Analysis of the Operating Efficiency of Online Game Industry in China Actualized by DEA

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Abstract—In the past 10 years, China's online game industry has become a sunrise industry with unlimited potential as its rapid development. Its rapid growth not only provides important support for the new round of upcoming economic growth, but also becomes a measure on building an innovation-oriented country comprehensively by grasping strategic opportunities of new scientific and technological revolution in China. However, its overall operating efficiency is not high due to the characteristics of online game industry, being young people indulgence in online games, homogeneity of games, talent shortage, virtual property transactions and other issues. In this paper, the target system is built to reflect the operational efficiency of this industry, according to economic data of liquid assets, fixed assets, employee salaries, administrative expenses, financial expenses, total profit and net investment income of the domestic 15 listed online game industries selected. Then operating efficiency is analyzed respectively based on the 2002-2008 panel data by using super-efficient data envelopment analysis and window analysis. The empirical results show that the operating efficiency of these enterprises has great fluctuation in seven years, being the widespread phenomena of inputs redundancy and outputs shortage; when the entire industry is in the period of increasing returns to scale, it is an urgent task to help enterprises become bigger and stronger in current time.

Index Terms—online games industry, operating efficiency, returns to scale, super-efficient data envelopment analysis, window analysis

I. INTRODUCTION

As one of the key factors to build innovation-oriented country comprehensively in China, the development of online game industry plays a role in exploitation and promotion of technological innovation, and cultivation of new economic growth point in the optimization and adjustment of industrial structure, which is an important measure to face with the financial crisis. By expanding employment opportunities and improving comprehensive national power, the industry becomes a very important support in the promotion of high-tech industry development and plays an important role in optimizing industrial structure to achieve sustainable economic development. Therefore, it is necessary to carry out researches which focus on how to improve the operating efficiency of online game industry, to design the incentives with the purpose of fostering sustainable competitive advantages and promoting the rapid development of online game industry. If we are not able to change the phenomena of imitation and exaggeration in the period the development of online game industry now, its operating efficiency will still not increase significantly, which may result in the influence of its international competitiveness and restrict the development of its follow-up development. It is time that we took the enhancement of the operating efficiency of online game industry as the basic direction; and it is the only way to promote the development of China's information industry.

At present, in the face of the international financial crisis, China's online game industry achieved rapid growth in revenues contrarian. According to statistical data, the actual sales revenue of China's online game industry added to 18.38 billion yuan in 2008, increasing 76.6% compared with 2007; it has brought 47.84 billion yuan direct revenue for the telecommunications, IT and other industries at the same time. According to relevant forecasts, the market sales of the industry are still expected to achieve 30% -50% growth in 2009, being 24-27 billion yuan, and to bring nearly 67 billion in direct revenue for the telecommunications, IT and other related industries [1]. The concentration of the industry increased gradually and it is entering an era of oligopolistic competition. In 2008, the revenue of the top ten operators accounted for over 90% in the entire industry, of which nine operators are listed companies, an operator is listing [2]. Under such circumstances, as a key factor to promote the rapid growth of online game industry, the listed companies have relatively better research ability than others; they are also important carriers to achieve self-innovation and multinational operations. It is an important way to promote the online game industry by helping these companies develop into large enterprises with strong profitability and international competitiveness.

On the contrary, China's online game industry is still at primary state though it has developed for 10 years. There are many problems such as small scale, teenagers' indulgency, old management mode, game homogeneity, talent shortage and virtual fortune exchange, low speed of product innovation [3]. China's online game industry develops rapidly; the government speeds up this

industrial from simply tracing and copying to focusing on self-innovation by industrial policy and legislation justice system [4]. However, single game of China's online game industry has short life and product quality needs to be improved extremely. The online game survey of CNNIC 2008 shows that online game users in China replace products for a short time, and 34.1% use single type game time for less than 6 month [5]. Meanwhile, the economic theory and empirical research related to online game industry are limited and lack of enough deeply quantitative analysis. Therefore, how to imply the mechanism of improving operating efficiency of online game industry, to pursue the policy simulation of the industry's rapid growth afterwards and to reduce investment redundancy and insufficient output mostly by effective inspiration are important issues that the industrial administrative departments are facing.

