MEASURING EFFICIENCY OF UK CHARTERED ACCOUNTING FIRMS
USING DATA ENVELOPMENT ANALYSIS

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In this paper, we examine the input-output efficiency of United Kingdom CPA firms using the Data Envelopment Analysis (DEA) approach. We find that a majority of CPA firms in the United Kingdom appear not to be efficient on a yearly basis, and we further find no evidence of persistent efficiency on a multi-period basis. The results of our study may serve as a yardstick for CPA firms interested in assessing their efficiency relative to their peers, and as a new gauge of CPA performance.

INTRODUCTION

The consolidation of professional services firms in the US, UK, Europe, Australia and elsewhere suggests that there are benefits of economies of scope in the production of services, and economies of scale in the costs incurred in their production. There is a developing literature on the efficiency of such service firms. Consequently, several well-known professional publications in the United States, the United Kingdom, and Australia have been providing comprehensive information on CPA firms such as revenues, the number of offices, the number of partners, the number of professionals, and the total number of staff. However, when it comes to the rankings of these companies, most of the previous literature exclusively focuses on the total amount of revenue generated by each accounting firm (for example, Jerris and Pearson, 1997). We propose a more refined methodology, and discover that few firms meet standards for efficiency yielded in studies of other sectors. While the methodology is readily applicable to CPA firm analyses, this methodology may be applied to other sectors that provide a similar diversity of services.

Although the total revenues of accounting firms can serve as a measure of production capacity and market demand for accounting services, it is an insufficient gauge of a professional services firm's ability to utilise resources for generating revenues. Total revenue, a measure for production output, is an incomplete measure because it disregards the first component of input-output efficiency. In order to measure the productive efficiency of accounting firms, we must analyze the entire input-output relationship. Accordingly, previous studies have used the Data Envelopment Analysis (hereafter, DEA) approach to analyse the input-output efficiency of accounting firms (see Banker, Chang, and Cunningham, 2003; Banker, Chang, and Natarajan, 2007). For example, Banker, Chang, and Cunningham (2003) and Banker, Chang, and Natarajan (2007) cover the accounting periods from the years 1995–1999 and 1995–1998, respectively.

In this study we apply the DEA approach to analyse a dataset containing the input factors and output performance of the public accounting firms in the United Kingdom from the years 2004 to 2008. This period marks a transition worldwide in the role of CPA firms in the systems of modern commerce. In the aftermath of an accounting scandal involving the accounting and managerial consulting firm Arthur Andersen and the energy giant Enron, internal and external auditing was transformed. The Sarbanes-Oxley Act, signed into law by then United States President Bush in 2002, required the chief executive and financial officers to endorse the conclusions of annual audits. This greater responsibility for corporate malfeasance induced firms to strengthen their internal risk management control systems. Smaller publicly traded companies without the extensive system of internal controls typically engaged CPA firms to develop new internal systems and provide for more substantial audits, including specific descriptions of internal controls.

This extension of the auditing duties for US CPA firms ratcheted up the expectation for audits and corporate accountability worldwide. Consequently, revenue for CPA firms rose, but so did the product that these firms provided. In the post-Sarbanes-Oxley world, measures of CPA firm efficiency and productivity must be re-evaluated.

The purpose of this study is twofold. First, given that the datasets used by prior research have been outdated, it warrants the need to investigate the input-output efficiency of accounting firms in the post-Sarbanes Oxley Act period using DEA approach. Second, earlier DEA studies focus on the data of US accounting firms, this study is the first DEA study, to the best of our knowledge, analysing the efficiency of accounting firms using the data of UK accounting firms. We find that this technique allows us to provide much more robust firm rankings than are obtainable by other simpler methods.

LITERATURE REVIEW

Over the years numerous researchers have used various criteria to measure the productivity and efficiency of CPA firms. For example, Jerris and Pearson (1996) relate revenues, an output performance measure, to the input resources for evaluating the performance of CPA firms. Jerris and Pearson (1997) use five different ratios to assess the relative productivity performance of accounting firms including 1) revenue per firm, 2) revenue per partner, 3) revenue per professional, 4) revenue per employee to evaluate the efficiency of the firm when using its entire supporting workforce, and the 5) revenue per office. Their findings suggest (1) that small firms are as efficient as large firms and that each firm can employ support personnel to generate revenues, (2) revenue used autonomously does not offer a comprehensive representation of the accounting firms' performance because revenue ranking fails to show how successful the firm is in using its resources, and (3) that CPA firms need to

regularly assess their productivity and various services relative to comparable benchmarks.

