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An Evaluation of Technical Efficiencies for the Top 100 Public Accounting Firms in China

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Abstract

This paper investigates the effect of a China's government policy, which forces a public accounting firm to enhance its production scale, technical efficiency and economies of scale. We apply and estimate a standard input distance frontier using data on the top 100 Chinese accounting firms covering 2008-2009. We find that the larger the firm size is, the more technically efficient it is, thus justifying policy enforcement. Furthermore, economies of scale prevail in the top 100 accounting firms and are not exhausted, supporting that these firms keep extending their production scale to reduce their long-run average costs. Empirical results reveal that larger accounting firms have more competitive advantage.

Keywords: Chinese public accounting firms, technical efficiency, economies of scale, merger and acquisition.

1. Introduction

The economic reforms and opening up in China over the last 20 years have not only generated enormous economic growth for the country, but also boosted its influence in the world. China's economic development has become extremely vital to balancing the global economy, especially after the recent global financial crisis. With rapid economic growth, China's capital market is also expanding at a skyrocketing speed. Certified public accountant (CPA) firms that play a key role in the formation of the domestic capital market have also enjoyed nearly two-digit annual growth in operating revenue over the period 2002-2009.

According to the Chinese Institute of Certified Public Accountants (CICPA), the operating revenue of the top 100 accounting firms in China amounted to 4.43 billion RMB in 2002, but exceeded 206.1 billion RMB by 2009, or a huge growth of 47 times over the time period. However, this huge increase was mainly contributed and enjoyed by the top four leading international accounting firms (henceforth, Big Four), which dominate China's audit and assurance market. In a bid to rectify this situation, the government adopted several measures to increase the business scale and global competitiveness of local CPA

firms. For instance, the government launched a program called Making accounting firms big and strong in 2006 and approved CICPA's suggestions on making accounting firms big and strong in January 2007. These policies are attempting to enlarge the scale of the local accounting industry and to advance its global competitiveness.

The Ministry of Finance of the People's Republic of China (PRC) and China Securities Regulatory Commission in 2007 modified "Notifications about accounting firms' practices of securities and futures services", which require that accounting firms with more than 80 CPAs and more than 5 million RMB capital are qualified to provide audit and attestation services for publicly listed companies. To audit state-owned enterprises, an accounting firm must have a minimum number of CPAs, as required by the PRC authority. This requirement is intended to motivate local CPA firms to expand their business scale. In compliance with The Guidelines on Audit of Central Enterprises' Final Accounts", "The Measures for the Administration of Reports of Central Enterprises on Final Accounts", and "The State-owned Assets Supervision and Administration Commission's Tentative Measures for Outsourcing Operations to Accountancy Firms" promulgated by the PRC State-owned Assets Supervision and Administration Commission (SASAC), state-owned enterprises with total assets more than 100 billion RMB shall have their financial reports audited and assured by a CPA firm that has at least 100 CPAs. In order to provide and maintain services to state-owned enterprises, local CPA firms must expand their size to meet these requirements.

In the Shanghai stock market and Shenzhen stock market, about 60∼70% of publicly listed companies are state-owned. This fact provides a strong incentive for Chinese CPA firms to either merge or recruit more CPAs to inflate their business scale. Under government promotion, increasing the sizes of CPA firms has become prevalent among the local CPA industry. After three years of enforcement of the Making accountancy firms big and strong policy, the question arises: is there any improvement in the scale and competitiveness of domestic CPA firms in China? Such issues have not drawn much attention from academic researchers and are important for regulators to assess these firms' performance.

Banker et al. (2005), Chang et al. (2009a, b) and Knechel et al. (2009) explore the operating efficiency of the top 100 accounting firms in the U.S. Chang et al. (2011) studies 51 accounting firms in Taiwan to determine how IT capital and human capital affect the productivity of the firm. Although the Chinese government releases input and output data of the top 100 Chinese accounting firms, the performance of that industry with regard to efficiency and scale economies has yet to be examined in-depth. Put simply, most previous studies have employed data envelopment analysis (DEA) to measure the operating efficiency of the accounting firms in a single country.

This paper thus collects data on the top 100 CPA firms in China and examines whether or not this policy is indeed effective. As an accounting firm usually hires various types of inputs to provide multiple services, such as auditing and tax and financial consulting services, we adopt the stochastic input distance function, which allows for evaluating the input-oriented technical efficiency for a given output mix. This reflects the fact that CPA firms have the most control over input quantities, rather than outputs.

In this context, a set of interesting topics can be validly examined, e.g., the technical efficiency of different firm sizes and whether a merger and acquisition improves technical efficiencies. In sum, the findings imply that operating scale positively affects the competitive advantage of accounting firms in China.

The rest of the paper is organized as follows. Section 2 gives a brief review on the related literature and establishes relevant hypotheses to be examined. Section 3 introduces the empirical model, which is a stochastic input distance function. Section 4 describes data sources and variables' definitions. Section 5 presents the empirical results, while the last section concludes the paper.

2. Literature Review and Hypotheses' Development

2.1 Development of China's CPA industry

The auditing quality of Chinese CPA firms is thought to be far inferior to that of CPAs in developed nations. In order to increase the auditing capabilities of local CPAs and attract inflows of foreign capital, the PRC government has launched a series of reforms on the CPA industry. Among these reforms, the CPA firm disaffiliation program, initiated in 1998, has been the most remarkable. This program required each CPA firm to disaffiliate from its sponsoring body such that they have different company names and separate staff, finance, and business services. As a result, the independency of CPAs can be raised (Gul, Sami, and Zhou [14]).

