PRINT: ISSN 0973-5070 ONLINE: 2456-6772
Ethno Med, 8(1): 51-60 (2014)
DOI: 10.31901/24566322.2014/08.01.07

Evaluating Business Performance of China's Pharmaceutical Companies Based on Data Envelopment Analysis

Yunshi Mao [1], Jianrui Li and Yangchun Liu [2*]

School of Business, Sun Yat-sen University, Guangzhou, 510275, China
Telephone: [1]<86-20-8411-0699>, [2]<86-(020) 8411-4127>
E-mail: [1]<mnsmys@mail.sysu.edu.cn>, [2]<mnslyc@mail.sysu.edu.cn>*

KEYWORDS Data Envelopment Analysis. Pharmaceutical Companies. Business Performance. Scale Efficiency. Total Efficiency. Pure Technical Efficiency

ABSTRACT Based on the data of 34 listed pharmaceutical companies in a share of China pharmaceutical industry in 2011, Data Envelopment Analysis (DEA), Sensitivity Analysis and Slack Variable Analysis are combined to measure the Total Efficiency (TE), Pure Technical Efficiency (PTE), and Scale Efficiency (SE). Moreover, in-depth Sensitivity Analysis and Slack Variable Analysis show that the Overall Efficiency of China's listed pharmaceutical companies is not high, where Accord Pharmaceutical and Meheco present better input/output ratio because of the centralized resources, optimal managerial systems, and excellent asset structures. Layn appears the worst result in Technical Efficiency. The general disadvantages and the shortage of various enterprises are further proposed suggestions for improvement.

INTRODUCTION

According to the international standard, pharmaceutical industry is one of the 15 internationalized industries and one of the rapid sunrise industries in the world. Since the reforming and opening-up, the medical requirements for healthcare have been enhanced with the promotion of national living standard. The gross production of pharmaceutical industry remains higher growth, about 16.6%[1]. The gross production value of pharmaceutical manufacturing industry reached 1.336806 trillion dollars in 2011, with the year-on-year growth 29.02%, which was about 2.83% GDP[2]. In the first half of 2012, the gross production value of pharmaceutical industry in China achieved 67.2 billion dollars, with the year-on-year growth 19.2%[3]. Meanwhile, China's pharmaceutical industry has been emphasized by the public and the government that it presents the critical role in national economy. China's pharmaceutical production remains continuous, stable, and rapid development in recent years[4].

In 2012-2016 Pharmaceutical Industry Investment Strategies and In-depth Research Reports, announced on China Industry Research Net[5], pharmacy is regarded as the industry with the highest technology, risks, inputs, and rewards that it has been the competitive focus among developed countries. With the development of globalized economy, the international competitiveness has become fierce. In order to enhance the competiveness, multinational corporations establish global production and sales network through large-scale reunion and merger and international capital market operation to expand the market shares. The competitors in China's pharmaceutical industry have become greater. In face of such fierce market competition, the overall development of China's pharmaceutical industry still presents large differences from developed countries, particularly in business performance. Research and improvement are therefore considered necessary.

Address for correspondence:
Dr. Yangchun Liu
School of Business, Sun Yat-sen University,
Guangzhou, 510275, China
E-mail: mnslyc@mail.sysu.edu.cn

Literature Review

Charnes and Cooper (1978) first proposed Data Envelopment Analysis (DEA) for evaluating the comparative validity among departments (called DEA validity). The first model was named CCR model. From the aspect of production function, such a model was used for multiple inputs, especially a production department with several inputs, and was an ideal and effective method for scale validity and technical validity.

In recent years, Data Envelopment Analysis (DEA) has been utilized in domestic and international research on efficiency analyses. With DEA to evaluate efficiency, neither given weights for indicators nor pre-given production functions is required, and several inputs and outputs could be simultaneously managed[6].Reynolds Dennis (2003) applied CCR and BCC models in DEA to the research on catering industry for analyzing the applicability and proposed the shortcomings of abnormal reference of DEA[7]. Barros (2004) preceded Data Envelopment Analysis in the public bar chains in Portugal, ranked the efficiency with the total production rate, and proposed the improvement policies for facilitating the technology progress[8].Yu (2007) assumed R and D personnel and R and D expenses as the input variables and sales of new products and the number of patents as the outputs for the innovation system and estimated the innovation efficiency of large- and middle-scale enterprises with DEA[9]. Li and Wang (2006) had personnel and expenses for technical innovation activities as the input variables and the application number of patents, theses and publications in technology, and the change rate of industrial gross production value as the output variables and analyzed the innovation efficiency of manufacturing industry in Beijing with DEA[10] (Li and Pan 2005) regarded expense and human resource as the innovation inputs, while the sales rate of new products and the sales revenue as the innovation income, and evaluated the innovation efficiency of several technology enterprises in Xian with DEA[11]. Qian (2004) took technical innovation expenses, researchers, and R and D equipment as the input indicators and R and D results and sales as the output indicators to evaluate the statistical data of 85 machinery manufacturers with DEA[12].

