	0	−26.44
130	56.43	0	41	62.9	37.1	46.1	53.9	77.2	77.2	0	0	3,805,919	287	0	0.00
131	42.67	0	94	97.8	2.2	100	0	134.4	134.4	0	−37.6	76,518,985	763	0	−18.80
132	39.13	0	108	98.2	1.8	100	0	155.6	155.6	0	−72.6	53,940,108	442	0	−53.71
133	39.14	0	107	91.9	8.1	100	0	155.5	155.5	0	−71.2	18,460,421	726	0	−23.50
134	25.73	0	178	94.7	5.3	100	0	288.6	288.6	0	−83.7	6,194,893	153	0	−11.72
135	24.68	0	183	93.3	6.7	100	0	305.2	305.2	0	−73.3	12,377,391	394	0	−13.19
136	73.03	0	12	96.7	3.3	100	0	36.9	36.9	0	−47.3	6,313,591	96	0	−5.20
137	54.14	0	53	96.9	3.1	100	0	84.7	84.7	0	−74.7	14,673,342	208	0	−23.16
138	76.22	0	10	86.4	13.6	52.7	47.3	31.2	31.2	0	0	5,411,725	109	0	0.00
139	29.83	0	156	95.5	4.5	100	0	235.2	235.2	0	−73.4	17,702,751	369	0	−18.36
140	39.84	0	104	95.1	4.9	100	0	151	151	0	−94.1	12,586,501	291	0	−89.36
141	49.57	0	64	96.5	3.5	100	0	101.7	101.7	0	−95.2	12,858,354	206	0	−125.63
142	39.95	0	103	94.7	5.3	100	0	150.3	150.3	0	−61.2	23,770,599	597	0	−17.13
143	21.42	0	193	94.4	5.6	100	0	366.8	366.8	0	−32.6	11,430,348	301	0	−1.96
144	13.23	0	210	96.7	3.3	100	0	656.1	656.1	0	−72.3	38,780,727	590	0	−28.92
145	31.78	0	143	97.2	2.8	100	0	214.6	214.6	0	−29.4	21,880,117	285	0	−3.24
146	55.42	0	45	91.7	8.3	58.8	41.2	80.5	80.5	0	0	7,415,420	86	0	0.00
147	46.22	0	79	96.2	3.8	100	0	116.4	116.4	0	−70.9	22,780,343	398	0	−26.24
148	31.79	0	142	94.3	5.7	100	0	214.5	214.5	0	−98.1	58,016,658	1,573	0	−1,226.18
149	24.14	0	186	94.3	5.7	100	0	314.3	314.3	0	−51.6	15,743,503	424	0	−6.20
150	38.67	0	111	97	3	100	0	158.6	158.6	0	−49.3	86,379,037	1,207	0	−33.55
151	25.06	0	181	91.8	8.2	100	0	299.1	299.1	0	−57.6	6,053,573	242	0	−3.46
152	54.23	0	52	97.2	2.8	100	0	84.4	84.4	0	−81.6	9,794,110	125	0	−22.84
153	29.2	0	160	93.5	6.5	100	0	242.5	242.5	0	−63.1	30,594,343	948	0	−21.45
154	43.18	0	92	82.9	17.1	100	0	131.6	131.6	0	−77.9	4,147,735	380	0	−11.68
155	29.67	0	157	93.2	6.8	100	0	237	237	0	−83.2	7,212,156	235	0	−14.98

(continued)

Table AI.

Table AI.