According to the statistics of CICPA, the top 100 CPA firms in China generated total revenue of 206.1 billion RMB in 2009, about 47 times the revenue they accumulated in 2002. Further analysis of the revenue structure shows that the Big Four firms and the remaining top 96 domestic CPA firms have different market shares and growth rates. In particular, the revenue growth is mainly contributed by the Big Four firms. This fact has motivated the PRC government to increase the size of local CPA firms.

CICPA suggests that the ultimate goal of the "Making accountancy firms big and strong" program is to promote the scale of the top 100 CPA firms to a considerable size within 5-10 years and foster 10 international CPA firms that can offer cross-country services and compete with the Big Four. This program also encourages local CPA firms to establish partnerships with international CPA firms on the condition of equality and reciprocity. In 2007, the Ministry of Finance of the PRC and the China Securities Regulatory Commission mandated that all publicly listed firms shall have their financial reports audited and attested by those CPA firms having more than 80 CPAs and a minimum capital of 5 million RMB.

The PRC government requires the financial reports of its own state-owned enterprises, having total assets of more than 100 billion RMB, to be audited and attested by CPA firms that have at least 100 CPAs. In the Shanghai and Shenzhen stock markets, about 60 70listed firms are state-owned. To satisfy such a large demand for accounting services, local CPA firms have strong incentives to enlarge their scale to meet this requirement, by merger and acquisitions, or by recruiting more CPAs.

Merger and acquisitions appear to be the quick path to expand a firm. Several mergers have taken place in 2006. For instance, Hua Zheng, Xiamen Pan Huatian, and Beijing Hua Shen Accounting Firm settled a merger agreement in September 2006. The merger immediately pushed them to 12th place on the top 100 list. In the same year, Shanghai BDO China Shu Lun Pan Certified Public Accountants LLP, the largest CPA firm in China, announced its cooperation with Beijing Zhong Tian Hua Zheng Accountancy Firm and Guangdong China Guang Dong Hu Lun Pan Certified Public Accountants to jointly establish Shu Lun Pan CPA Management Co., Ltd. Their cooperation highlighted that mergers will be a trend in China's audit market in the years to come. Moreover, HLB International Accountancy Firm was acquired by Shinewing Certified Public Accountants, while Yuehua and RSM International Accountancy Firm, both among the top 10 CPA firms in China, announced their merger in December 2007. After the merger, their business revenue exceeded 500 million RMB, reducing the gap between local CPA firms and the Big Four.

Ever since the "Making accountancy firms big and strong" program was introduced in 2006, only a few studies have investigated the improvement in production scale among the top 100 CPA firms in China. The extant research works on whether Chinese CPA firms' performance has improved after the enforcement of the program is worth studying more in depth.

2.2. Hypotheses' development

Banker et al. (2005) and Chang et al. (2009a, b) conclude that the top four accounting firms in the U.S. or larger firms have higher technical efficiency than the non-top four or smaller firms. Similar outcomes are reached for Taiwanese accounting firms by Chang et al. (2011). A large-scaled CPA firm in China is more likely to be qualified to offer services to state-owned and listed enterprise, which then makes it easier for such a CPA firm to establish a higher reputation and acquire and maintain contracts related to providing audit and non-audit services to large enterprises. Whether a large CPA firm hires fewer inputs to produce the same output quantities than a small CPA firm does has crucial economic implications. Put differently, whether a large CPA firm is more technically efficient than a small firm is a signal that reflects whether the government policy is successful or not. This paper proposes a hypothesis as follows.

Hypothesis I: Larger Chinese CPA firms are more technically efficient than smaller ones.

As the existing literature on merger and acquisitions among CPA firms is very limited, it is difficult to tell such merger effects on a CPA firm's operating performance. Since CPA firms provide similar financial, tax, and management consulting services, their mergers belong to the scope of a horizontal merger commonly seen in the manufacturing industry. In service-based industries, such as banking and transportation industries, a merger is a means of expanding a firm's business scale and achieving synergy. Therefore, in order to understand whether CPA firms can increase their operating

performance through a merger, this paper briefly reviews the literature on horizontal mergers in the manufacturing and service industries.

An expansion through a horizontal merger is theoretically usually regulated by governments in almost all nations. Brouwer [4] developes a theoretical model to analyze the relationship between horizontal mergers and efficiency. Chon and Linnemer [9] focus on the trade-off between unilateral effects and efficiency gains in horizontal mergers and examine the role of uncertainty in the trade-off.

Empirical research studies on the relationship between merger and efficiency in service industries have reached mixed conclusions. For instance, the relationship is found to be positive in the non-life insurance industry (Cummins and Xie [11]), the medical industry (Groff, Lien and Su [13]), and the credit industry (Worthington [24]). Some studies attain the opposite finding from the telecommunications industry (Majumdar, Moussawi and Yaylacicegi [19]) and the banking industry (Rezitis [22]). Other studies observe no direct relationship between a merger and efficiency in the power generation industry (Kwoda and Pollitt 2010) and the banking industry (Peristiani [21]; Rhoades [23]).