II. INDICATOR SYSTEM, SAMPLES AND DATA

This article takes Data Envelopment Analysis (DEA) as the evaluation method of operating efficiency of online game industry. DEA is one of the good methods to carry out quantitative evaluations of operating efficiency which was proposed in 1978. For the past thirty-one years it has been continued to develop and improve by many scholars all over the world and has become a data-oriented method set which measures the relative efficiency of multi-input & multi-output decision making units (DMU) [6]. Many scholars in China (Sheng Zhaohan, 1996; Wei Quanling, 2004) thinks that the homogeneity of the DMUs requests the entities have the same goals or tasks, the same external environment, as well as the same input and output indicators and the same dimension [7-8]. The enterprises of online game industry meet the requirements for such DMU unit, while their operating efficiency are subject to dynamic effects of different regional factors which not only change themselves constantly, but also influence and constrain each other. Different index systems will produce different effects. How to build a more reasonable index system based on some factors, which is also important in affecting economic scale, structure and growth of the online game industry?

Table 2 is a comprehensive evaluation index system the empirical analysis needs. Specifically, in the input

indicators, fixed asset, reflecting the company's overall strength, is the physical form of fixed assets and it plays a long-term role in the production process; liquid asset is an essential component; staff salary is mainly workers' actual wages and other cash paid by employers; administrative expenses are primarily various fees when the administration departments organize and manage production and operation activities, reflecting its management level; financial expenses are to raise the funds of production and operation activities, reflecting their financing capacity and debt structure. In the output indicators, total profit is a very important economic indicator to measure business performance; net income from investments is the net of business investment income minus investment losses; to corporate investor, it is the basic elements of getting the return on investment; as for the managers, it is a basis for management decision-making.

Taking into account the representativeness of samples and availability of data, this article collected 15 Chinese online game industries in Shanghai and Shenzhen stock markets as evaluation samples, including five inputs and two outputs data of the above-mentioned seven indicators from 2002 to 2008, which come from Genius Finance Database. In the collected 735 data of samples, there are six missing values, less than 1% of the total, so we use the multiple imputation propensity score method, from which first to gain the propensity score of the missing values indicating the missing probability, then to group according it and apply the approximate Bayes Bootstrap to interpolate [9]. Because there are negative values in some indicators such as total profit, we make a non-dimensional treatment with the original data.

$$x_i' = 0.1 + 0.9 \times \frac{x_i - x_{min}}{x_{max} - x_{min}} \tag{1}$$

where x_i is the actual value; x_{max} is the upper limit of indicator or the maximum; x_{min} is the lower limit or the minimum; x_i' is the corresponding value after the non-dimensional treatment. Then the range of x_i' is [0.1, 1]. Due to limited space, the multiple imputation propensity score method can be obtained from the authors. The standardized data is in Table I.

TABLE I.
THE STANDARDIZED DATA

Company	LCXX	LTGF	ZSCM	HHKG	GDXX	ZGLT	ZQL	XWSX	ZDWX	ZGGM	TFGF	DFMZ	ZYGF	ZKYH	FZKJ
2002															
(I)LDZC	0.13	0.18	0.11	0.11	0.22	1	0.13	0.1	0.14	0.11	0.22	0.11	0.12	0.11	0.14
(I)GDZC	0.1	0.11	0.11	0.1	0.1	1	0.1	0.1	0.1	0.13	0.11	0.11	0.1	0.1	0.1
(I)ZGXC	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.11	0.1	0.1
(I)GLFY	0.11	0.14	0.11	0.11	0.17	1	0.12	0.1	0.12	0.11	0.17	0.12	0.11	0.11	0.12
(I)CWFY	0.1	0.16	0.11	0.12	0.13	1	0.11	0.1	0.12	0.1	0.12	0.12	0.11	0.11	0.13
(O)LRZE	0.11	0.11	0.1	0.11	0.12	1	0.11	0.1	0.11	0.14	0.14	0.14	0.1	0.11	0.12
(I)TZSY	0.18	0.24	0.1	0.18	1	0.19	0.11	0.12	0.24	0.1	0.16	0.17	0.15	0.11	0.12

