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Technical efficiency and its determinants of Chinese service outsourcing industry

Hongzhou Li[1], Min Yang[1], Yuki Tamai [2] and Yu Hong[3*]

[1]*Center for Industrial and Business Organization, Dongbei University of Finance and Economics, Dalian, China*
[2]*Faculty of Urban Management, Fukuyama City University, Fukuyama, Japan*
[3]*College of Humanities and Sciences, Northeast Normal University, Changchun, China*

ABSTRACT

Based on the panel data for 2005-2011, the paper conducts an empirical analysis on the efficiency and its determinants of China's service outsourcing industry by using the three-stage DEA technique. The empirical results show that the production efficiency of the service outsourcing industry in the year of 2011 is 0.803 from Super-DEA model and 0.573 from standard DEA model. The too-small scale is the main cause that hinders the efficiency promotion, although some regions have already owned the ability to carry out high-end outsourcing business. Influencing factors analysis reveals that the degree of economic openness, the competitiveness of human resources and the level of economic growth have positive impacts on production efficiency. However, IPR protection and the level of informationalization are negatively related to production efficiency. The role of government is insignificant, implying that the industrial development is primarily driven by market forces rather than government intervention.

Keywords: Service outsourcing industry; Production efficiency; Three-stage DEA model

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INTRODUCTION

The purpose of this study is twofold. First and foremost, it is designed to measure the technical efficiency of the Chinese service outsourcing industry by using a three-stage DEA technique, which can separate the environmental effects and the statistical noise from managerial inefficiencies; Secondly, we attempt to identify the determinants of the efficiency of the Chinese service outsourcing industry.

During the past decades, China has evolved as the second biggest offshore service outsourcing provider, with a total contract amount of 23.83 billion US Dollar in 2011, following behind India which records an offshore revenue of 49.7 billion US Dollar. However, some underlying conditions which had been supporting the development of the Chinese service outsourcing industry began to change in recent years. Firstly, the implementation of new labor law in 2008 has increased the Chinese labor costs gradually. The average annual pay per capita in China in 2005 was 8.4 thousand US Dollar whereas that number jumped to 11.2 thousand US Dollar in 2011, a 33 percent growth in only 6 years. Secondly, the reform of RMB exchange rate formation mechanism since 2005 has appreciated the value of RMB agianst US Dollar from RMB 8.19/US Dollar in 2005 to 6.45 in 2011, or an increase of 21.2 percent. Thirdly, a larger number of service outsourcing-targeted industrial parks have been established by both central and many regional governments with an ambition to develop the low carbon industries to the new engine of economy. The intensified competition for acquiring offshore deals has driven down the profit margin. All these changes are challenging the cost leader strategy which has fueled the development of the Chinese outsourcing industry in the past years. In other words, in order to keep up with the changes in the world business environment and maintain the competitiveness in the future, there is a need for China’s service outsourcing industry to improve its efficiency and productivity. A thorough investigation of the efficiency and the deteminants of the industry will help the Chinese policy makers to have more knowledge about the optimal spatial ditribution pattern of the outsourcing industry, as

well as about the effective supporting policies of the centenal and the regional governments.

The paper is organized as follows. In section 2 we present methodology employed, model specified and data collected in the study. Section 3 provides and analyzes empirical results. Concluding remarks are given in section 4.

2. Methodology, model specification and data

2.1 Methodology and model specification

We take 17 provincial regions of China, where 21 model cities for service outsourcing industry are located and their service outsourcing industry outputs account for about 95% of national total outputs, as decision making unit (hereinafter DMU). Thus we have a panel data set from 2005 to 2011. We chose the three-stage DEA model propsed by Fried et al. [1] rahter than single-stage or two-stage DEA model because the former has the virtue of being capable of seperating managerial inefficiency from both environmental effects and statistical noise, and consequently can give improved estimations of DMUs' efficiency. Detailed discussion about the DEA related methodology and model specification can be found in [2-4] .