Nevertheless, it is hard to find in the past literature in using the listed companies as research samples in China. The combination of DEA, Sensitivity Analysis, and slack variable tends to evaluate the efficiency and propose improvement.

Based on the previous research, this research used the 2011 date of listed pharmaceutical companies (A shares) to carry out the Data Envelopment Analysis (DEA), Sensitivity Analysis, and Slack Variable Analysis. With the data of listed companies, typical enterprises with the best and the worst overall efficiency are further analyzed.

METHODOLOGY

Data Envelopment Analysis (DEA), proposed by 1978. Charne and Cooper, is a system analysis based on Relative Efficiency Evaluation. Since the first CCR model in DEA was proposed in 1978, relevant research is deepened and the application fields are widened[13].

As a linear planning, DEA projects all inputs and outputs of Decision Making Units (DMU) to the geometric space for the minimum inputs or the maximum outputs being the boundary. When a DMU locates on the boundary, it is regarded as the most efficient unit with the relative efficiency 1, showing that the DMU could not increase outputs or decrease inputs when other conditions remain unchanged. When DMUs locate in the boundary, they are considered as inefficient units, with the efficiency between 0-1, revealing that the input/output efficiency could be improved by changing the proportion among inputs. Accordingly, each DMU could be summarized the quantitative index of overall efficiency, with which the DMUs are ranked by scale, the DMU with the highest relative efficiency is confirmed, and the reason and degree of other DMUs being inefficiency are indicated as the management information for competent authorities. BCC model is show as below.

$$\underset{\theta_l \lambda_l}{\text{Max}}\ h_k = \theta_k - \varepsilon\left[\sum_{i=1}^{m} S_{i=1}^{m} + \sum_{r=1}^{s} S_{rk}^{+}\right]$$

$$\text{s.t.}\quad \sum_{j=1}^{n} \lambda_j Y_{rj} - \theta_k Y_{rk} = S_{rk}^{+} = 0$$

$$\sum_{j=1}^{n} \lambda_j X_{ij} + S_{ik}^{-} = X_{ik}$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

where sik- stands for the slack variable of inputs, srk+ the excess variable of outputs, λj the multiplier for DMUs, (hk – 1) the potential of equally proportional increase of all outputs when the inputs remain unchanged, and 1/hk the Pure Technical Efficiency.

With Data Envelopment Analysis to evaluate the efficiency, each increased input/output would reduce the discrimination of Data Envelopment Analysis. When there are four inputs and five outputs, twenty output/input proportional increases are received. In this case, at least two or more DMUs are required for the model discrimination theoretically. Golany and Roll (1989) further proposed the experience rules for Data Envelopment Analysis that the number of evalu-

ated DMUs should be at least double the sum of the numbers of inputs and outputs[14].

Data Selection and Variable Description

Listed Company Industry Classification Standard (revised in 2012), announced by China Securities Regulatory Commission, defined manufacturing industry as new products through physical change or chemical change by either power machine manufacturing or hand-made and for either wholesale or retail[15]. Class C Divisions 13-43[16] in Listed Company Industry Classification Standard (revised in 2012) responds to such a definition.

According to Listed Company Industry Classification Standard (revised in 2012), announced by China Securities Regulatory Commission, this study defined listed pharmaceutical enterprises as listed pharmaceutical manufacturers, as in Class C 27 divisions[17].

With systematic sampling, total 102 listed pharmaceutical enterprises in A shares in 2011 are selected 34 valid samples.

Four input/output variables are selected and total 34 valid DMUs are sieved out that the standard 8 DMUs required by the experience rules for Data Envelopment Analysis proposed by Golany and Roll (1989)[18] is achieved.

The selection of variables is shown as follows.

Input Variable

Labor: Number of employees is selected as the input variable (referring to the total number of employees in the company, including managers, R and D personnel, sales staff, and manufacturing staff). Merely number of employees can be compared, as the data of work time and quality difference cannot be considered the availability and authenticity.