2003															
(I)LDZC	0.14	0.21	0.11	0.13	0.29	1	0.13	0.1	0.18	0.1	0.3	0.1	0.13	0.11	0.2
(I)GDZC	0.1	0.11	0.1	0.1	0.1	1	0.1	0.1	0.1	0.13	0.11	0.11	0.1	0.1	0.1
(I)ZGXC	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.11	0.1	0.1	0.1	0.1
(I)GLFY	0.12	0.13	0.1	0.11	0.13	1	0.11	0.1	0.12	0.1	0.15	0.11	0.1	0.1	0.11
(I)CWFY	0.1	0.13	0.1	0.11	0.11	1	0.11	0.1	0.12	0.1	0.11	0.12	0.11	0.11	0.11
(O)LRZE	0.11	0.1	0.1	0.12	0.14	1	0.1	0.1	0.11	0.15	0.13	0.15	0.1	0.11	0.12
(I)TZSY	0.72	0.75	0.73	0.76	1	0.1	0.81	0.73	0.74	0.73	0.76	0.77	0.72	0.73	0.73
2004															
(I)LDZC	0.16	0.22	0.12	0.13	0.38	1	0.13	0.11	0.24	0.1	0.4	0.11	0.14	0.11	0.24
(I)GDZC	0.1	0.11	0.1	0.1	0.11	1	0.1	0.1	0.1	0.13	0.11	0.12	0.1	0.1	0.1
(I)ZGXC	0.11	0.11	0.1	0.1	0.1	1	0.11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
(I)GLFY	0.12	0.15	0.1	0.11	0.12	1	0.11	0.1	0.12	0.1	0.15	0.12	0.11	0.1	0.12
(I)CWFY	0.97	1	0.97	0.97	0.99	0.1	0.97	0.97	0.99	0.97	0.99	0.99	0.98	0.97	0.98
(O)LRZE	0.15	0.1	0.15	0.2	0.17	1	0.16	0.15	0.16	0.19	0.18	0.2	0.15	0.16	0.17
(I)TZSY	0.36	0.27	0.35	1	0.65	0.1	0.43	0.34	0.39	0.35	0.33	0.41	0.34	0.33	0.33
2005															
(I)LDZC	0.15	0.22	0.11	0.14	0.38	1	0.18	0.1	0.28	0.11	0.51	0.12	0.14	0.1	0.25
(I)GDZC	0.1	0.11	0.1	0.1	0.11	1	0.1	0.1	0.1	0.12	0.12	0.12	0.1	0.1	0.1
(I)ZGXC	0.12	0.12	0.1	0.11	0.11	1	0.13	0.11	0.11	0.1	0.14	0.1	0.12	0.1	0.11
(I)GLFY	0.12	0.12	0.1	0.12	0.13	1	0.11	0.1	0.13	0.1	0.18	0.12	0.11	0.1	0.12
(I)CWFY	0.1	0.15	0.1	0.1	0.16	1	0.1	0.1	0.13	0.11	0.17	0.13	0.1	0.11	0.12
(O)LRZE	0.11	0.1	0.11	0.11	0.1	1	0.11	0.1	0.12	0.15	0.13	0.17	0.11	0.11	0.13
(I)TZSY	0.56	0.58	0.52	0.95	1	0.1	0.53	0.53	0.63	0.55	0.72	0.88	0.53	0.58	0.5
2006															
(I)LDZC	0.12	0.18	0.12	0.13	0.24	1	0.18	0.1	0.23	0.1	0.48	0.14	0.14	0.11	0.21
(I)GDZC	0.1	0.11	0.1	0.1	0.11	1	0.11	0.1	0.1	0.12	0.12	0.12	0.1	0.1	0.11
(I)ZGXC	0.1	0.12	0.1	0.11	0.11	1	0.12	0.11	0.11	0.1	0.12	0.1	0.11	0.1	0.1
(I)GLFY	0.11	0.13	0.1	0.12	0.13	1	0.11	0.1	0.12	0.1	0.19	0.11	0.1	0.1	0.12
(I)CWFY	0.1	0.17	0.11	0.1	0.2	1	0.11	0.1	0.15	0.17	0.24	0.14	0.12	0.11	0.14
(O)LRZE	0.11	0.11	0.12	0.11	0.1	1	0.12	0.11	0.12	0.15	0.15	0.16	0.11	0.12	0.13
(I)TZSY	0.65	0.61	0.6	0.87	1	0.1	0.76	0.61	0.78	0.64	0.82	0.84	0.65	0.69	0.57
2007															
(I)LDZC	0.13	0.19	0.14	0.14	0.23	1	0.19	0.1	0.27	0.1	0.74	0.23	0.13	0.13	0.27
(I)GDZC	0.1	0.11	0.1	0.1	0.1	1	0.11	0.1	0.1	0.1	0.12	0.11	0.1	0.1	0.11
(I)ZGXC	0.1	0.13	0.11	0.11	0.23	1	0.12	0.1	0.11	0.11	0.28	0.14	0.11	0.1	0.1
(I)GLFY	0.11	0.13	0.1	0.11	0.14	1	0.12	0.1	0.13	0.1	0.21	0.12	0.1	0.11	0.12
(I)CWFY	0.56	0.73	0.56	0.57	0.87	0.1	0.59	0.56	0.72	0.58	1	0.64	0.59	0.61	0.68
(O)LRZE	0.1	0.1	0.1	0.1	0.1	1	0.12	0.1	0.11	0.13	0.15	0.15	0.11	0.11	0.12
(I)TZSY	0.12	0.18	0.1	0.12	0.73	0.1	0.22	0.1	0.28	0.1	0.51	1	0.24	0.2	0.1
2008															
(I)LDZC	0.11	0.14	0.13	0.12	0.14	1	0.14	0.1	0.19	0.1	0.4	0.19	0.11	0.14	0.16
(I)GDZC	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.11	0.11	0.1	0.1	0.11
(I)ZGXC	0.1	0.1	0.1	0.1	0.12	1	0.1	0.1	0.1	0.11	0.14	0.1	0.1	0.1	0.1
(I)GLFY	0.1	0.12	0.1	0.11	0.12	1	0.11	0.1	0.12	0.1	0.17	0.11	0.1	0.11	0.11
(I)CWFY	0.1	0.14	0.1	0.11	0.17	1	0.11	0.1	0.13	0.1	0.21	0.13	0.11	0.12	0.14