2.2 Possible determinants of the efficiency of Chinese outsourcing industry

Financial and taxational government supports may lower the costs of the service outsourcing providers; workers with higher educational background may accomplish projects more efficiently. Moreover, better IT infrastructure may improve the regional productivity as a whole as well as that of the service outsourcing industry. We thus take these three factors as the determinants of the outsourcing industry efficiency from supply side. Furthermore, regional openness to international market, protection of intellectual property and regional economic development may have impacts on the willingness of outsourcing deal providers to choose the locations of their partners. We thus hypothesize that other conditions being equal, all those factors may influence the efficiency of a regional outsourcing industry from the demand side.

In the subsequent empirical work, government support enters the model as a dummy variable with value 1 if there is an established outsourcing industrial association in the region and 0 if otherwise. The number of students enrolled in regional higher education institutes and the share of population with internet access in the total regional population proxy the level of talents competitiveness and regional informationization, respectively. Furthermore, the share of the regional total foreign trade volume in the corresponding regional GDP, the number of patents granted to a region and the regional GDP capture the level of openness, protection of intellectual property and economic development, respectively.

2.3 Data collection

Table 1 and Table 2 present a summary statistics of the variables included in this study. All Chinese RMB and US Dollar values are adjusted for inflation by GDP deflators with 2005 as the base year.

Table 1 The mean of inputs and outputs variables for 17 DMUs from 2005 to 2011

	Y_1 *(Million US Dollar)*	Y_2 *(Million RMB Yuan)*	X_1 *（Thousand Person）*	X_2 *(Million RMB Yuan）*
2005	94.1	110.194	57.24	7015.3
2006	303.2	122.430	61.53	7047.1
2007	358.1	111.323	66.38	6151.8
2008	580.5	142.221	72.04	6470.8
2009	885.4	169.633	77.98	7117.4
2010	1156.9	197.512	85.57	6041.4
2011	1448.7	265.368	98.94	4656.7

Y_1: software service exports ; Y_2 : revenues from system integration and supporting service;

X_1 : labor forces engaging in information processing; X_2 : capital investments in information processing.

In line with Cobb-Douglas production function model, the choice of inputs in production should mainly focus on labor factor and capital factor. Taking availability and credibility of data collection into consideration, we use labor forces engaging in and capital investments in information processing, computer service and software as labor input and capital input to outsourcing industry, respectively.

Table 2 The mean of influencing factor variables for 17 DMUs from 2005 to 2011

	β_1	β_2	β_3	β_4	β_5	β_6
2005	0.059	0.577	2209.512	8464.176	885.347	0.117
2006	0.059	0.600	2476.294	11304.941	907.558	0.137
2007	0.176	0.581	2647.059	15057.294	946.887	0.204
2008	0.294	0.557	2303.108	17765.882	995.304	0.276
2009	0.529	0.473	2739.610	26121.000	1018.071	0.343
2010	0.647	0.477	2816.734	39085.176	1038.310	0.392
2011	0.765	0.487	2770.382	52977.627	1105.546	0.436

β_1 :government support; β_2 :openness; β_3 :talents competitiveness; β_4 : protection of Intellectual Property
β_5 : regional GDP (billion RMB); β_6 :informationization level

As to outputs, the study chooses the money value of software service exports as well as revenues from system integration and support service as two outsourcing industry's output indexes.The definition of outsourcing industry in this study follows what is given by Commercial Department of China in its 556th notice, with a title of "the notice on implementation of model projects in service outsourcing industry" issued in 2006. The data are mainly collected from China statistic yearbook in electronic information industry and China yearbook in information industry. Some part of the data are taken from outsourcing industry leading website "China service outsourcing internet and academic database" with providers such as CEInet Statistics Database and DRCNET Statistics Database System.