Franz and Jerris (2005) apply the ratios introduced by Jarris and Pearson (1996) to evaluate the performance of the top 10 CPA firms in the UK. Their results show that when revenues alone were examined to gauge productivity and efficiency, the Big Six in 1994 and the Big Four in 2004 were the peak producers of revenues and were at the top of the list of the largest CPA firms. However, in contrast, once the ratios of revenues per partner, per professional, per employee, and per office were used, the Big Six in 1994 and the Big Four in 2004 were not part of the top 10 CPA firms. Based on their findings, they conclude that firm size does not produce greater returns per partner.

While the above research focuses on the performance of accounting firms, some research shift their attention to input-output efficiency of accounting firms. For example, using DEA approach Banker, Chang, and Cunningham (2003) examine whether or not the input-output efficiency depends on the share of compensation given to partners and to other professionals (i.e., the inputs). Their study was based on a dataset of 64 CPA firms published by Accounting Today during the years 1995–1999, and include measures of output including the net revenues generated from three sources: Accounting and Auditing, Tax Services, and Manage¬ment Advisory Services. They find that partners, on average, are not over-compensated when compared to professionals and other type of employees. Similarly, Banker, Chang, and Natarajan (2007) apply the DEA approach to evaluate the efficiency of the top 100 US accounting firms using the data from 1995–1998. They suggest that there exists considerable inefficiency in the way tasks are allocated inside the US accounting firms.

The remainder of the paper is organised as follows. Our sampling process and the criteria for data collection are discussed in the next section. Then, we explain the methodology used for DEA analysis in the fourth section. Our results are presented in the fifth section. We conclude with a summary and recommendations for further research.

PUBLIC ACCOUNTING FIRMS' DATA IN THE UK

The public accounting firms used in this study are obtained from Accountancy Age Magazine of the UK during the five-year period 2004–2008. As suggested by prior literature, to be included in our dataset, the CPA firms in the UK must offer services in the following three areas: Accounting and Auditing (A & A), Taxes Services (Taxes), and Management Advisory Services (MAS). We exclude firms without the following information: generated revenues, number of partners, number of offices and number of professionals available each year. Accordingly, we exclude the following companies from the study: Vantis, MacIntyre Hudson, Rawlinson & Hunter, Target Chartered Accountants, Campbell Dallas, Simmons Gainsford, Anderson Anderson & Brown, and Barnes Roffe. These exclusions reduce the number of firms in our study to 42, which are ranked by revenue in descending order from largest to smallest and tracked during the entire investigative period.

DEA METHODOLOGY

Traditionally inputs and outputs refer to the activities of CPA firms for Data Envelopment Analysis (DEA). In this study we use 4 variables that include three input variables and one output variable. The input variables are the number of UK offices, the number of partners and the number of professional staff. The output variable s revenue. We use these inputs and output to examine which CPA firms are efficient and non-efficient.

We reproduce the notation from Charnes, Cooper and Rhodes (1978) and Zhu (2003) for simple efficiency and super efficiency models. When using simple DEA, we must maximise the ratio of outputs divided by inputs in equation (1) to form the objective function for the particular CPA firm . We designate CPA firms denoted by j={1,2,…, n} and use quantities of i inputs with i={1,2….m} to generate quantities of r outputs with r={1,2,…s}. In addition, we let be the quantity of input i for j used to generate the quantity of output r. Each CPA firm uses a variable quantity of m different inputs (i =1,2,…, m) to generate s different outputs (r=1,2,…, s). More specifically, a CPA firm j uses amount of output i and generates of output r. We then assume , and that each individual CPA firm has at least one positive input and one positive output.

DEA optimisation handles the observed vectors of and as given and selects values of output and input weights for a particular CPA firm. In Equation (1) in an input-oriented CCR model (Charnes, Cooper and Rhodes, 1978) the formulation minimises the inputs given the outputs. We obtain the following optimisation:

$$h_0^* = \max \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \quad (1)$$

subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \quad j = 1,2,...n \quad (2)$$

where:

s = number of outputs
m = number of inputs
u_r = weight of output r
v_i = weight of input i
x_{ij} = amount of i used by the CPA firm
y_{rj} = amount of r used by the CPA firm

Equation (2) is the constraint which entails that the equivalent weights, when applied to all CPA firms, do not allow any CPA firms to attain an efficiency score greater than 100% (or less than one). The rating score can range from 0 to 100% and a CPA firm is viewed as being efficient when attaining an efficiency score of 100%. Therefore, each CPA firm will select weights to maximise its own efficiency by using the constraint in Equation (2).