(O)LRZE	0.21	0.21	0.21	0.21	0.1	1	0.24	0.21	0.22	0.26	0.25	0.27	0.21	0.22	0.22
(I)TZSY	0.16	0.13	0.1	0.14	0.24	0.1	0.1	0.1	0.25	0.1	0.67	1	0.39	0.23	0.13

Data source: calculated according to Genius Finance Database.

It is necessary to concern the identification of input and output evaluation indexes. The ability to distinguish the strength of operating efficiency is the key. If all samples' scores are identical in some evaluation index, they may not have the ability to determine the strength of operating efficiency. Therefore, the standard deviation coefficient is used to identify them:

$$v_\sigma = \frac{\sigma}{\bar{x}} \times 100\% \qquad (2)$$

where σ is the standard deviation of sample; $\bar{x}$ is the arithmetic mean of sample. According to calculations, absolute values of standard deviation coefficient of the various indicators over the years are large (≥ 1). So that the indicator system showed in Table II is reasonable.

TABLE II.
THE COMPREHENSIVE EVALUATION INDEX SYSTEM AND STANDARD DEVIATION COEFFICIENT OF ONLINE GAME INDUSTRY

Index Type	Input Indicator					Output Indicator	
Index Name	Liquid Assets	Fix Assets	Staff Salary	Administrative Expenses	Financial Expenses	Total Profit	Net Investment Income
Index Code	(I)LDZC	(I)GDZC	(I)ZGXC	(I)GLFY	(I)CWFY	(O)LRZE	(I)TZSY
2002	2.23	3.42	3.64	2.61	3.09	2.90	2.37
2003	1.76	3.40	3.61	2.87	3.33	2.86	-19.28
2004	1.48	3.34	3.55	2.80	-4.58	2.90	3.20
2005	1.30	3.34	2.84	2.74	2.80	2.95	2.43
2006	1.57	3.32	3.06	2.77	2.29	3.00	2.61
2007	1.35	3.41	2.40	2.56	3.14	2.97	1.49
2008	1.90	3.59	3.38	2.97	2.76	3.12	1.41

Data source: calculated according to Genius Finance Database.