Code of DMU	Efficiency score	No. of references	DEA rankings	Input and output contribution (%)				Improvement percentages (%)				Improvement space			
				O1	O2	I1	I2	O1	O2	I1	I2	O1	O2	I1	I2
156	15.9	0	207	85.5	14.5	43.5	56.5	528.8	528.8	0	0	31,725,736	687	0	0.00
157	73.12	0	11	76.9	23.1	46.1	53.9	36.8	36.8	0	0	1,911,477	74	0	0.00
158	54.93	0	50	95.7	4.3	100	0	82.1	82.1	0	−38.7	55,060,652	1,104	0	−20.12
159	37.95	0	112	96.2	3.8	100	0	163.5	163.5	0	−89.8	148,453,768	2,609	0	−535.15
160	33.93	0	131	93.6	6.4	100	0	194.7	194.7	0	−83.3	9,526,791	290	0	−20.83
161	41.1	0	98	97.3	2.7	100	0	143.3	143.3	0	−93	10,087,253	126	0	−54.88
162	50.67	0	61	94.1	5.9	100	0	97.3	97.3	0	−31.7	7,148,970	201	0	−1.90
163	55.28	0	47	91.3	8.7	48.1	51.9	80.9	80.9	0	0	23,540,867	286	0	0.00
164	16.12	0	205	95.3	4.7	100	0	520.2	520.2	0	−90.3	7,033,677	156	0	−20.76
165	40.49	0	100	96.9	3.1	100	0	147	147	0	−66.6	38,060,255	548	0	−31.28
166	27.11	0	172	96.8	3.2	100	0	268.8	268.8	0	−85.6	27,939,606	417	0	−56.53
167	49.41	0	66	94.3	5.7	100	0	102.4	102.4	0	−8	39,884,747	1,079	0	−1.93
168	35.11	0	128	96.6	3.4	100	0	184.8	184.8	0	−94.6	30,345,919	479	0	−203.34
169	57.21	0	38	84.9	15.1	52.7	47.3	74.8	74.8	0	0	9,569,172	217	0	0.00
170	36.52	0	123	97.5	2.5	100	0	173.8	173.8	0	−91.3	23,162,614	262	0	−91.34
171	28.84	0	162	91.7	8.3	100	0	246.8	246.8	0	−96.9	4,310,718	173	0	−60.09
172	32.97	0	136	93.7	6.3	100	0	203.3	203.3	0	−70.3	20,726,245	624	0	−21.09
173	35.4	0	126	92.7	7.3	100	0	182.5	182.5	0	−81.5	15,811,063	557	0	−32.61
174	48.5	0	71	87.2	12.8	51.7	48.3	106.2	106.2	0	0	64,832,453	1,222	0	0.00
175	57.65	0	37	97.8	2.2	100	0	73.5	73.5	0	−52.3	16,410,767	163	0	−9.94
176	51.07	0	59	98.1	1.9	100	0	95.8	95.8	0	−47.7	169,026,119	1,463	0	−72.48
177	44.61	0	87	97.6	2.4	100	0	124.2	124.2	0	−94.5	38,075,532	416	0	−279.75
178	29.98	0	154	95.1	4.9	100	0	233.6	233.6	0	−66.3	8,795,707	201	0	−6.63
179	29.86	0	155	95	5	100	0	234.9	234.9	0	−75.8	17,597,193	414	0	−21.22
180	56.38	0	42	100	0	100	0	77.4	135.4	0	−68.9	11,325,456	115	0	−13.09
181	10.59	0	214	95.7	4.3	100	0	844.4	844.4	0	−61.5	26,355,577	532	0	−12.30
182	17.46	0	201	96.2	3.8	100	0	472.7	472.7	0	−39.1	59,440,838	1,035	0	−11.72
183	49.16	0	69	96.9	3.1	100	0	103.4	103.4	0	−79.3	18,429,544	264	0	−34.10
184	45.21	0	85	95.4	4.6	100	0	121.2	121.2	0	−66	12,654,109	271	0	−11.88
185	22.89	0	189	91.6	8.4	100	0	336.9	336.9	0	−7.7	101,058,900	4,120	0	−3.46
186	24.82	0	182	95.3	4.7	100	0	302.9	302.9	0	−90.1	23,643,309	524	0	−76.61

(*continued*)