Administrative Expenses: It refers to the expenses of the administration department organizing and managing the production activities.

Gross Assets: Assets are the equipment for company operation, which are not for sale. Gross assets, on the other hand, contain the sum of land cost, building cost, machine and equipment cost, other equipment cost, construction in progress and prepaid expenses, revaluation increments, and accumulated depreciation listed in balance sheet.

Output Variable

Operating Revenue: It refers to the revenue acquired from selling products or providing services in a period of time, including sales revenue, service revenue, agency revenue, and other operating revenue. Operating revenue is utilized as the only output variable for the analyses.

DATA ANALYSIS

Analysis of Relative Efficiency

The above inputs/output variables are inputted in DEAP2.1 for DEA calculation. Output-oriented BCC model is applied to acquiring the relative efficiency of pharmaceutical companies (Table 1).

The concept of technical efficiency was first proposed by Farrell (Later scholars have also called the overall efficiency) (1957), who, from the aspect of inputs, defined it as the ratio of the ideally possible minimum inputs and the real inputs under the same outputs[19]. From the aspect of outputs, Leibenstein (1966) considered technical efficiency as the ratio of the real outputs and the ideally possible maximum outputs under the same inputs. Pure technical efficiency is the production efficiency affected by management and technology, mainly reflecting the management standard in the industry. Scale efficiency refers to the production efficiency with the effect of business scale. The following overall technical efficiency is composed of pure technical efficiency and scale efficiency, which are the divisions of overall efficiency, and is the product of pure technical efficiency and scale efficiency (Fig. 1).

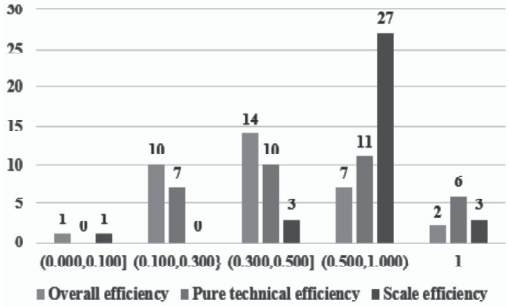

Fig. 1. Distribution of businesses in distinct efficiency intervals
Data Source: This Study

Table 1: Relative efficiency of China's pharmaceutical companies

Pharmaceutical company	*DEAP result*		
	Overall efficiency	*Pure technical efficiency*	*Scale efficiency*
Shanghai Pharma	0.591	1.000	0.591
Dong-e E-jiao	0.331	0.343	0.964
Hepalink	0.501	0.615	0.815
China Resources Sanjiu	0.368	0.369	1.000
Hualan Biologicals	0.195	0.247	0.790
Guangzhou Pharmaceutical	0.568	0.583	0.974
Zhongheng Group	0.190	0.216	0.881
Pien Tze Huang	0.330	0.590	0.560
ZhiFei Biological	0.173	0.245	0.707
Joincare	0.275	0.295	0.935
Sanjin	0.267	0.359	0.746
Huahai Pharmaceutical	0.359	0.394	0.913
ChiCheng	0.326	0.761	0.429
Accord Pharmaceutical	1.000	1.000	1.000
Huapont	0.123	0.137	0.894
Meheco	1.000	1.000	1.000
Yi Pai	0.534	0.624	0.857
KHB	0.382	1.000	0.382
Kao Xin	0.319	0.362	0.880
MaYingLong	0.433	0.669	0.647
Jinling Pharmaceutical	0.387	0.416	0.930
Nhwa	0.735	1.000	0.735
Jinyu Group	0.178	0.299	0.596
Xianju Pharmaceutical	0.425	0.485	0.876
Ringpu	0.204	0.370	0.553
Hisoar Pharmaceutical	0.458	0.605	0.758
Qianjin Pharmaceutical	0.497	0.661	0.752
Taiji Group	0.407	0.414	0.982
Topfond	0.536	0.637	0.842
Northeast Pharmaceutical	0.335	0.340	0.987
Lummy	0.250	0.500	0.500
Xiangxue	0.187	0.297	0.628
Chengzhi	0.500	0.595	0.841
Layn	0.081	1.000	0.081
Average	0.396	0.542	0.765

Source: This Study

Overall Data Description

In terms of overall efficiency, the average efficiency was about 0.396, where Accord Pharmaceutical and Meheco appeared the best performance (1.000), while Layn the worst (0.081). Within the 34 businesses, merely 7 companies presented the overall efficiency higher than 0.500, 10 of them between 0.100 and 0.300, 14 of them between 0.300 and 0.500, and 7 of them higher than 0.500. Apparently, Accord Pharmaceutical and Meheco showed the best performance in 2011, while Layn the worst and the overall efficiency of pharmaceutical industry were not high.