III. OPERATING EFFICIENCY EVALUATION BASED ON SE-DEA

In the DEA model methods set, the non-parametric DEA (CCR model) proposed by Charnes, Cooper and Rhodes (1978) which is applied to frontier estimation is the most basic and the most important technology of DEA [6]. Banker, Charnes and Cooper (1984) subsequently proposed an expansion model of DEA analysis for Fixed Returns-To-Scale mode, taking into account Variable Returns-To-Scale (VRS); that is to say that when not all the DMUs run in the best size, it could make the scale efficiency (SE) affect on the measure of technical efficiency. VRS model allows the calculation of technical efficiency is not affected by scale efficiency, which is one of the Banker-Charnes-Cooper (BCC) models [10]. Through analyzing the main features of China's online game industry in the current, considering the status which come from their internal organizational structure and outside external conditions, particularly international business competition, financial constraints and so on, leading some DMUs can not run in the optimal size, Input Oriented BCC-I model of the VRS model is used as the evaluation model. BCC-I model can give the feature of DMU Returns-To-Scale (RTS). Considering the unique advantages of Super-Efficiency DEA (SE-DEA) in the comprehensive evaluation of effective DMU (Andersen & Petersen, 1993) [11], its expansion model (Super-BCC-I), therefore, which belongs to the improved DEA model, is selected. In CCR model,

$$(D)\begin{cases} \min \quad \theta \\ s.t \quad \sum_{j=1}^{n} \lambda_j X_j + S^- \leq \theta X_k \\ \quad \sum_{j=1}^{n} \lambda_j Y_j - S^+ \geq Y_k \\ \lambda_j \geq 0, \\ j = 1, \ 2, \cdots, n \\ S^- \geq 0, S^+ \geq 0 \end{cases} \qquad (3)$$

to be added constraint condition,

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad (4)$$

then it becomes the BCC model. In the BCC model, there are three status on returns to scale of decision-making unit: when $\theta_0 = 1$, it means returns to scale is constant; when $\theta_0 < 1$, and

$$\frac{1}{\theta_0} \sum_{j=1}^{n} \lambda_j^0 > 1 \qquad (5)$$

it means decreasing returns to scale; when $\theta_0 > 1$, and

$$\frac{1}{\theta_0} \sum_{j=1}^{n} \lambda_j^0 < 1 \qquad (6)$$

it means increasing returns to scale [12]. If the BCC model is added another constraints j≠k, it will become Super-BCC model. The data format requirements and

calculation of BCC and its expansion models are the same with CCR, being the basic model of DEA. The specific operating efficiency scores of each enterprise are in Table III, which is calculated by Super-BCC-I model.

Because there are so many enterprises in increasing and constant returns to scale more than one year and the limited space, only China Unicom (ZGLT) being decreasing returns to scale in 2002, these are not listed.

TABLE III.
THE OPERATING EFFICIENCY SCORES OF LISTED COMPANIES IN ONLINE GAME INDUSTRY

	Year							Input Redundancy					Output Shortage	
	2002	2003	2004	2005	2006	2007	2008	LDZC	GDZC	ZGXC	GLFY	CWFY	LRZE	TZSY
LCXX	0.98	1.01	0.97	0.98	1.01	0.99	1.01	0.02	0.00	0.00	0.01	0.18	0.00	0.07
LTGF	0.96	0.96	0.93	0.93	0.94	0.94	0.98	0.06	0.00	0.01	0.02	0.23	0.02	0.07
ZSCM	1.00	1.00	1.00	1.00	1.00	1.00	1.03	0.01	0.00	0.00	0.00	0.19	0.00	0.11
HHKG	0.99	0.99	1.47	1.19	1.01	0.99	1.00	0.01	0.00	0.00	0.00	0.07	0.00	0.12
GDXX	1.02	1.21	0.99	0.96	0.96	0.97	0.99	0.07	0.00	0.02	0.01	0.22	0.04	0.00
ZGLT	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00
ZQL	0.98	0.98	0.97	1.00	0.95	0.90	0.98	0.03	0.00	0.01	0.00	0.13	0.01	0.14
XWSX	1.02	1.05	1.00	1.02	1.00	1.00	1.01	0.00	0.00	0.00	0.00	0.07	0.00	0.03
ZDWX	1.00	0.99	0.99	0.99	0.98	0.98	0.99	0.10	0.00	0.00	0.02	0.22	0.00	0.08
ZGGM	1.00	1.10	1.01	0.99	1.00	1.00	1.55	0.00	0.00	0.00	0.00	0.07	0.00	0.05
TFGF	0.96	0.95	0.96	0.87	0.87	0.83	0.94	0.26	0.00	0.02	0.05	0.22	0.00	0.07
DFMZ	1.00	1.05	1.00	1.09	1.00	0.92	1.00	0.01	0.00	0.00	0.00	0.04	0.01	0.00
ZYGF	0.99	0.99	0.99	0.98	0.99	0.99	1.02	0.02	0.00	0.01	0.00	0.19	0.00	0.09
ZKYH	1.00	1.00	1.00	1.00	1.00	1.00	1.01	0.00	0.00	0.00	0.00	0.07	0.00	0.11
FZKJ	1.00	1.00	0.99	0.96	1.00	1.00	1.01	0.07	0.00	0.00	0.01	0.21	0.00	0.20

Data source: calculated using SE-DEA expanded model according to Genius Finance Database.