The merger trend among CPA firms in China appeared only after 2007, making data available for empirical research rather insufficient. CPA firms belong to the professional service industry, providing professional audit and non-audit services to enterprises, which are very different from the services of the manufacturing or retail industry in nature. While a merger may incur immediate and beneficial results, it may also create some new problems, such as conflicts in management concepts, organizational culture, and management system between two merging firms, or additional expenses for training and office renewal. These negative effects at least partially offset the positive effects. It is doubtful whether the synergy in fact benefits the merged firms in the short run.

As a merger entails both negative and positive effects on a firm's performance and previous research studies do not reach consistent empirical evidence, it appears to be pivotal for us to empirically estimate and compare the efficiency between CPA firms with and without mergers. We therefore propose the following hypothesis.

Hypothesis II The technical efficiency of merged CPA firms is greater than that of non-merged CPA firms.

3. Empirical Model

Following Karagiannis et al. [15] and Kumbhakar and Wang [16], this paper applies an input distance function to characterize the production process of the Chinese CPA industry, due to the fact that the function allows a firm to transform multiple inputs into multiple outputs, in which the firm has the most control over inputs, rather than outputs. In addition, this function has some nice properties, as have been discussed by, e.g., Fre and Primont [12] and Karagiannis et al. [15]. More specifically, returns to scale can be derived from the input distance function and, under certain conditions, technical change (cost diminution) can be deduced, using the dual relationship between the distance function and cost function.

According to Fre and Primont [12], input distance functions (D) are non-decreasing, concave, and linearly homogenous in inputs x, a J-vector, and non-increasing and convex in y, an M-vector. Let subscript i denote the ith $(= 1, \ldots, N)$ firm and t is period t $(= 1, \ldots, T)$. An input distance function can be formulated by a flexible translog function as follows:

$$\begin{aligned}\ln D_{it} &= a_0 + \sum_{j=1}^{J} a_j \ln x_{jit} + \sum_{m=1}^{M} b_m \ln x_{mit} + 0.5 \sum_{j=1}^{J}\sum_{k=1}^{J} a_{jk} \ln x_{jit} \ln x_{kit} \\ &= -0.5 \sum_{m=1}^{M}\sum_{k=1}^{M} b_{mk} \ln y_{mit} \ln y_{kit} + \sum_{j=1}^{J}\sum_{m=1}^{M} c_{jm} \ln x_{jit} \ln y_{mit} \qquad (3.1)\end{aligned}$$

Here, a, b, and c denote unknown parameters to be estimated. A time trend can be added and treated as an extra output.

The input distance function with linear homogeneity and symmetry should be taken into consideration in equation (3.1), i.e.:

$$\sum_{j=1}^{J} a_j = 1,\ \sum_{k=1}^{J} a_{jk} = 0,\ \forall\, j,\ \sum_{j=1}^{J} c_{jm} = 0,\ \forall\, m,\ a_{jk} = a_{kj}\ \forall\, j \neq k b_{mk} = b_{km}\ \forall\, m \neq k. \quad (3.2)$$

Equivalently, the linear homogeneity restriction can be imposed on (3.1) by arbitrarily selecting one of the J inputs, say x_1, as the numeraire to normalize the original distance function as follows.

$$\begin{aligned}\ln(D_{it}/x_{1it}) &= a_0 + \sum_{j=2}^{J} a_j \ln(x_{jit}/x_{1it}) + \sum_{m=1}^{M} b_m \ln y_{mit} \\ &\quad + 0.5 \sum_{j=2}^{J}\sum_{k=2}^{J} a_{jk} \ln(x_{jit}/x_{1it}) \ln(x_{kit}/x_{1it}) \\ &\quad + 0.5 \sum_{m=1}^{M}\sum_{k=1}^{M} b_{mk} \ln y_{mit} \ln y_{kit} + \sum_{j=2}^{J}\sum_{m=1}^{M} c_{jm} \ln(x_{jit}/x_{1it}) \ln y_{mit}. \qquad (3.3)\end{aligned}$$

Here, D_{it} must be greater than or equal to unity by construction. Let $\ln D_{it} = U_{it}$ and after re-arranging terms, (3.3) can be written as:

$$\begin{aligned}-\ln x_{1it} &= a_0 + \sum_{j=2}^{J} a_j \ln(x_{jit}/x_{1it}) + \sum_{m=1}^{M} b_m \ln y_{mit} \\ &\quad + 0.5 \sum_{j=2}^{J}\sum_{k=2}^{J} a_{jk} \ln(x_{jit}/x_{1it}) \ln(x_{kit}/x_{1it}) + 0.5 \sum_{m=1}^{M}\sum_{k=1}^{M} b_{mk} \ln y_{mit} \ln y_{kit} \\ &\quad + \sum_{j=2}^{J}\sum_{m=1}^{M} c_{jm} \ln(x_{jit}/x_{1it}) \ln y_{mit} + v_{it} - U_{it}. \qquad (3.4)\end{aligned}$$

Following Battese and Coelli [3], $U_{it} = U_i \exp[\eta(t-T)]$ and $U_i \sim |N(0,\sigma_u^2)|$ is now assumed to be a non-negative, half-normal random variable, representing a firm's technical inefficiency. A positive value of η indicates that technical efficiencies of the sample firms improve over time, while the reverse is true for a negative value of η. After inserting a random disturbance term $v_{it} \sim N(0,\sigma_v^2)$ independent of U_i, (3.4) becomes a stochastic frontier regression equation and can be estimated by the maximum likelihood. Note that this requires deriving the probability density function of the composed error $\varepsilon_{it} = v_{it} - U_{it}$ and the corresponding log-likelihood function. Please see Battese and Coelli [3] and Kumbhakar and Lovell [17].