3. Empirical analysis

3.1 Estimates of efficiency and its decomposition

We calculate efficiency scores of every DMU using super-DEA model given that traditional DEA model (the first and the third stage in the three-stage DEA model) is incapable of ranking DMU when the numbers of efficient DMU are more than one. For DMU that have efficiency scores below or equal to one, the results from super-DEA model and traditional DEA model are the same, while for DUM that have efficiency scores beyond one, the results from two models are different.

Table 3 Efficiency scores and their decomposition for 17 DUMS in 2011

DMU	*Ranking*	*Super-DEA*	*DEA*	*Pure technical Efficiency*	*Scale efficiency*	**Trends in scale economy**
Beijing	8	0.707	0.707	1	0.707	drs
Tianjin	12	0.233	0.233	1	0.233	irs
Shanghai	4	1.184	1	1	1	-
Liaoning	1	3.959	1	1	1	-
Guangdong	6	0.876	0.876	1	0.876	drs
Jiangsu	5	0.946	0.946	0.951	0.995	irs
Shandong	7	0.846	0.846	0.868	0.974	irs
Zhejiang	10	0.536	0.536	0.761	0.704	irs
Fujian	11	0.513	0.513	0.976	0.525	irs
Hubei	14	0.113	0.113	0.85	0.133	irs
Anhui	17	0.057	0.057	0.951	0.06	irs
Heilongjiang	16	0.067	0.067	0.835	0.08	irs
Jiangxi	13	0.121	0.121	1	0.121	irs
Hunan	15	0.103	0.103	0.813	0.126	irs
Sichuan	2	1.651	1	1	1	-
Chongqing	3	1.638	1	1	1	-
Shanxi	9	0.630	0.63	0.869	0.724	irs
Average		**0.803**	**0.573**	**0.934**	**0.603**	

Table 3 provides the estimated efficiencies and their decomposition of individual DMUs in 2011 (other years' results are available on request). As can be seen, outsourcing industries in Liaoning, Sichuan, Chongqing and Shanghai obtained efficiency scores beyond one, meaning those DMUs produced at the frontier in 2011 and could not produce more effectively under given production technology. Pure technical efficiency stands for the deviation of realized production from production possibility frontier, reflecting the internal management level and resource utility level of DMUs with given production technology, ranging from zero to one, the average value of pure technical efficiency of 17 DMUs in 2011was 0.934, a relatively higher score when compared with that of scale efficiency. While as far as individual DUM is concerned, a slight difference could be found, ranging from 1 for Liaoning and other regions to 0.761 for Zhejiang province, indicating there is a big room for improvements in management level and resource utility level. As indicated by the name, scale efficiency gives hints on whether DMUs have achieved best scale

economy, a state of being equal to one. In contrast to pure technical efficiency, the average score of scale efficiency for DUMs was small and the difference among individual DMUs was quite big, ranging from 0.06 for Anhui and 0.08 for Heilongjiang to 1 for Liaoning and other 3 regions.