We then use super-efficiency (Andersen and Petersen, 1993) to rank the CPA firms. In essence, this concept of super-efficiency 'breaks ties' in the simple efficiency model when CPA firms are rated as 100% efficient. The super-efficiency model excludes the CPA firm under evaluation from the reference set from the regular DEA model. Super-efficiency (input-oriented) permits a CPA firm that is highly efficient to achieve an efficiency score greater than 100% (or 1) by removing the constraint in Equation (4).

$$h_0^* = \max \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \quad (3)$$

subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \quad j = 1,2,...n \quad \text{and} \quad j \neq 0 \quad (4)$$

RESULTS

Table 1 provides the simple and super-efficiency scores for the CPA firms under investigation. We observe that there are only a few efficient CPA firms (using simple efficiency) in the 2004–2008 period. An efficiency score of 1.0 implies that a CPA firm is efficient and that no other CPA firm has produced better outputs with the inputs used. The table exhibits both of the efficient and inefficient (less than 1.0) CPA firms.

For example, in Year 2004 of Table 1, KPMG achieved an efficiency score of 0.86742 which implies that the CPA firm is 86.742% efficient in its use of inputs and outputs. This suggests the CPA firm would have to diminish its inputs by 13.258%, without a reduction in output, to be considered efficient. CPA firms that attain an efficiency score near 1.0 would need to make only minor corrections to their inputs to be considered efficient. CPA firms attaining scores well below 70% (for example, Cooper Parry in 2004 achieved an efficiency score of 53.798%) are well away from being efficient. It may be feasible for these CPA firms to perform the necessary input modifications to attain efficiency. Such CPA firms with very low scores could perhaps attain efficiency if inputs are reduced while outputs are enhanced. In essence, DEA presents the degree of inefficiency, which can be regarded as a valuable tool to fine tune the efficiency of CPA firms to achieve 100% efficiency.

Over the five-year period only two other firms, Smith and Williamson and KPMG, were efficient in 3 years and 2 years respectively. These firms also had efficiency scores of 80% in the years they were not efficient and seem to be close to the best practices frontier. When we observe CPA firms over time, only Deloitte is efficient year-after-year (persistency), and only if the simple efficiency model score is employed. However, when using super-efficiency to break ties in 2004, 2007 and 2008, we find that only Deloitte attained the highest super efficiency score over time. We label this firm a 'champion CPA firm'.

From Table 2, we conclude that smaller firms in terms of revenue that are more regularly found in the lowest efficiency category. This conclusion is persistent. We further find that, on average, the larger CPA firms score the highest, while smaller firms tend to be the least efficient. One possible explanation is that large firms with many offices experience economies of scale and have higher billings. In addition, the majority of CPA firms fall in the 0.41–0.51, 0.51–0.60 and 0.61–0.70 ranges. Nevertheless, as the ranges of efficiency