Following the convention, the technical inefficiency measure is calculated according to the conditional expectation:

$$E(U_{it} \mid \varepsilon_{it}) = \exp[-\eta(t-T)]E(U_i \mid \varepsilon_{it}),$$

after obtaining the parameter estimates of (3.4). We employ the software Frontier 4.1 to estimate (3.4). The software calculates technical efficiencies for each observation automatically, based on the formula provided by Battese and Coelli [3].

To derive the measure of returns to scale (RTS), we first take the partial derivatives of (3.4) with respect to $\ln y_m$, $m = 1, \ldots, M$, and then multiply -1 to the sum of those partial derivatives. The outcome is equal to the inverse of RTS, i.e., RTS is defined by:

$$\begin{aligned} RTS^{-1} &= -\sum_{m=1}^{M} \frac{\partial \ln D(y,x,t)}{\partial \ln y_m} \\ &= -\sum_{m=1}^{M} \Big[b_m + \sum_{k=1}^{M} b_{mk} \ln y_k + \sum_{j=2}^{J} c_{jm} \ln(x_j/x_1) \Big]. \end{aligned} \tag{3.5}$$

Here, RTS greater than 1 signifies increasing returns to scale, while the reverse implies decreasing returns to scale. A value of unity for RTS means constant returns to scale.

4. Variables' Definition and Research Data

4.1. Data source

Starting from 2002, CICPA surveyed CPA firms in China, based on general evaluation criteria, and released relevant statistics of the top 100 firms, including revenue, inputs, number of branches, average revenue per employee, etc. However, the released data items of each year are not entirely the same during the period 2002-2009. Therefore, it is difficult to combine the cross-period data into a long panel. After a thorough comparison of the data, we find that the data items shown in 2008 and 2009 are similar. We thus use the data of the top 100 CPA firms published by CICPA in 2008 and 2009.

China's capital markets have grown significantly in the last 10 years. The capital markets in Shanghai and Shenzhen have expanded quickly in recent years and are ranked among the top three international capital markets in the world. The source of growth

comes from the increase in the number of publicly listed companies. CPA firms play a critical role in assisting companies before and after they are publicly listed. The professional services they provide to publicly listed companies are mainly reflected in their total service revenue. Figure 1 draws the trend of the total revenue that the top 100 CPA firms received from publicly listed and other companies over 2002-2009.

Figure 1 clearly manifests the effects of the "Making accountancy firms big and strong" program. Recall that the PRC government launched the program in 2006 and approved CICPA's suggestions in January 2007. The figure reveals that the Big Four firms earn more revenues than the sum of the other 96 CPA firms in the years 2006 to 2008. However, in 2009, two years after implementing the program, the total revenue of the non-Big Four exceeded that of the Big Four.

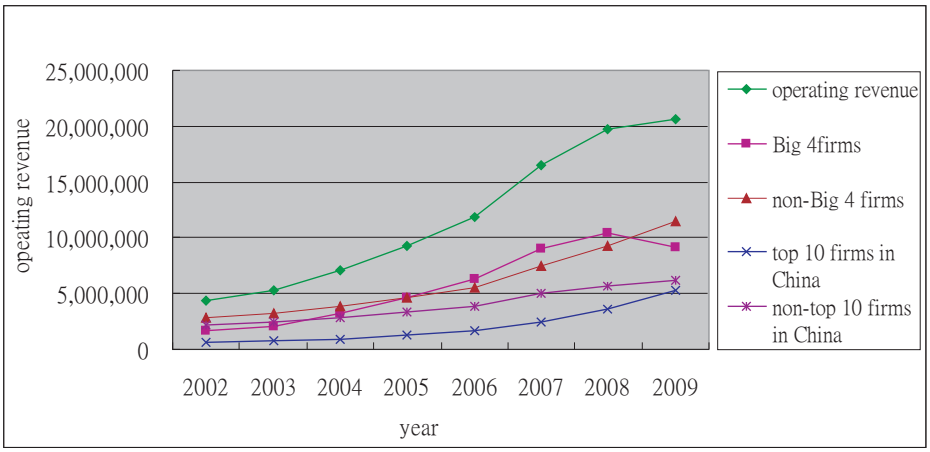

Figure 1: Trends in service revenue among the top 100 CPA firms during 2002∼2009.

If the 96 non-Big Four firms are further classified into top 10 firms and non-top 10 firms (the remaining 86 firms), then we see that the top 10 CPA firms present steady growth in total revenue ever since 2002 and the rate of growth speeds up after 2006. By 2009, their total revenue almost catches up with that generated by all the non-top 10 firms, implying that the 96 non-Big Four firms earn more revenues than the Big Four in 2009 due to a quicker growth of service revenue among the top 10 CPA firms. The program certainly appears to have produced the expected effects by the government.

4.2. Variables' definition

CPA firms are business organizations that hire professional employees with accounting knowledge and skills to provide their clients with financial, tax, and management consulting services. Among the employees of a CPA firm, partners are generally well-experienced in practice and are responsible for seeking new customers and cases and manage almost all internal aspects of the firm. Therefore, they are certainly more competent than other members in terms of internal management and service quality. Following Banker, Chang and Cunningham [1], Banker, Chang and Natarajan [2], Chang,

Choy, Cooper, Parker and Ruefli [6] and Chang, Choy, Cooper and Ruefli [5], this paper identifies three main human resources as the inputs of a CPA firm - numbers of partners, CPAs, and other staffs - and two forms of outputs. Their specific definitions are as follows.