Table 4 Changes in technical efficiencies calculated by DEA-Window technique

	2005	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	**Growth rate***
Beijing	0.052	0.008	0.015	0.016	0.038	0.258	0.258	30.6%
Tianjin	0.053	0.188	0.116	0.398	0.098	0.104	0.076	6.2%
Shanghai	0.151	0.412	0.351	0.333	0.353	0.408	0.382	16.7%
Liaoning	0.079	0.786	0.649	0.933	1.000	0.982	1.000	52.7%
Guangdong	0.086	0.115	0.289	0.252	0.165	0.185	0.135	7.8%
Jiangsu	0.034	0.183	0.189	0.347	0.250	0.171	0.197	34.0%
Shandong	0.021	0.115	0.115	0.172	0.079	0.120	0.089	27.2%
Zhejiang	0.095	0.133	0.179	0.193	0.241	0.166	0.162	9.3%
Fujian	0.000	0.007	0.000	0.026	0.002	0.015	0.011	7.8%
Average for East area	**0.063**	**0.216**	**0.211**	**0.297**	**0.247**	**0.268**	**0.257**	26.4%
Hubei	0.011	0.597	0.232	0.145	0.124	0.070	0.285	72.0%
Anhui	0.301	0.101	0.080	0.014	0.130	0.002	0.198	-6.7%
Heilongjiang	0.044	0.041	0.237	0.211	0.188	0.166	0.149	22.5%
Jiangxi	0.028	0.011	0.011	0.054	0.028	0.024	0.010	-15.8%
Hunan	0.008	0.005	0.020	0.095	0.423	0.311	0.062	40.7%
Average for Middle area	**0.078**	**0.151**	**0.116**	**0.104**	**0.179**	**0.115**	**0.141**	10.4%
Sichuan	0.054	0.031	0.059	0.071	0.514	0.067	0.047	-2.3%
Chongqing	0.003	0.003	0.036	0.002	0.066	0.030	0.141	90.0%
Shanxi	0.009	0.044	0.097	0.270	0.255	0.295	0.288	78.2%
Average for West area	**0.022**	**0.026**	**0.064**	**0.114**	**0.278**	**0.131**	**0.159**	39.0%
Average	**0.061**	**0.163**	**0.157**	**0.208**	**0.233**	**0.198**	**0.205**	22.4%

Table 4 presents dynamic changes in efficiency scores of Chinese service outsourcing industry during the sample period, however, due to limited space of this paper, detailed analysis will not be offered here ([5] provides in detail an analysis of productivity of Chinese service outsourcing industry).

In concluding this subsection, we argue that scale diseconomy due in particular to small scale (as shown in Table 3, most DUMs were a state of increase return to scale) led to low technical efficiency scores in 2011, being 0.573 from traditional DEA model and 0.803 from super-DEA model. As exceptions, service outsourcing industries in Beijing and Guangdong were facing decrease return on scale, indicating that both provinces should reduce their scales to a proper level in order for further efficiency gains.

3.2 Results of hypotheses testing

Results of the Stage 2 SFA regressions are based on a half normal specification of the one-sided inefficiency error component, and are summarized in Table 4. These results suggest that the operating environment does indeed exert a statistically significant influence on service outsourcing industry performance. As can be seen in Table 5, contrary to expectations of policy makers, the impact of government support on efficiency of outsourcing industry is not statistically significant. We argue that this surprising result may stem from subsequent reasons, firstly, following [6], support contents of regional governments do not match well with what outsourcing service providers really need. Secondly, the dummy variable of establishment of industrial association may be not a defining proxy for government support. As for regional openness to the international markets, estimation results show that the higher the level of a regional openness is, the lower the slacks both in capital inputs and labor inputs are. In line with [7] the level of openness may improve efficiency of a regional outsourcing industry through either scale economy or learning effects of both managerial and technological experiences from abroad, or both of them.

Again, the directions of the coefficients of talents competitiveness and regional GDP are reasonable and statistically significant. But as far as the influence of protection of Intellectual Property is concerned, regression results show a positive correlation between the level of protection of Intellectual Property and inefficiency (mostly through the channel of labor inputs). We offer three possible explanations for this estimation results. Firstly, since skills and know-how that could improve efficiency of outsourcing industry are mostly embedded in human capital instead of in capital goods, this may be the reason for a statistically significant relationship between efficiency and labor force inputs. Secondly, the higher the level of protection of Intellectual Property in a region is, the bigger the possibility of restricting free movement of core workers between firms is, and the smaller the spilling over effects of knowledge within that region is likely to be, which eventually leads to a relative lower efficiency gains when compared to the

opposite situation. Thirdly, we believe there indeed is a positive relationship between protection of Intellectual Property and efficiency, as supported by many academic researchers and industrial leaders [8], however, the positive effects coming from demand-enlarging are not big enough to offset negative effects stemming from inactive spilling over effects of knowledge.