Table 1: Efficiency Scores of UK Firms Using Simple and Super Efficiency

	2004		2005		2006		2007		2008	
	SIMPLE	SUPER	SIMPLE	SUPER	SIMPLE	SUPER	SIMPLE	SUPER	SIMPLE	SUPER
PricewaterhouseCoopers	0.95341	-	0.90065	-	0.94913	-	0.88994	-	0.90161	-
Deloitte	1.00000	1.41667	1.00000	1.54784	1.00000	1.25758	1.00000	1.28971	1.00000	1.22539
KPMG	0.86742	-	0.83818	-	0.92090	-	1.00000	1.06020	1.00000	1.02260
Ernst & Young	0.98192	-	0.92078	-	0.97051	-	0.82714	-	0.91652	-
Grant Thornton	0.71750	-	0.60680	-	0.62828	-	0.72166	-	0.61361	-
BDO Stoy Hayward	0.82902	-	0.58851	-	0.63364	-	0.80726	-	0.74462	-
Baker Tilly	0.66285	-	0.57348	-	0.54061	-	0.77456	-	0.61392	-
Smith & Williamson	1.00000	1.02036	0.84861	-	0.87738	-	1.00000	1.08081	1.00000	1.04165
PFK	0.53528	-	0.50447	-	0.51672	-	0.49918	-	0.50829	-
Tenon Grp	0.40262	-	0.45164	-	0.41534	-	0.51391	-	0.43806	-
Moore Stephens	0.55256	-	0.48579	-	0.57512	-	0.56892	-	0.55972	-
Mazars	0.53402	-	0.64728	-	0.53136	-	0.74147	-	0.58201	-
RSM Bently Jennison	0.43135	-	0.40736	-	0.38911	-	0.52801	-	0.43054	-
Hains Watts Group	0.55648	-	0.11909	-	0.47741	-	0.49826	-	0.48504	-
Saffery Chamoness	0.82637	-	0.76077	-	0.72673	-	0.81150	-	0.72438	-
Horwath Clark Whitehill	0.66717	-	0.52114	-	0.52131	-	0.55691	-	0.54254	-
UHY Hacker Young Group	0.48327	-	0.44185	-	0.43224	-	0.45589	-	0.41795	-
Kingston Smith	0.68096	-	0.55963	-	0.59246	-	0.63660	-	0.59850	-
Menzies	0.70107	-	0.61102	-	0.60765	-	0.62394	-	0.57111	-
Chantrey Vellacott DFK	0.62496	-	0.75479	-	0.62823	-	0.63042	-	0.54877	-
Wilkins Kennedy	0.65122	-	0.58302	-	0.51330	-	0.61361	-	0.59410	-
Johnston Carmichael	0.42786	-	0.37623	-	0.39953	-	0.40973	-	0.31877	-
Armstrong Watson	0.45213	-	0.44548	-	0.42857	-	0.44268	-	0.38871	-
LittleJohn	0.76900	-	0.68279	-	0.65943	-	0.76040	-	0.74303	-
Buzzacott	0.36542	-	0.62279	-	0.54681	-	0.58317	-	0.50043	-
DTE Group	0.63243	-	0.61418	-	0.72106	-	0.91275	-	0.58439	-
Cooper Parry	0.53798	-	0.46378	-	0.48387	-	0.49125	-	0.43209	-
Framcis Clark	0.47363	-	0.39935	-	0.32514	-	0.38059	-	0.63090	-
Haysmacintyre	0.75283	-	0.63263	-	0.65020	-	0.67665	-	0.66157	-
Street	0.63005	-	0.66558	-	0.86217	-	0.91128	-	0.51412	-
Duncan & Toplis	0.34259	-	0.29163	-	0.36447	-	0.42691	-	0.40973	-
Hazlewoods	0.61906	-	0.52465	-	0.54080	-	0.59737	-	0.50533	-
Shipleys	0.79395	-	0.67747	-	0.68022	-	0.70825	-	0.68024	-
Lovewell Blake	0.45512	-	0.36526	-	0.39812	-	0.48971	-	0.49454	-
Haslers	0.98313	-	0.95762	-	0.81413	-	0.88847	-	0.87348	-
Price Bailey	0.50372	-	0.48197	-	0.49660	-	0.50561	-	0.45805	-
Scott-Moncrieff	0.94065	-	0.42239	-	0.41323	-	0.45353	-	0.49078	-
Larking Gowen	0.37728	-	0.29432	-	0.28080	-	0.29827	-	0.27477	-
Reeves & Neylan	0.45025	-	0.45265	-	0.40707	-	0.49034	-	0.39373	-
Mercer & Hole	0.66606	-	0.91079	-	0.58800	-	0.59113	-	0.57391	-
Bishop Fleming	0.41035	-	0.30777	-	0.27218	-	0.36141	-	0.39191	-
Berg Kaprow Lewis	0.59766	-	0.57440	-	0.58065	-	0.63984	-	0.61778	-

increase, there are fewer firms that are becoming close to the best practices frontier of 100% efficiency.

Table 2: Frequency Distribution for Simple Efficiency Scores

EFFICIENCY RANGE	2004	2005	2006	2007	2008	TOTAL
Less than 0.40	3	7	7	3	6	26
0.41–0.50	9	9	8	9	10	45
0.51–0.60	7	8	10	8	11	44
0.61–0.70	9	9	7	8	6	39
0.71–0.80	5	2	2	5	3	17
0.81–0.90	3	2	3	4	2	14
0.91–0.99	4	4	4	2	1	15
1.00	2	1	1	3	3	10

CONCLUSION

In this study we apply the Data Envelopment Analysis (hereafter, DEA) approach to analyse the input-output efficiency of the public accounting firms in the United Kingdom from the years 2004 to 2008. The empirical results demonstrate that DEA can provide consistent results in the ranking of CPA firms. We believe the DEA methodology adds insights to supplement other performance measures and is a valuable addition to other measurement measures to analyse the efficiency of CPA firms. This study contributes to the literature by providing the latest report regarding the input-output efficiency of the UK accounting firms using the DEA approach. It also demonstrates a methodology that can be adapted readily to other professional services firms.

We find that, under a re-evaluation of efficiency post-Sarbanes-Oxley using the DEA approach, larger CPA firms with multiple offices were able to parlay their economies of scale into greater efficiency. By extending the scope of CPA firms' product more deeply into the realm of risk management and internal control systems, larger firms evidently have a competitive advantage. The DEA approach is a good methodology for the identification of these advantages in a meaningful way that lends itself to measurement and empirical verification.

The analysis also points to other avenues for future research. For instance, one may examine the input-output efficiency of the US accounting firms during the post Sarbanes-Oxley Act period to see (1) whether or not the implementation of SOX improves or deteriorates the efficiency of accounting firms, and (2) how the implementation of SOX results in the observed changes from the results gleaned above. Alternately, other factors of output, such as locational convenience, responsiveness, and client satisfaction measures could be incorporated into more generalised DEA analyses.

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