Data Development Analysis of the Relative Efficiency of Industry in Xinjiang of China

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Abstract By using the data from 2003 to 2008 of Xinjiang industrial departments, this article measures the efficiency of 36 industrial departments in Xinjiang, and we also make projection analysis on these departments based on the ultra efficiency data envelopment analysis (DEA) model. According to the analysis, firstly the efficiency of Xinjiang industry is low, particularly the technical efficiency. Secondly in Xinjiang of China, the industrial departments of high efficiency are mainly based on the resources profession. Thirdly, the industry of Xinjiang has been relatively surplus in the resources investment, so we should adjust the industrial structure of Xinjiang.
Key words DEA; Industry; Relative efficiency

1 Introduction

Xinjiang is vast and resourceful, but the industry develops behind the level of national development because of the historical and practical reasons [3]. In May 15-17 2010, the central government made major decisions and plans to promote rapid development and long-term stability on the forum about Xinjiang, at the same time, the central government made a series of preferential policies to support the constructions and development of Xinjiang.

There are some main methods to study the efficiency of the industrial economy, for example SFA method, Malmquist model, Data Envelopment Analysis (DEA), X -efficiency method etc[1][4]. In China, there are some specific cases[8] [11]. Such as Sunwei and Ye Zhengbo quantitative research the degree change of the Chinese industrial economy growth in the transition period using non-parametric productivity index method[7]; Sun Wei and Wang Xiuqing analyze and evaluate the efficiency of Chinese sugar industry using DEA method[6]; Fang Xianming analyze Chinese provincial economic efficiency and its influence factors using X-efficiency method[2].

Most research about the Xinjiang industrial economy is based on the industry competitive power. Such as Ni Tianqi analyze industry competitive power in Xinjiang and positioning through the establishment of index system [5], Wang Guirong and Huang Xuebing founder the creation of industrial competitiveness evaluation system, made a preliminary quantitative analysis and research about the 36 major industry's competitive power from the comparative advantage industry, industry development potential and industry relations and other aspects in Xinjiang [9]. However, measuring the industrial economy efficiency of Xinjiang is a blank .Based on this, this article through multi-input multi-output model of data envelopment analysis (DEA) to analysis the 36 sectors of industrial economic efficiency evaluation ,in order to provide reasonable advice to the development of Xinjiang's industrial economy .

2 Model

The data envelopment analysis (DEA) is a method of the relative efficiency to measure many inputs and outputs decision making unit (DMU), and which is proposed by two American scholars, A.Chames and W.W.Cooper[10].

We can compare multiple effective decision-making units at the same time by super efficiency model[13]. And the model is as follows:

$$\min\left[\theta-\varepsilon(e_1^T s^- + e^T s^+)\right]$$

$$s.t.\begin{cases}\sum_{j=1\ j\neq k}^{n} x_j\lambda_j + s^- = \theta x_k \\ \sum_{j=1\ j\neq k}^{n} x_j\lambda_j - s^+ = y_k \\ \lambda_f \geq 0, j=1,2,\cdots,n \\ e_1^T = (1,1,\cdots,1)^T \in E_m \\ e^T = (1,1,\cdots,1)^T \in E_s\end{cases}$$

Si^- and Sj^+ express the input and output slack variables respectively, ε is Archimedes infinitesimal.

Table 1 Results of 36 Industry Departments of Xinjiang Based on DEA Model (2003-2008)