(1) Number of partners: Including managing partners and shareholders. In China, CPA firms are allowed to be established as a limited liability company and their owners are called shareholders.
(2) Number of CPAs: CPAs refer to professional assistants, administrative employees, and other employees holding a CPA license.
(3) Number of other staffs: Other assistants and administrative employees without a CPA license.

According to Banker, Chang and Cunningham [1], Banker, Chang and Natarajan [2], Chang, Choy, Cooper, Parker and Ruefli [6], Chang, Choy, Cooper and Ruefli [5] and Cheng, Wang and Weng [7, 8], CPA firms produce three outputs: financial services, tax services, and management consulting services. However, service revenue is divided into only two items - namely, "revenue from audit and assurance services" and "revenue from non-audit and assurance services" - in CICPA's database of the top 100 CPA firms. As this research takes the data from CICPA, the above classification is not applicable. This paper identifies two outputs instead.

(1) Revenue from audit and assurance services: The sum of revenue from audit and assurance of financial statements, bank accommodation, and revenue from other assurance services.
(2) Revenue from non-audit and assurance services: The sum of revenue from tax planning services, revenue from tax dispute resolution, revenue from other tax-related services, and revenue from management consulting and practice of other services.

4.3. Descriptive statistics

Table 1 presents the descriptive statistics of each variable. Based on Section A of the table, audit and assurance services are the main source of revenues for the top 100 CPA firms, accounting for approximately 82% of the total revenue for each year. This indicates that there is much room for the sample firms to expand their services in non-audit and assurance aspects.

The variation in the number of partners and other staffs is quite small in the two years. However, there is a 19.44% growth rate in the average number of CPAs, suggesting that CPA firms have been active in reacting to the government policy during this period of time. Our observation of the upper (75%) quartile statistics indicates that CPA firms at this quartile have a 22.17% growth rate in the average number of CPAs. The growth is probably contributed by relatively larger firms. It is noticeable that the disparity between different quartiles is considerable, meaning that the standard deviations of the data are large, and that the mean value of each variable differs from the corresponding median, indicating that the distributions of these variables are skewed. This finding is

similar to Banker, Chang and Cunningham (2003) and Banker, Chang and Natarajan (2005), who investigate the top 100 CPA firms in the U.S.

Section B of Table 1 shows the descriptive statistics of non-Big Four firms. The statistics indicate that the average ratio of revenue from audit and assurance services is approximately 82%, and there is a 20.5% growth rate in the average number of CPAs among these firms. Overall, the sample structure is analogous to that including the Big Four. Remarkably, the average total revenue of non-Big Four firms during 2008-2009 is equal to 108.14 million RMB, or only about 53.69% of the average total revenue (201.42 million RMB) received by the Big Four during the same period. The Big Four firms dominate Chinese audit and assurance market.

As mentioned earlier, a portion of CPA firms pursues a quick expansion of business scale through a merger and acquisition. It is therefore necessary to explore whether the characteristics of firms that have undergone a merger are the same as unmerged firms. Table 2 shows the comparison results between the two groups of firms. Merged CPA firms earn an average of 324.32 million RMB, or about 65.39% of the average total revenue of the entire sample (495.96 million RMB), suggesting that these firms tend to be larger in size. Moreover, these firms' total revenues experience a 12.63% growth rate during 2008-2009, while unmerged firms grow merely 4.67% at the same time. An average merged firm hires 1,183 employees, or about 2.26 times as large as an average unmerged firm (524 persons). This large discrepancy is ascribable to the fast growth rate (65.5%) of merged firms whose average number of CPAs soars from 313 persons in 2008 to 518 persons in the next year.

We divide our sample into three equally numbered subsamples on the basis of their total revenues and call them small, medium, and large firms. The right side of Table 2 lists sample statistics of the variables of interest for the three groups, which earn average service revenues of 32.57, 62.80, and 506.80 million RMB, respectively.

Apparently, large firms dominate the audit and assurance market. It is also seen that the total revenues of small- and medium-sized CPA firms decrease over the two years at rates of -5.48% and -1.62%, respectively. In contrast, large firms' revenue increases about 6.34% in the same period. One is led to conclude that the revenue growth during 2008-2009 is entirely stimulated by large CPA firms.

Note that the average number of employees hired by the three groups shows a similar pattern to total revenues. Specifically, large CPA firms employ an average of 1,442 workers, as opposed to 176 and 336 workers hired by small and medium firms, respectively.

The numbers of employees of small and medium CPA firms also decrease over the sample period, while large CPA firms expand their workforce. Large CPA firms are found to have a 32.17% increase in their number of CPAs, which is much larger than the 5.7% increase among medium CPA firms. Small CPA firms even show a 14.86% decrease in the number of CPAs employed. The foregoing reflects a distinct trend in China's audit and assurance market - big firms are getting bigger.

Table 1: Descriptive statistics of the research variables (2008∼2009).