Code of DMU	Efficiency score	No. of references	DEA rankings	Input and output contribution (%)				Improvement percentages (%)				Improvement space			
				O1	O2	I1	I2	O1	O2	I1	I2	O1	O2	I1	I2
187	29.37	0	158	94.6	5.4	100	0	240.4	240.4	0	−96.2	19,116,974	486	0	−189.54
188	60.24	0	30	96.2	3.8	100	0	66	66	0	−97.1	13,474,102	235	0	−288.39
189	24.35	0	185	94.3	5.7	100	0	310.7	310.7	0	−81.4	25,120,010	677	0	−40.71
190	49.22	0	68	96.2	3.8	100	0	103.2	103.2	0	−43.3	129,027,307	2,261	0	−49.41
191	71.52	0	14	100	0	100	0	39.8	192.3	0	−86	1,199,882,335	21,355	0	−5,880.06
192	31.71	0	145	92.7	7.3	100	0	215.3	215.3	0	−93.8	20,895,384	734	0	−140.77
193	18.8	0	198	94	6	100	0	431.8	431.8	0	−88.3	62,145,422	1,770	0	−163.28
194	39.16	0	106	94.6	5.4	100	0	155.4	155.4	0	−70.2	49,412,114	1,252	0	−52.64
195	26.32	0	174	93.7	6.3	100	0	279.9	279.9	0	−71.4	41,029,325	1,226	0	−39.99
196	42.96	0	93	94.5	5.5	100	0	132.8	132.8	0	−86.2	14,240,850	366	0	−43.10
197	16.07	0	206	95.9	4.1	100	0	522.2	522.2	0	−35.4	56,682,702	1,081	0	−9.55
198	31.67	0	146	100	0	100	0	215.7	260.5	0	−56.2	11,826,273	96	0	−5.06
199	42.41	0	95	100	0	100	0	135.8	442.8	0	−90.1	17,443,256	190	0	−63.10
200	100	33	3	100	0	50	50	0	0	0	0	0	0	0	0.00
201	100	205	2	0	100	2.2	97.8	0	0	0	0	0	0	0	0.00
202	28.77	0	163	95.3	4.7	100	0	247.6	247.6	0	−30.2	22,409,725	493	0	−3.62
203	46.84	0	76	86.5	13.5	47.5	52.5	113.5	113.5	0	0	19,633,080	392	0	0.00
204	50.15	0	63	96.7	3.3	100	0	99.4	99.4	0	−73.1	30,755,214	472	0	−41.68
205	10.67	0	213	93.5	6.5	100	0	836.8	836.8	0	−40.3	14,712,925	452	0	−3.23
206	36.89	0	120	95.7	4.3	100	0	171.1	171.1	0	−53.4	558,096,009	11,280	0	−264.83
207	43.81	0	89	97	3	100	0	128.3	128.3	0	−65.6	44,386,890	611	0	−36.73
208	60.15	0	31	96.4	3.6	100	0	66.3	66.3	0	−81.5	89,644,506	1,482	0	−249.43
209	33.54	0	134	96.8	3.2	100	0	198.2	198.2	0	−26.3	39,632,238	591	0	−5.27
210	37.3	0	118	95.3	4.7	100	0	168.1	168.1	0	−80.6	22,353,055	492	0	−39.50
211	60.45	0	29	96.4	3.6	100	0	65.4	65.4	0	−89.3	5,033,512	84	0	−26.79
212	7.71	0	218	94.3	5.7	100	0	1,196.7	1,196.7	0	−95.9	5,744,173	156	0	−40.26
213	62.48	0	26	97.3	2.7	100	0	60.1	60.1	0	−92.3	26,519,755	327	0	−202.03
214	31.14	0	148	88.4	11.6	100	0	221.1	221.1	0	−95.5	5,356,662	314	0	−60.16
215	41.35	0	97	94.3	5.7	100	0	141.8	141.8	0	−71	6,084,237	165	0	−7.10
216	48.31	0	72	96.4	3.6	100	0	107	107	0	−96.6	74,591,947	1,230	0	−1,042.72
217	14.74	0	209	100	0	46.6	53.4	578.2	701.3	0	0	8,208,077	77	0	0.00
218	46.63	0	77	89.2	10.8	44.8	55.2	114.5	114.5	0	0	60,158,785	927	0	0.00
219	46.33	0	78	95.8	4.2	100	0	115.9	115.9	0	−12.5	99,597,009	1,942	0	−6.85
220	19.37	0	197	94.1	5.9	100	0	416.3	416.3	0	−61.1	33,417,091	924	0	−18.33

Table AI.

About the author
Chia-Chi Lee obtained her PhD degree from the National Yunlin University of Science and Technology, Taiwan. She is now Professor at the Department of Accounting Information, National Taipei University of Business, Republic of China (Taiwan). Her research interests include performance evaluation, decision making, service management and CPA industry analysis. Her papers appeared in *International Journal of Human Resource Management*, *The Service Industries Journal*, *Service Business, Quality and Quantity*, *Teaching and Teacher Education*, *Baltic Journal of Management*, *Expert Systems with Applications*, *Central European Journal of Operations Research*, *Journal of Information and Optimization Sciences*, etc. Chia-Chi Lee can be contacted at: cclee.vera@msa.hinet.net