Industry departments	2003	2004	2005	2006	2007	2008	Mean
Coal Mining and Washing	0.645	0.680	0.604	0.593	0.568	0.568	0.610
Extraction of Petroleum and Natural Gas	5.174	4.121	5.542	2.526	3.092	3.092	3.924
Processing of Ferrous Metals Ores	0.771	0.918	0.936	0.701	0.922	0.922	0.862
Processing of Nonferrous Metals Ores	0.750	1.252	1.217	1.928	0.956	0.956	1.176
Processing of Nonmetal Ores	0.872	1.170	0.955	0.669	0.724	0.724	0.852
Processing of from Agricultural Food	0.822	0.941	0.914	0.792	0.846	0.846	0.860
Manufacture of Food	0.748	0.835	0.598	0.551	0.577	0.577	0.648
Manufacture of Beverage	0.700	0.828	0.729	0.585	0.649	0.649	0.690
Manufacture of Tobacco	1.411	1.721	1.567	1.781	1.981	1.981	1.740
Manufacture of Textile	0.551	0.656	0.610	0.580	0.542	0.542	0.580
Clothes, Shoes and Caps	0.694	0.941	0.856	0.801	0.964	0.964	0.870
Leather, Fur, Feather	0.852	0.874	0.907	0.583	0.719	0.719	0.775
Processing of Timber, Wood, Bamboo, Cane, Grass Products	0.682	0.896	0.742	0.696	0.754	0.754	0.754
Manufacture of Furniture	0.880	0.929	0.816	0.638	0.559	0.559	0.730
Manufacture of Paper and Paper Products	0.587	0.602	0.593	0.532	0.495	0.495	0.551
Printing and Copying of Medium Record	0.762	0.780	0.732	0.626	0.510	0.510	0.653
Processing of Oil, Coking and Nuclear Fuel	1.629	2.146	2.053	2.063	1.494	1.494	1.813
Raw Chemical Material and Products	0.759	0.775	0.773	0.676	0.563	0.563	0.685
Manufacture of Medicine	0.776	0.730	0.687	0.587	0.657	0.657	0.682
Manufacture of Chemical Fiber	0.576	0.951	0.891	0.965	0.763	0.763	0.818
Manufacture of Rubber Products	0.732	0.880	0.923	0.875	0.793	0.793	0.833
Manufacture of Plastic Products	0.565	0.655	0.684	0.512	0.777	0.777	0.662
Manufacture of Nonmetal Minerals	0.606	0.592	0.525	0.493	0.566	0.566	0.558
Smelting and Pressing of Ferrous Metals	1.163	1.595	1.173	0.931	0.909	0.909	1.113
Smelting and Pressing Nonferrous Metals	0.849	0.825	0.892	1.031	0.921	0.921	0.906
Manufacture of Metal Products	0.830	1.002	0.898	0.844	1.036	1.036	0.941
Manufacture of General Machinery	0.617	0.727	0.710	0.652	0.806	0.806	0.719
Manufacture of Special Machinery	0.523	0.545	0.688	0.645	0.764	0.764	0.655
Manufacture of Transport Equipment	0.675	1.138	0.835	0.755	1.229	1.229	0.977
Manufacture of Electric Equipment and Machinery	0.856	0.975	1.018	1.207	2.732	2.732	1.587
Telecom Equipment, Computer and Other Electronic Equipment	1.429	0.786	0.651	0.570	0.578	0.578	0.765
Measuring Instruments and Machinery for Cultural Activity and Office Work	1.433	0.896	1.964	1.268	1.633	1.633	1.471
Art work and Other Manufacture	0.761	0.000	0.923	0.831	0.417	0.417	0.558
Electricity and Thermal	0.521	0.580	0.567	0.496	0.457	0.457	0.513
Gas Production and Supply	0.574	0.669	0.560	0.586	0.630	0.630	0.608
Water Production and Supply	0.619	0.542	0.493	0.535	0.445	0.445	0.513
Mean of super DEA model	0.928	0.976	1.006	0.864	0.917	0.917	0.935
Mean of DEA model	0.754	0.806	0.797	0.731	0.745	0.745	0.763

3 Analysis

3.1 The selection of DMU

DEA is used to evaluate the relative effectiveness of the same type departments, in this study, the decision-making units contains 36 industry, such as Xinjiang mining and washing of coal, extraction of petroleum and natural gas, processing of ferrous metals ores, processing of nonferrous metals ores etc.

3.2 Index selection and data sources

In this paper, according to the data's principles：Pertinence, comparability and operability, we select four representative input indexes among many indexes: employment (million), fixed assets (million), liquid assets (million), main business cost (million) and two output indexes: gross output value (million), main business income (million). All the data is from *Xinjiang Statistical yearbook* (2004-2009) [12].

3.3 Analysis of the DEA model

Based on the above indexes, we used the EMS2.0 software to measure the relative efficiency value of 36 industry departments from 2003 to 2008 in Xinjiang, and the results obtained in table 1.