Regarding pure technical efficiency, Shanghai Pharma, Accord Pharmaceutical, Meheco, KHB, Nhwa, and Layn revealed favorable performance (1.000), Huapond Pharamaceutical presents the worst performance (0.127). In regard to scale efficiency, the average efficiency appeared 0.765, where China Resources Sanjiu, Accord Pharmaceutical, and Meheco presented favorable performance (1.000), while Layn the worst (0.081).

Analysis of Enterprise

To sum up, Shenzhen Accord Pharmaceutical Co. Ltd. (Accord Pharmaceutical) 20, listed in top

20 pharmaceutical businesses in China and enterprises with the most growth in China, appears the best performance as it has integrated the company resources, optimized the management system, asset structure, and profit-making model, and established highly effective and orderly modern enterprise operation system with resource integration and capital operation[21] in recent years that the operation quality is obviously enhanced and the company management and performance are developed.

China Meheco Co., Ltd. (Meheco)[22], as top five medicine and health product importers in China, presents the best performance as it has distributed the business network in domestic pharmacy with key merger, stressed on building up the platform for science and technology industry, adjusted and innovated traditional import/export businesses, firmly stepped out in transition and promotion, rationalized the management structure, and promoted the management quality and efficiency[23].

On the other hand, Guilin Layn Natural Ingredients Corp. (Layn) reveals the worst performance as the dropping achievement and the negative growing assets present a hidden danger on finance[24]. The company focuses on the research and development of Chinese herbal extraction, which has been widely applied to medicine, dietary supplement, functional food, ordinary food, and cosmetics. The globally increasing requirement of herbal extraction continuously provides an enormous market development space, which offers a development opportunity for China's herbal extraction, but the market centralization is rather low as there are numerous companies in the industry that the market share is only 3% even though the export revenue is ranked in top ten. In this case, the major businesses of Layn are centralized, but cannot form a scale[25].

Sensitivity Analysis

The input variables were gradually deleted for DEA so as to understand the sensitivity to the efficiency. From Table 2, the overall performance of DMUs averagely changed -40.40% when gross assets were deleted. The higher sensitivity showed the greater effects of gross assets on the efficiency. When number of employees and administrative expenses were deleted, the overall performance of DMUs averagely changed -1.77% and -27.27%%, It shows the low sensitivity of number of employees to overall efficiency, while the effects of operating cost on overall efficiency appear in between total assets and number of employees.

Aiming at specific enterprises, Hepalink appeared the largest performance change (-30.94%) when number of employees was deleted. When deleting gross assets, Huahai Pharmaceutical showed the largest overall performance change (-74.65%); and, Zhongheng Group revealed the largest overall performance change (-21.05%) when deleting administrative expenses.

Slack Variable Analysis

In the process of relative efficiency analysis, the model showed that the slack movement of inputs (that is, input redundancy value) and the radial movement of outputs (that is, output insufficiency value) could help primarily understand the efficiency improvement directions for the listed companies.

According to the input redundancy and output insufficiency (Table 3), the overall performance could be combined for the following conclusions.

Several companies appeared input redundancy of labor cost, showing that the arrangement of personnel was not scientific. Too much labor cost invested in other alternative resources, such as gross assets, could result in idle assets. Reducing labor cost would benefit optimizing the structure so as to acquire the same outputs with fewer inputs.

To certain degree, pharmaceutical industry presents the characters of product and technology research and development. The most important intrinsic factor in the success of technological innovation is the accumulation of technology, for which the accumulation of individual knowledge and skills are the basis. The accumulation of individual knowledge and skills is the process of promoting individual learning of new knowledge, experiences, and skills.