Part A: All the accounting firms

	Year	Mean	Std. dev.	25%	Median	75%
Y_1	2008	157,920	403,520	32,710	52,240	96,910
(in 1,000 RMB)	2009	169,890	376,860	29,040	50,090	110,940
	all	163,910	389,490	30,010	51,700	107,040
Y_2	2008	38,800	125,740	5,410	12,750	20,580
(in 1,000 RMB)	2009	36,210	103,250	4,180	10,270	20,090
	all	37,510	114,760	4,890	11,970	20,090
X_1	2008	18	11	8	16	26
(Total number of partners)	2009	16	11	7	15	24
	all	17	11	7	15	25
X_2	2008	180	174	80	121	203
(Number of CPAs)	2009	215	239	69	120	248
	all	197	209	80	120	217
X_3	2008	470	874	147	225	353
(Number of other staffs)	2009	441	796	82	188	325
	all	456	834	116	209	348

Part B: Non-Big Four accounting firms

	Year	Mean	Std. dev.	25%	Median	75%
Y_1	2008	79,950	91,370	31,970	51,210	88,490
(in 1,000 RMB)	2009	99,230	128,800	27,970	49,170	105,820
	all	89,590	111,790	29,050	50,300	94,180
Y_2	2008	16,750	21,610	5,080	12,330	19,080
(in 1,000 RMB)	2009	20,350	32,050	3,950	9,450	18,540
	all	18,550	27,320	4,720	10,830	18,590
X_1	2008	18	11	8	16	26
(Total number of partners)	2009	17	11	8	16	24
	all	18	11	8	16	25
$X_2$2008	161	148	80	113	186	
(Number of CPAs)	2009	194	219	67	113	200
	all	177	187	77	113	197
X_3 (people)	2008	303	293	143	216	318
(Number of other staffs)	2009	296	354	78	182	286
	all	299	324	115	200	303

Note: Y_1 denotes the revenue from audit and assurance services (in 1,000 RMB); Y_2 denotes the revenue from non-audit and assurance services (in 1,000 RMB); X_1 denotes the total number of partners (including shareholders); X_2 denotes the number of CPAs; X_3 denotes the number of other staffs.

5. Empirical Results

This paper uses an input distance function to estimate the technical efficiency of China's top 100 CPA firms, with the estimation results presented in the Appendix. More than one half of the estimated coefficients are statistically significant at least at the 10Since parameters $\sigma^2(= \sigma_n^2 + \sigma_n^2)$ and $\sigma(= \sigma_u^2/\sigma^2)$ are significantly estimated, the assumption of composed errors seems to be correct and necessary. Although the positive

Table 2: Variables' descriptive statistics compared by merger status and firm size.

Part A: 2008 Variables	Merged	Unmerged	Small-scale	Medium-size	Large-scale
Total revenue (in 1,000 RMB)	306,460 (567,690)(486,640)	167,550 (7,470)	33,370 (12,980)	63,690 (805,640)	497,130
Revenue from audit and assurance services (in 1,000 RMB)	256,260 (475,850)	131,780 (381,200)	26,060 (8,440)	52,480 (12,530)	398,430 (643,530)
Revenue from non-audit and assurance services (in 1,000 RMB)	50,200 (92,900)	35,770 (133,460)	7,320 (5,790)	11,210 (6,230)	98,700 (208,110)
Total number	1,066 (1,064)	539 (975)	210 (90)	344 (122)	1,404 (1,504)
Total number of partners (including shareholders)	22 (11)	17 (11)	15 (11)	19 (12)	19 (12)
Number of CPAs	313 (234)	144 (135)	74 (41)	122 (52)	345 (214)
Number of other staffs	753 (872)	394 (865)	136 (63)	222 (89)	1,059 (1,346)
Part B: 2009 Variables	Merged	Unmerged	Small-scale	Medium-size	Large-scale
Total revenue (in 1,000 RMB)	345,160 (215,680)	175,580 (488,470)	31,540 (6,020)	62,460 (17,060)	528,670 (693,500)
Revenue from audit and assurance services (in 1,000 RMB)	288,330 (173,080)	143,900 (404,350)	23,990 (6,970)	53,340 (15,870)	435,880 (574,230)
Revenue from non-audit and assurance services (in 1,000 RMB)	56,840 (46,230)	31,690 (111,650)	7,550 (5,990)	9,120 (7,360)	92,780 (167,220)
Total number	1,319 (756)	511 (979)	142 (78)	324 (138)	1,512 (1,365)
Total number of partners (including shareholders)	24 (10)	15 (10)	11 (7)	16 (10)	22 (12)
Number of CPAs	518 (299)	148 (162)	63 (41)	129 (59)	456 (283)
Number of other staffs	801 (468)	362 (833)	79 (48)	196 (105)	1,057 (1,165)
Part C: 2008-2009 Variables	Merged	Unmerged	Small-scale	Medium-size	Large-scale
Total revenue (in 1,000 RMB)	324,320 (436,820)	171,640 (486,060)	32,570 (6,790)	62,800 (14,150)	506,800 (742,040)
Revenue from audit and assurance services (in 1,000 RMB)	271,060 (364,470)	137,950 (391,980)	25,220 (7,830)	52,410 (13,140)	412,430 (602,090)
Revenue from non-audit and assurance services (in 1,000 RMB)	53,270 (74,230)	33,690 (122,460)	7,350 (5,810)	10,390 (6,910)	94,370 (186,250)
Total number	1,183 (932)	524 (975)	176 (90)	336 (130)	1,442 (1,422)
Total number of partners (including shareholders)	23 (10)	16 (11)	13 (9)	18 (11)	20 (12)
Number of CPAs	408 (282)	146 (149)	71 (42)	125 (58)	395 (256)
Number of other staffs	775 (706)	378 (846)	106 (60)	211 (96)	1,046 (1,244)

Table 3: Testing results for differences in technical efficiency across different firm sizes.