4 Results

4.1 Trend analysis

We can obtain chart 1 by using the traditional DEA mean value from 2003 to 2008 in Table 1, using the traditional DEA but not the super efficient DEA can avoid misleading the results.

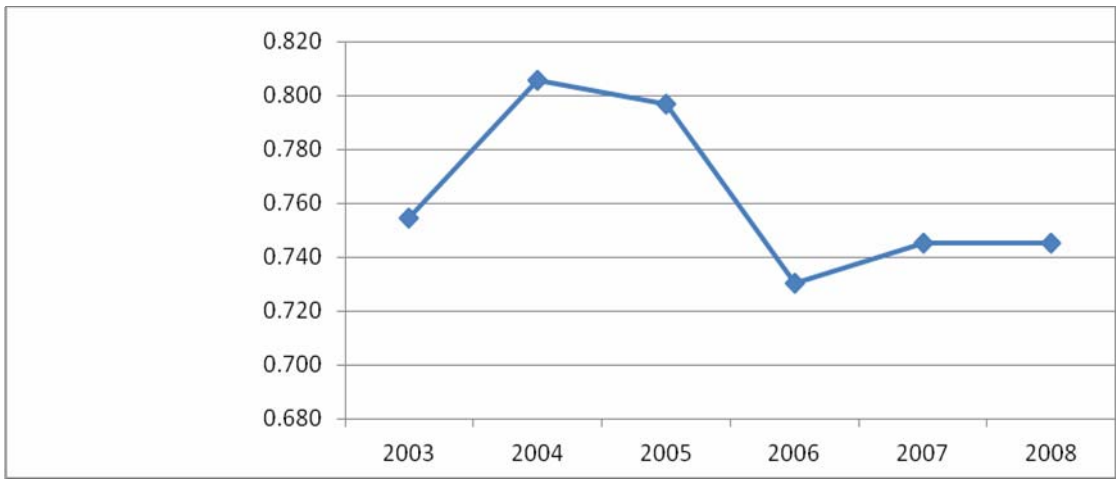

Figure 1 The Efficiency Strandline of Industry in Xinjiang (2003-2008)

From figure 1, we can see that the industrial economic efficiency mean value in Xinjiang is 0.768 from 2003 to 2008, at a lower lever, and there is still plenty of room for promotion. Efficiency change significantly each year, which are affected by various factors. Relative efficiency in 2004 is highest than other years, is lowest in 2006, and from 2006 to 2008 the index are all lower.

4.2 Distribution analysis

From various industries，industries relative efficiency differ widely among them, DEA value of petroleum and natural gas extraction is 3.924, maintain the highest level, and the lowest average relative efficiency are industries of electric power, heating power and water production and supply , the index is only 0.513. Among 36 industries, seven industries are DEA effective.

4.3 Industries analysis

From the related industrial chain of various industries, we can see oil extraction and oil processing industry remain higher efficiency, but the efficiency of downstream industries such as rubber products industry, chemical fiber industry, chemical raw materials and chemical products manufacturing and plastic industry is not high, it shows that the industrial chain of downstream industries are underdeveloped, the upstream resource advantages have not been fully transformed into the downstream product advantage. But we see the industry of black and non-ferrous metal remain high efficiency, and average efficiency in the lower-middle reaches of black, non-ferrous metal smelting industry, metal manufacturing, electrical machinery and equipment manufacturing industry is high, and a large group of big enterprises in Xinjiang works with great effort on this situation, such as Bayi Iron&Steel Co., Zhonghe Group, Tebian Electric Apparatus Stock Co Ltd, etc. From upstream to downstream, the

efficiency of coal mining and washing industry and related electricity production supply industry is low. It shows that comprehensive development and utilization of coal resources is not high, with hysteretic of coal resource exploration, exploitation, mine shaft type, unreasonable layout and lower value-added products and the content of science and technology being the primary means. The average efficiency of agricultural product processing industry, food industry, beverage industry in Xinjiang is only 0.7326, which accord with underdeveloped food production processing industry in Xinjiang, products in the market depend on the outside market heavily, especially most brand products from outside Xinjiang provinces. Moreover the average efficiency of textile industry, garment processing industry and further producing industry are only 0.742, which is not in harmony with the status of the main areas of cotton production and animal husbandry in the whole nation, from this angle it also shows downstream industries in Xinjiang are not developed as food, Xinjiang lack the famous textile and garment industry brands. From the perspective of the equipment manufacturing industry in Xinjiang, transportation equipment manufacturing is 0.977, general equipment manufacturing efficiency is 0.719, special equipment manufacturing efficiency is 0.655, average efficiency is 0.783, not high, especially the special equipment efficiency is very low, the mining, oil, chemical production, special equipment in construction are almost from other provinces in our nation, and with the serious shortage of independent production and innovation ability.