It is clearly explained in the production management that an enterprise should systematically invest in human resource (education, training, and introduction of employees) in order to accumulate the technology. The investment in human resource presents apparent precedence in the business development that the precedent human resource investment would appear hu-

Table 2: Sensitivity analysis of single inputs being gradually deleted

Pharmaceutical business	*Original value*	*Delete number of employees*		*Deletegross assets expenses*		*Delete administrative*	
		Present value	*Change rate*	*Present value*	*Change rate*	*Present value*	*Change rate*
Shanghai Pharma	0.591	0.591	0.00%	0.403	-31.81%	0.584	-1.18%
Dong-e E-jiao	0.331	0.331	0.00%	0.187	-43.50%	0.331	0.00%
Hepalink	0.501	0.346	-30.94%	0.501	0.00%	0.501	0.00%
China Resources Sanjiu	0.368	0.368	0.00%	0.171	-53.53%	0.368	0.00%
Hualan Biologicals	0.195	0.178	-8.72%	0.135	-30.77%	0.195	0.00%
Guangzhou Pharmaceutical	0.568	0.568	0.00%	0.177	-68.84%	0.568	0.00%
Zhongheng Group	0.190	0.190	0.00%	0.148	-22.11%	0.150	-21.05%
Pien Tze Huang	0.330	0.330	0.00%	0.205	-37.88%	0.330	0.00%
ZhiFei Biological	0.173	0.166	-4.05%	0.135	-21.97%	0.173	0.00%
Joincare	0.275	0.275	0.00%	0.155	-43.64%	0.275	0.00%
Sanjin	0.267	0.267	0.00%	0.174	-34.83%	0.267	0.00%
Huahai Pharmaceutical	0.359	0.359	0.00%	0.091	-74.65%	0.359	0.00%
ChiCheng	0.326	0.326	0.00%	0.233	-28.53%	0.294	-9.82%
Accord Pharmaceutical	1.000	1.000	0.00%	0.678	-32.20%	1.000	0.00%
Huapont	0.123	0.112	-8.94%	0.115	-6.50%	0.123	0.00%
Meheco	1.000	1.000	0.00%	1.000	0.00%	1.000	0.00%
Yi Pai	0.534	0.534	0.00%	0.235	-55.99%	0.534	0.00%
KHB	0.382	0.382	0.00%	0.264	-30.89%	0.368	-3.66%
Kao Xin	0.319	0.319	0.00%	0.087	-72.73%	0.319	0.00%
MaYingLong	0.433	0.433	0.00%	0.271	-37.41%	0.433	0.00%
Jinling Pharmaceutical	0.387	0.387	0.00%	0.192	-50.39%	0.387	0.00%
Nhwa	0.735	0.735	0.00%	0.300	-59.18%	0.735	0.00%
Jinyu Group	0.178	0.169	-5.06%	0.122	-31.46%	0.178	0.00%
Xianju Pharmaceutical	0.425	0.425	0.00%	0.163	-61.65%	0.425	0.00%
Ringpu	0.204	0.204	0.00%	0.149	-26.96%	0.178	-12.75%
Hisoar Pharmaceutical	0.458	0.458	0.00%	0.138	-69.87%	0.458	0.00%
Qianjin Pharmaceutical	0.497	0.497	0.00%	0.217	-56.34%	0.497	0.00%
Taiji Group	0.407	0.407	0.00%	0.210	-48.40%	0.407	0.00%
Topfond	0.536	0.536	0.00%	0.406	-24.25%	0.440	-17.91%
Northeast Pharmaceutical	0.335	0.335	0.00%	0.091	-72.84%	0.335	0.00%
Lummy	0.250	0.250	0.00%	0.129	-48.40%	0.250	0.00%
Xiangxue	0.187	0.187	0.00%	0.136	-27.27%	0.162	-13.37%
Chengzhi	0.500	0.500	0.00%	0.358	-28.40%	0.481	-3.80%
Layn	0.081	0.073	-9.88%	0.059	-27.16%	0.081	0.00%
Average	0.396	0.389	-1.77%	0.236	-40.40%	0.288	-27.27%

Data Source: This Study

man resource redundancy. As a result, the accumulation of individual knowledge and skills and the technology of a business is the appreciation process of human resource redundancy[26].

Merely Chengzhi appeared operating revenue insufficiency with no input redundancy, showing that labor cost, gross assets, and administrative expenses received sufficient outputs. The factor in revenue shortage might be the slow capital return and unfavorable supply-chain efficiency. Worth mentioning, 10 enterprises appear redundant manpower investment and redundant management fee; besides, 33 out of 34 enterprises do not show redundant total assets, revealing the insufficient fixed input of domestic pharmaceutical enterprises, comparing to variable input. Increasing fixed input could improve the output efficiency.

From the above analyses, the accumulation and innovation of technology, the effective integration and allocation of resources, and controlling administrative expenses on the development of pharmaceutical industry present the critical functions.