The overall operating efficiency of China's online game industry is good, but there are differentiations and has much room for growth among most listed companies, as it is seen from Table III. The revenue scale of many enterprises does not reach the best state, even in the background that national and local governments' full support to online game industry. It also confirms that the development of online game industry will take some time, which is influenced by a variety of factors, such as its own technical and management level and overseas markets. It is necessary to promote the online game industry in operation comprehensively to improve returns to scale of the industry. In the process of economic transition in China, if online game industry is not outdate of the competitive process and continuous development in the market economy, we must strive to improve the level of operating efficiency and increase returns to scale as soon as possible through technological and management innovation during the development and growth. Meanwhile, it is necessary to pay attention to avoid decreasing returns to scale. Management departments of this industry should not only perfect a series of development plans of online game industry, but also take effective measures to assist them moderately. In the framework of market economy, to support a relatively vulnerable and reduce the negative intervention to these enterprises will contribute to the establishment of good and fast scientific development of China's online game industry.

IV. DEA WINDOW ANALYSIS OF PANEL DATA

Panel Data, as a data structure which has dual dimensions of the time and sample, have some advantages such as understanding the heterogeneity of samples, increasing the degree of freedom, reducing the multicollinearity between the variables, providing more information through the large samples and carrying out analysis of timing and single samples (Cheng Hsiao, 2003) [13]. Panel data is concerned widespread by the experts in recent years, by which its solutions have been greatly developed. Charnes (1985) proposed to analyze panel data by using DEA firstly [14]. The basic idea takes the same multi-input & multi-output DMUs in different periods as different DMUs, in which each DMU do not need to be compared with all the other data sets, but with some panel data. If there are number N of DMUs（n=1,2,…,N）in the T period（t=1,2,…,N）, there will be N×T samples. It is assumed that each DMU has r inputs and s outputs, and input vector is $X_{tn} = (X_{1tn}, X_{2tn}, \cdots X_{rtn})$, output vector is $Y_{tn} = (Y_{1tn}, Y_{2tn}, \cdots Y_{stn})$, time is k (1≤k≤T), width is w(1≤w≤T-k), window is with that kw . Then for a DMU in the variable returns to scale (VRS) the efficiency values can be calculated.

$$(D) \begin{cases} \min \quad \theta \\ s.t \quad -X_{kw}\lambda + \theta x_t^{'} \geq 0 \\ \quad\quad Y_{kw}\lambda - Y_t^{'} \geq 0 \\ \quad\quad \lambda_j \geq 0 \\ \quad\quad \sum_{j=1}^{N \times W} \lambda_j = 1 \\ \quad\quad j = 1, \ 2, \cdots, n \end{cases} \quad (7)$$

In the window, it is more appropriate than computing the average level by time. Many scholars choose three years as the window length [15], but there are no references to prove exactly how to select the appropriate window length. Taking into account the formula

$$W = \begin{cases} \dfrac{T+1}{2}, & T = 2a+1, \ a \in N \\ \dfrac{T+1}{2} \pm \dfrac{1}{2}, & T = 2a, \quad a \in N \end{cases} \quad (8)$$

so the window length is selected as 4 years. Given the majority of listed companies of China's online game industry are in the status of increasing returns to scale currently, and in order to maintain a link with the second part of this article, Input Oriented and DEA Window Analysis of VRS are used to calculate based on the 2000-2008 year panel data of listed companies. The results can be seen in Table IV.