Table 5 Stochastic frontier estimation results

Independent Variables	X_1 (labor forces)		X_2 (capital investments)	
	Coefficient	Standard errors	Coefficient	Standard errors
β_0	1.126	0.64	12.966	7.448
β_1	0.255	0.313	-2.675	3.331
β_2	-0.875**	0.479	-8.259**	5.803
β_3	-0.001	0.000	-0.005**	0.002
β_4	0.001***	0.000	-0.001	0.000
β_5	-0.008**	0.001	-0.007**	0.005
β_6	2.434***	1.21	38.756***	15.214
σ^2	3.350	0.777	892.225	1.813
γ	0.807	0.073	0.821	0.025
Log-likelihood function	-202.612		-491.677	
LR test of the one-sided error	52.602***		99.605***	

*** and ***mean significant at the level 5% and 1% respectively.*

Another influencing factor that need to explain carefully is regional informationizaiton. As shown in Table 4, estimation results present a statistically significant positive correlation between the level of regional informationizaiton and inefficiency, contrary to our expectations. We argue that the disappointing results may have something to do with relatively low value-added chain in which Chinese outsourcing industry is engaging, that is the growth rate with which outputs achieved cannot keep up with the rise rate with which regional government invested in informationization, resulting in an increasing slacks in inputs.

CONCLUSION

Employing the three-stage DEA model, this paper investigates the technical efficiency and its determinants factors of China service outsourcing industry with a panel data set covering 17 provincial regions during the period from 2005 to 2011, our research results show: (1) service outsourcing industries in most regions are in a state of below best level scale except Beijing and Guangdong; (2) there is serious inequality in efficiency among different regions, service outsourcing industries in areas such as Liaoning, Sichuan and Chongqing stand for the highest efficiency level when compared with those located in areas such as Anhui, Heilongjiang and other provinces;(3) the level of regional openness, talents competitiveness and regional economic development has positive impacts on the efficiency of outsourcing industry, whereas the level of protection of Intellectual Property and informationization influences the efficiency in an unexpected negative way. Government support has no statistically significant impacts on efficiency as far as our empirical results are concerned.

From the viewpoint of methodology, as traditional DEA model has two drawbacks. First, it is deterministic, and so is incapable of dealing with measurement errors in included variables and the omission of unobserved but potentially relevant variables, the impacts of which would be captured by a disturbance term in a stochastic model. Second, some omitted variables are what we have referred to as environmental variables, those that capture features of the operating environment have an impact on the efficiency with which conventional inputs are used to produce conventional outputs. In comparison with traditional DEA model, the three-stage model is capable of decomposing variations in efficiency scores into environmental effects, statistical noise and managerial inefficiency, which could offer an improved estimation of DMU's efficiency in most cases, we recommend researchers employ this model rather than the single-stage and the two-stage model as long as the data requirement can be met.

From the viewpoint of policy implications of this empirical research, we argue that different regions should pursue more targeted efficiency-improving strategies according to their different efficiency scores and sources of efficiency scores, by which they could avoid pricing war for obtaining low value-added service outsourcing business. Specifically, Areas like Liaoning, Shanghai and other regions with an efficiency score of 1 or above 1 have been in a position to shift its outsourcing service from current low-end cost leader activities to relatively high value added activities, the proper competitive strategies for outsourcing firms in those regions are to demonstrate their high

potential in performing high-end, high-value added business with low cost and high benefit to their existing and new developed overseas partners. But for outsourcing industry in areas suffering from low scale economies, like Anhui or Heilongjiang, the most important thing is to exploit internal as well as external markets, especially paying more attention to low-end, low value-added labor intensive business in their market- exploiting efforts. As for regions such as Zhejiang and Hunan which hold relatively low pure technical efficiencies, the targeted strategies may be to carry out on the job training and facilitate the diffusion of best practice in the workshop, accompanying with establishments of some form of incentive mechanisms that can motivate workers to improve their skills actively.

Last but not least, in light of increases in purchasing power of RMB, it is time for outsourcing sevice providers in China to implement overseas merger and acquisition of their counterparts in adanced economies, through which they can obtain channels of enlarging markets, learning best practise and accessing to high-end business.

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