	(1) Small-scale firms (n=67)		(2) Medium-scale firms (n=66)		(3) Large-scale firms (n=67)	
Comparison items	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
	0.6581	0.1994	0.6564	0.1264	0.7580	0.1155
(2) − (1)	$t = 0.0606$, p-value = 0.9517					
(3) − (2)	$t = 4.8408$, p-value < 0.001					
(3) − (1)	$t = 3.5473$, p-value < 0.001					

estimate of η is insignificant, it implies that the technical efficiency of the sample firms potentially improved over the sample period. The parameter estimates are next used to evaluate technical efficiencies for the sample firms. The average technical efficiency scores in 2008 and 2009 do indeed increase and are equal to 0.6783 and 0.7037, respectively. In order to achieve fully productive efficiency while maintaining the same amount of outputs, the CPA firms need to reduce 32.17% and 29.63% of their inputs in 2008 and 2009, respectively.

5.1 Results based on the entire sample

We now test Hypothesis I that larger CPA firms are more technically efficient than smaller ones. The sample firms are classified into three groups - small, medium, and large - as in Table 2. Table 3 shows the t-test results between pairs of groups with respect to technical efficiency scores. Since small- and medium-sized CPA firms have quite close average technical efficiency measures, i.e., 0.6581 and 0.6565, respectively, the t-test statistic is merely 0.0606 (p-value =0.9517), indicating that the two group's technical efficiencies are statistically the same. Large CPA firms have an average efficiency level of 0.7580, significantly higher than those of small and medium firms at the 1significance. This empirical finding confirms the proposed hypothesis and justifies the policy "Making accountancy firms big and strong" that was implemented in 2007. Larger CPA firms do have higher technical efficiency than smaller ones and hence they are likely to be more competitive.

As mentioned in Section 2, a merger is a quicker way to business expansion for CPA firms. However, a merger may incur some inevitable conflicts between the merging firms, such as management ideas, organizational culture, and management systems, making positive effects of the merger fail to be observed in the short run. This paper thus tests Hypothesis II: The technical efficiency of merged CPA firms is greater than that of non-merged CPA firms. As shown in Table 4, CPA firms that have undergone a merger have a mean level of technical efficiency at 0.7072. Although this figure is greater than that of firms without a merger, the t-test result shows that the difference is insignificant. A merger appears to have at most a weak effect on a CPA firm's technical efficiency. This finding reveals that the positive effects of a merger take some time and therefore the favorable synergy effects do not immediately happen.

Table 4: Testing results for differences in technical efficiency between merged and unmerged CPA firms.

	(1) Merged sample ($n=39$)		(2) Unmerged sample ($n=161$)			
Variables	Mean	Std. dev.	Mean	Std. dev.	t-value (1)-(2)	p-value
Technical efficiency	0.7072	0.1238	0.6871	0.1658	0.7100	0.4785

Whether the CPA firms' production technology is constant returns to scale (CRS) is an interesting question. We re-estimate (4) by imposing the CRS restrictions and apply the likelihood ratio test approach to test for the hypothesis of CRS. The test statistic is equal to 34.57, with 7 degrees of freedom, allowing us to reject the null hypothesis at the 1They are all operating under increasing returns to scale, in which large CPA firms enjoy higher economies of scale than medium CPA firms, and medium CPA firms exhibit higher economies of scale than small CPA firms. The small-sized firms are running close to CRS. It is suggested that large- and medium-sized CPA firms keep expanding their production scale such that their long-run average costs can decrease. Such an adjustment in scale is also consistent with the expectation of China's government.

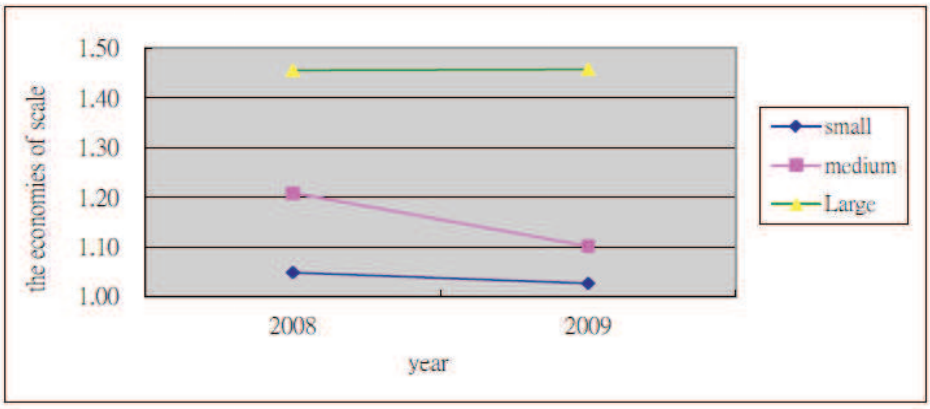

Figure 2: Average measure of scale economies for different firm sizes.

Table 5 presents the testing results for the differences in the economies of scale measures between pairs of the three groups. Small, medium, and large CPA firms have estimated measures of scale economies of 1.0388, 1.1613, and 1.4461, respectively. Their differences attain statistical significance at the 1% level[1].