Table 3: Improvable degree of China's pharmaceutical companies

DMU	*Input improvable value*			*Output improvable value*
	Number of employees	*Gross assets*	*Administrative expenses*	*Operating revenue*
Shanghai Pharma				
Dong-e E-jiao	-2830.879 (-49.9%)		–0.208 (-9%)	-52.822
Hepalink	-41.657 (-52.2%)	– 0.327 (-28.9%)	–15.613	
China Resources Sanjiu	-9195.876 (-69.4%)	–1.597 (-31.5%)	94.669	
Hualan Biologicals			-0.429 (-27.5%)	29.374
Guangzhou Pharmaceutical	-2413.154 (-44.1%)	-2.454 (-51%)	38.891	
Zhongheng Group	-784.921 (-32.6%)			41.840
Pien Tze Huang			-0.035 (-4.5%)	7.110
ZhiFei Biological			-0.011 (-1.4%)	19.399
Joincare	-5187.523	-0.828 (-17.1%)	114.793 (-50.9%)	
Sanjin				20.774
Huahai Pharmaceutical	-1337.518 (-37.3%)		-1.708 (-54.4%)	28.150
ChiCheng	-399.386 (-29.0%)			2.471
Accord Pharmaceutical				
Huapont			-0.154 (-14.8%)	40.163
Meheco				
Yi Pai	-2640.984 (-57.3%)		-0.152 (-11.9%)	11.471
KHB				
Kao Xin	-1033.112 (-33.4%)		-1.108 (-47.6%)	22.806
MaYingLong	-192.267 (-11.9%)		7.010	
Jinling Pharmaceutical	-1203.744 (-33.6%)		-0.253 (-13.8%)	31.712
Nhwa				
Jinyu Group	-0.185 (-19.5%)			13.483
Xianju Pharmaceutical	-217.149 (-9.6%)		-0.426 (-26.1%)	17.939
Ringpu	-587.009 (-34.7%)		10.033	
Hisoar Pharmaceutical			-0.590 (-33%)	8.477
Qianjin Pharmaceutical			-0.028 (-3.1%)	6.447
Taiji Group	-8383.881 (-66.1%)		-1.132 (-24.1%)	90.293
Topfond	-969.146 (-38.2%)			16.697
Northeast Pharmaceutical	-6155.310 (-64.3%)		-3.949 (-58.8%)	75.501
Lummy	-502.005 (-28.9%)			5.334
Xiangxue	-517.104 (-30.2%)			14.578
Chengzhi				20.341
Layn				

Data Source: This Study

CONCLUSION

Technical Efficiency of the Entire Industry is not High

The average overall pure technical efficiency of China's pharmaceutical industry is merely 0.542, average overall efficiency merely 0.396, but average scale efficiency appears 0.765. Overall, the asset investment is insufficient, while the labor power input is relatively surplus, in domestic pharmaceutical enterprises, resulting in low overall efficiency.

Enterprise Differences in the Industry is arge

The differences among enterprises are large, mainly because of the differences in scale, input degree, and R and D capability. The enterprises involved in this study could be divided into three groups.

First, resource-integrated enterprises broaden the scales and enhance the R and D capability by merger, resource integration, and capital operation that they present better Technical Efficiency and Scale Efficiency, such as Shanghai Pharma, Accord Pharmaceutical in top 20 phar-

maceutical businesses in China and enterprises with the most growth in China, and Meheco in top five medicine and health product importers in China. Such enterprises should remain the advantage of favorable resource integration, strive for more resources and development opportunities, and further reinforce the production operation and efficiency[27].

Second, smaller-scale high and new technology enterprises focus on certain bio-technology, but the market share and business scale is smaller that they could not maximize the integrated resources, such as Layn focusing on researching and developing Chinese herbal extraction as a genetic engineering industry. Presently, the capital for high-tech pharmaceutical industry mainly comes from loans and the equity capital of shareholders that the finance channel is rather narrow. As banks emphasize the security and mobility of capitals, the risk of investing in high-technology has pull them back. The financing capability of pharmaceutical enterprises is obviously weak that the capitals are seriously short. The shortage of development capitals has become the huge obstacle for pharmaceutical enterprises developing new medicine, updating equipment, and expanding the market[28].