TABLE IV.
RESULTS OF DEA WINDOW ANALYSIS

	2002	2003	2004	2005	2006	2007	2008	Average	C-Average
LCXX	1.00	1.00	0.98	0.98				0.99	0.99
		1.00	0.98	0.98	1.00			0.99	
			0.98	0.98	1.00	0.99		0.99	
				0.98	1.00	0.99	1.00	0.99	
LTGF	0.96	0.96	0.93	0.93				0.94	0.94
		0.96	0.93	0.93	0.94			0.94	
			0.93	0.93	0.94	0.94		0.94	
				0.93	0.94	0.94	0.98	0.95	
ZSCM	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	1.00		1.00	
				1.00	1.00	1.00	1.00	1.00	
HHGF	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	0.99		1.00	
				1.00	1.00	0.99	1.00	1.00	
GDXX	1.00	1.00	0.99	1.00				1.00	0.99
		1.00	0.99	1.00	1.00			1.00	
			0.99	1.00	1.00	0.97		0.99	
				0.97	0.97	0.97	0.99	0.97	
ZGLT	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	1.00		1.00	
				1.00	1.00	1.00	1.00	1.00	
ZQL	0.98	0.98	0.97	1.00				0.98	0.97
		0.98	0.97	1.00	0.97			0.98	
			0.97	1.00	0.99	0.90		0.96	
				1.00	0.97	0.90	0.98	0.96	
XWSX	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	1.00		1.00	

				1.00	1.00	1.00	1.00	1.00	
ZDWX	1.00	0.99	1.00	1.00				1.00	0.99
		0.99	1.00	1.00	0.99			1.00	
			1.00	1.00	1.00	0.98		0.99	
				1.00	0.99	0.98	0.99	0.99	
ZGGM	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	1.00		1.00	
				1.00	1.00	1.00	1.00	1.00	
TFGF	0.98	0.96	0.97	0.89				0.95	0.92
		0.96	0.97	0.89	0.90			0.93	
			0.97	0.91	0.94	0.84		0.91	
				0.87	0.88	0.83	0.95	0.88	
DFMZ	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	1.00		1.00	
				1.00	1.00	0.93	1.00	0.98	
ZYGF	0.99	0.99	0.99	0.99				0.99	0.99
		0.99	0.99	0.98	0.99			0.99	
			0.99	0.98	0.99	0.99		0.99	
				0.98	0.99	0.99	1.00	0.99	
ZKYH	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	1.00		1.00	
				1.00	1.00	1.00	1.00	1.00	
FZKJ	1.00	1.00	1.00	1.00				1.00	1.00
		1.00	1.00	1.00	1.00			1.00	
			1.00	1.00	1.00	1.00		1.00	
				0.96	1.00	1.00	1.00	0.99	

Data Source: calculated by the using of DEA Window Analysis based on Macro Database in China.

Table IV shows that there are ups and downs of the operating efficiency of China's online game industry although they had developed during the seven years. The reason is mainly that the scale and level of many companies are low generally. The degree of concentration is at a low level in online game companies; it will have format redundancy of input. These all make the stations of inputs redundancy and output shortage exist in most businesses, and cause the operating efficiency of China's online game industry to have changed little in the seven years. Therefore, under the premise of identifying the controllable risks, it is necessary to give some degree of support towards the enterprises with innovative capabilities in accordance with the laws of market economy; and sound fiscal policies ought to be established as soon as possible to provide appropriate financial subsidies to these companies.

V. CONCLUSIONS

It is an important aspect of government activities to support the rapid development of online game industry. The key to the effectiveness of government policies is that whether it is important to the growth of operating efficiency of online game industry. Specifically speaking, the recommendations of supporting the online game industry include: (1) After finding the factors of restricting the enterprises to be bigger and stronger by empirical analysis, it is necessary to clarify the relationship among them, by which the system model is established and find the policy factors to improve the operating efficiency at last; (2) Through the adjustment and simulation of the current policies by quantitative analysis on the redundancy of inputs and the shortage of outputs, it can be ensured greatest effects of China's online game industry and promote its sustainable development.

Through establishing the appraisal system about the operating efficiency of online game industry, taking its increasing into comprehensive evaluation system, which is an important content for the online game industry and its administrators, responsibility is established to ensure

the development of the whole online game industry. It is necessary to study the results of comprehensive evaluation about the online game industry by different methods, including comparing with other study results, the comparison among the results of different ways and the comparison of the actual effects and so on. Dynamic evaluation system ought to be established to analyze their development status and problems arising during the process. Therefore, in the process of innovating methodology of DEA with the efficiency evaluation, it is efficient to use integrated evaluations and improved Panel Data model to establish the evaluation system of online game industry's operating efficiency. By setting the targets under the circumstances of dynamic changeable situation in order to ensure that the entire evaluation system is in flux and formatting a complete evaluation system to substitute evaluation after the event with pre-evaluation, the DEA models with Monte Carlo simulation will give better evaluation of data, which as a result will promote the development of the online game industry finally.

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