5.2. Results based on the sample excluding the Big Four

It is known that the Big Four CPA firms have governed China's audit and assurance market for many years. Previous studies such as Banker, Chang and Cunningham (2003)

[1] Using the number of employees as the proxy for scale, the three groups of CPA firms are found to hire significantly different volumes of workforce, similar to the results using total revenues as the proxy variable.

Table 5: Testing results for the differences in the economies of scale measures.

Comparison items	(1) Small-scale firms ($n=67$)		(2) Medium-scale firms ($n=66$)		(3) Large-scale firms ($n=67$)	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
	1.0388	0.1357	1.1613	0.1765	1.4461	0.2994
(2) − (1)	$t = 4.4906$, p-value < 0.001					
(3) − (2)	$t = 6.6941$, p-value < 0.001					
(3) − (1)	$t = 10.1425$, p-value < 0.001					

and Banker, Chang and Natarajan (2005) intentionally exclude these firms to perform a robustness test. Following this vein, the current paper re-estimates (4) after deleting the Big Four from the original sample and performs a series of tests[2]. The testing results are very akin to Table 3 using the entire sample. Only the mean efficiency level of large CPA firms declines slightly, but the large firms still outperform small and medium firms even at the 1% level of significance.

We next examine whether the technical efficiency scores of merged and unmerged firms are the same and the conclusion is the same as Table 4 - that is, the two forms of CPA firms are equally efficient. We finally conduct tests for the difference in the economies of scale measures among the three groups. The results are also similar to Table 5, i.e., their measures of scale economies are statistically different from one another at the 1% level. Generally speaking, the exclusion of the Big Four from the sample does not alter the conclusion drawn on the basis of Tables 3-5. This validates the robustness of the results obtained from the entire sample.

6. Concluding Remarks

CPA firms have made a considerable contribution to China's capital markets during the era of economic reforms initiated several decades ago. Their service revenues have grown at a two-digit percentage rate per annum. Because the audit and assurance market of China has been dominated by the Big Four firms, the PRC government thus launched a special program in 2006 to increase the business scale and global competitiveness of local CPA firms. Using an input distance frontier with three inputs and three outputs, this paper has examined the effects of this program and obtains the following conclusions.

First, large CPA firms have significantly higher technical efficiencies than small and medium ones. This finding justifies the enforcement of the policy "Making accountancy firms big and strong" in 2007. Second, CPA firms that have undergone a merger have a higher average level of technical efficiency than firms that have not, but the difference is not significant, due possibly to the fact that the advantageous synergy effects from a merger need to take some time to pan out and our sample period is not long enough.

[2]As these testing results are very similar to those in Tables 3-5, we do not show the results, but they are available upon request from the authors.

Third and finally, large and medium CPA firms enjoy large economies of size that are not exhausted. These firms are suggested to enlarge their production scale in order to lower long-run average costs and raise competitive competence. On the contrary, small-sized CPA firms are operating nearly under the optimal firm size.

Overall, the above findings imply that accounting firms with larger size are preferable of smaller ones. Since larger and merged accounting firms are more technically efficient than smaller ones and enjoy scale economies, managers of accounting firms are encouraged to expand their production scale by, e.g., merger or acquisition, in order to reduce their long-run average costs. Authorities are suggested to enact policy that encourages accounting firms to do so.

Due to inconsistency of the available data, this paper is forced to extract the sample covering only 2008-2009. Some interesting and more in-depth issues, such as what are the key factors that affect the production efficiency of the top 100 CPA firms in China and the comparison of technical efficiencies among different countries, are worth studying once the required data become available in the future. Finally, the degree of competitiveness in China's audit and assurance market, particularly after the execution of the special program in 2006, possibly has important policy implications.

Appendix

Stochastic input distance frontier estimation results

	Coefficient estimates	t-value
Constant	31.6572***	17.2116
$\ln(X_2)$	-0.0612	-0.1015
$\ln(X_3)$	1.3196**	2.3153
$\ln(Y_1)$	-1.4414***	-2.6119
$\ln(Y_2)$	-0.7476***	-2.7734
t	-36.5144***	-33.2484
$0.5 \times \ln(X_2)^2$	0.4064***	6.2272
$0.5 \times \ln(X_3)^2$	0.5806***	4.3664
$0.5 \times \ln(Y_1)^2$	0.0263	0.3375
$0.5 \times \ln(Y_2)^2$	-0.0676***	-3.1342
$0.5 \times t^2$	24.7733***	33.1669
$\ln(X_2) \times \ln(X_3)$	-0.3815***	-4.3200
$\ln(X_2) \times \ln(X_1)$	0.0470	0.6323
$\ln(X_2) \times \ln(Y_2)$	0.0695*	1.7596
$\ln(X_2) \times t$	-0.1347**	-2.4629
$\ln(X_3) \times \ln(Y_1)$	-0.1596**	-1.9752
$\ln(X_3) \times \ln(Y_2)$	-0.0816**	-1.9631
$\ln(X_3) \times t$	0.1317**	2.1776
$\ln(Y_1) \times \ln(Y_2)$	0.1343***	3.3883
$\ln(Y_1) \times t$	-0.0365	-0.7984
$\ln(Y_2) \times t$	-0.0489	-1.4623
$\sigma^2(=\sigma_u^2+\sigma_v^2)$	0.2455***	4.8648
$\gamma(=\sigma_u^2+\sigma^2)$	0.9048***	25.8568
η	0.0609	0.5777
Sample size	200	
Log-likelihood	-19.2538	

Note: All the variables X_i $(i = 2, 3)$ are normalized by dividing X_1.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

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