Third, OEM enterprises are lack of autonomous R and D patents that produce the original pharmacy of large-scale multinational pharmaceutical enterprises, such as Huahai Pharmaceutical and Hisoar Pharmaceutical. A lot of OEM enterprises can hardly survive in the industry, as foreign invested pharmaceutical enterprises merely remain the gross profit of 10%-20% in the beginning of transfer, which is regarded low value-added. OEM enterprises of overseas large-scale pharmaceutical enterprises can no longer satisfy the development of mature pharmaceutical enterprises in China; even the leading Sanhai Group has also encountered great impact from competitors. Such enterprises would not make great profits, but could promote the capability. Nowadays, such enterprises could distribute domestic pharmaceutical network by key merger and integration, focus on constructing the platform for science and technology industry, adjust and innovate the traditional import/export businesses, and complete transition and promotion[29].

RECOMMENDATIONS

Accumulating Technological Strengths by Human Resource Investment

More than 50% companies in this study appeared Labor cost redundancy, mainly because of low human resource costs. Such companies are suggested to adjust the allocation of internal resources and reduce Labor cost or enhance other resource allocation. By remaining the effective investment in human capital for accumulating the skills to promote the innovation and R and D capability, the input/output ratio could be enhanced[30].

Aggregating Resources with Merger and Reconstruction

Domestic pharmaceutical industry has been boxed up by numerous enterprises, small scales, high costs, and low efficiency. After joining in World Trade Organization, the market competition becomes fierce that some enterprises would be merged and reconstructed. Other enterprises might be forced to leave the market that China's pharmaceutical market would be re-divided. Aiming at such situations, deepening enterprise reform, adjusting industrial structures, and assisting numerous large listed companies and groups in reunion, merger, and reconstruction to accumulate the super-conventional resource accumulation, asset appreciation, and capital expansion could form the powerful strength making China's pharmaceutical industry always win in the competitively global market[31].

Facilitating Transition and Promotion through Policies

Pharmaceutical industry presents strong policy correlations that the pharmaceutical policies are constantly improved for promoting the transition and promotion. Present pharmaceutical policies are definite, but the key is to practice[32].

The details of industrial policies should be further defined, such as the financial support for researching and developing new medicine and

GMP renovation. Major technology should "focus on enterprises" to facilitate the transformation of enterprises with technological research strength. For environmental problems, which show large difficulty in governance and relate to lots of inputs, the policies should support with funds. Present pricing system and bidding procurement should be scientifically complete[33]

EPILOGUE

A lot of listed companies major in pharmaceutical businesses, but more or less involve in sales and import/export. Such business development and industry focus shift could result in deviation in evaluating Business Performance. Meanwhile, public companies, private businesses, and public-private shared enterprises are included in this study that the efficiency could be affected by the different systems and policies. The 34 listed companies are directly proceeded DEA without considering the above differences that it is regarded as the limitation of this study.

In summary, with the continuous development of national economy, the requirement for new treatment and drugs would be continuously enlarged in China. The overall pharmaceutical industry is well-developed, but the weak competitiveness is considered as the major problem. Accurately knowing the effects of macro-environment and various pharmaceutical innovation policies on enterprises, combining the reality, correctly mastering the market trend and development directions, orientating the quasi-market, and adapting to the market change would be the keys for enterprise managers.

NOTES

1. China Value. http://www.chinavalue.net/
2. Global Analysis. http://zx.qqfx.com.cn/
3. MeNet. http://www.menet.com.cn/. Operation Analysis of Medicine Economy in the first half of 2012, 2012-07-18
4. China Economic Information Network. http:// www.cei.gov.cn/ 5C hina Industrial Research Net. 2012—2016
5. Pharmaceutical Industry Investment Strategies and In-depth Research Reports in China, March, 2012
6. Mao, Ching. Principles of Data Envelopment Analysis [J], Principles , 2011.01
7. Reynolds Dennis, Hospitality-productivity assessment using data envelopment analysis, Cornell Hotel and Restaurant Administration Quarterly ₄44. 2 (Apr 2003): 130-137.
8. Barros, Carlos. P, Productivity in the Tourism Industry, International Advances in Economic Research 10. 3 (Aug 2004): 215-225.
9. Yu, Li-ping, Business characters and innovation efficiency—A study based on national large- and middle-scale businesses [J]. The Journal of Quantitative and Technical Economics, 2007, (5).
10. Li, Shuang-Jei, Wang, Hai-yen and Liu, Ren. Innovative new resource allocation efficiency analysis of manufacturing industry based on DEA model [J]. Journal of Industrial Technological Economics, 2006,(3).
11. Li, Yen -ling, Pan, Jei-yi and Chen, Yue-xi. Evaluation of DEA-based business technology and innovation efficiency [J]. Hebei Journal of Industrial Science and Technology, 2005, (2).
12. Qian, Yen-yun. DEA evaluation of business technology and innovation efficiency and effectiveness [J]. Technology and Management, 2004, (1).
13. Banker R D A (Charnes W. W Cooper) Some Modelsfor Estimating Technical and Scale Inefficiencies in DataEnvelopment Analysis ; (J =).Management Science (1984 ((30)) 1078-1092.
14. Golany,Band and Roll Y. (19 89). An Application Procedure for DEA, Omega, VOL, 17(3), pp. 237-250.
15. China Securities Regulatory Commission, Listed Company Industry Classification Standard (revised in 2012), 2012
16. China Securities Regulatory Commission, Listed Company Industry Class ification Standard (revised in 2012), 2012
17. China Securities Regulatory Commission, Listed Company Industry Classification Standard (revised in 2012), 2012
18. Golany, Band and Roll Y. (1989). An Application Procedure for DEA, Omega, VOL, 17(3), pp. 237-250.
19. Farrell, M. J.(1957). The Measurement of Productive Efficiency. Journal of the Royal Statistical Society- Series A (General), Part3, 253-290.
20. Business cases in China. http:// www. keweisoft.com/, Accord Pharma-cetical—resources integration and centraliz ed management, 2011-07-24
21. Shenzhen Accord Pharmacetical Co., Ltd. (Accord Pharmacetical, Code: 000028) 2011 Annual report
22. Sohu Rinance. http://roll.sohu.com/, China Meheco Co., Ltd., 2011-09-09
23. China Meheco Co., Ltd. (Meheco, Code: 600056), 2011 Annu al report
24. Guilin Layn Natural Ingredients Corp. (Layn, Code: 002166), 2011 Annual report
25. Chinese Industry Analysis, 2011 China Bio-Medical Analysis, 2011-11-03
26. Fu, Chia-chi. Develop Enterprises with Technological Innovation [J]. Management Review, 1989, (1).
27. Li, Dong-hua and Bian, Ying. On the Merger and Acquisition in Medicine Industry [J]. Reformation and Strategy, 2008, (9).
28. Yang, Liu, Dai, Yu-liang and Ma, Kuai-min Innovation and Development of National Phar-

maceutical Industry [J]. International Business, 2003, (3).
29. Liu, Shu-jung. Pain in Transition—Opportunity and challenge of national pharmacy according to the operation and sales of Anter Pharmacy [J]. Guide of China Medicine, 2009, (19).
30. Liu, Yen-li. Brief introduction of human resource planning and management in national medical industry [J]. International Medicine and Health Guidance News, 2005, (19)
31. Tsao, Li-chun and Shao, Jung. Governmental behaviors in the merger and reconstruction of pharmaceutical businesses [J]. Journal of China Pharmaceutical, 2005, (6).
32. Lu, Xin. Analysis of new medical reformation for the future—China medical health policy and development annual conference in Beijing [J]. China Food Drug Administration, 2012, (1).
33. China Chemical Market Weekly, http:// www.qrx.cn/, Transition and promotion: No choice for pharmaceutical industry, 2012-05-30

REFERENCES

Barros Carlos P 2004. Productivity in the tourism industry. *International Advances in Economic Research,* 10(3): 215-225.

Farrell MJ 1957. The measurement of productive efficiency. *Journal of the Royal Statistical Society-Series A,*3: 253-290.

Golany Band, Roll Y 1989. An application procedure for DEA. *Omega,* 17(3): 237-250.

Leibenstein H 1966. Allocative efficiency vs. 'X-efficiency'. *American Economic Review,* 56: 392-415.

Li Shuang-Jei, Wang, Hai-yen, Liu Ren 2006. Innovative new resource allocation efficiency analysis of manufacturing industry based on DEA model [J]. *Journal of Industrial Technological Economics,* 3: 33-54.

Li Yen-ling, Pan Jei-yi, Chen Yue-xi 2005. Evaluation of DEA-based business technology and innovation efficiency. *Hebei Journal of Industrial Science and Technology,* 2: 117-134.

Qian Yen-yun 2004. DEA evaluation of business technology and innovation efficiency and effectiveness .*Technology and Management,* 1: 224-239.

Reynolds Dennis 2003. Hospitality-productivity assessment using data envelopment analysis. *Cornell Hotel and Restaurant Administration Quarterly,* 44: 130-137.

Yu Li-ping 2007. Business characters and innovation efficiency- A study based on national large- and middle-scale businesses. *The Journal of Quantitative and Technical Economics,* 5: 34-48.