4.4 Non-DEA effectiveness unit analysis

The non-DEA effectiveness says the industry is non-scale or non-technical effectiveness, in order to understand the relative efficiency of non-DEA effective among 29 industries, we adopt the model to product projection analysis on 29 industries, which is used to evaluate technical effectiveness, we obtain input redundancy and output insufficient of 29 industries in 2008, and analysis results list in table 2.

By analyzing table 2, we can see technical efficiency of metal production industries is 1.0, which shows that suchlike industries are technical effectiveness, that is to say, the corresponding investment can not been reduced any more. However, other businesses are non-technical effectiveness and no-scale effectiveness.

From objective improvement value of the DEA effective decision-making units, according to the DEA “projection” theorem, we can confirm adjustive distance and direction that the non-DEA effective decision units arrive to effective decision units and transform to productive frontier. From the table 3, we can see: at the existing investment level, most industries appear in excess of investment, there are bigger redundancies in investment, especially in employment, and redundancy rate is 63%, which shows that all industries should be concise. In terms of assets investment, all sorts of assets redundancy rate are relatively high, which show that assets are not sufficiently used, and all industries should improve the efficiency in the use of assets. In terms of output, all sorts of output are relatively high, redundancy rate is low. From technical efficiency and scale efficiency, technical efficiency of non-DEA unit is less than the average size of scale efficiency, which shows that technology level in Xinjiang is low; enhancing the efficiency depends on increasing scale economy, while we also can see that the industrial economic development mode in Xinjiang is still extensive development, rather than intensive development.

From the scale analysis of non-DEA effective decision-making units, we know in economic activities, large-scale production is commonly used to reflect the output scale returns to the input scale on relative non-dimmed. When a process is in the state of increasing return to scale, it shows that on the basis of original investment, we can produce high output revenue than inputs when increase inputs appropriately. And when the production process is in the state of decreasing return to scale, which shows that we can only obtain relatively smaller output benefit relative to incremental investment scale, in this case, resource inputs must be steady or shrinking. In figure 3, we see there are 15 industries remain in increasing return to scale, such as nonmetal minerals mining and dressing, textile, clothing, shoes and hats manufacturing, etc, in the premise of improving efficiency of resource use, we should continue to increase investment. And 14 industries such as coal mining and washing, ferrous metals mining and dressing are in the state of decreasing return to scale, we should control the scale and reducing investment in order to improve the efficiency of the industry.

5 Conclusions

The efficiency of Xinjiang industry economy is low, particularly the technical efficiency. Xinjiang's industry economy still used extension pattern, leads economic growth through the investment of resources. Later we should adjust the economic growth way, from extension to intensive type. Each department should improve the efficiency of industry economy, by raising the technical level,

strengthening the independent innovation ability in their own profession.

Table 2 Projection of 36 Industry Departments of Inefficiency

Industry departments	Srste	Vrste	Scale	Returns to scale	Projection of DMUs of inefficiency					
					X1	X2	X3	X4	Y1	Y2
Coal Mining and Washing	0.57	0.60	0.94	drs	0.52	0.40	0.37	0.84	0.07	-
Extraction of Petroleum and Natural Gas	0.92	0.93	0.92	drs	0.37	0.07	0.07	0.37	-	0.04
Processing of Ferrous Metals Ores	0.96	0.94	0.95	drs	0.46	0.07	0.06	0.71	0.08	-
Processing of Nonferrous Metals Ores	0.72	0.75	0.96	irs	0.25	0.25	0.25	0.79	0.08	
Processing of Nonmetal Ores	0.85	0.89	0.95	drs	0.11	0.11	0.11	0.57	-	0.01
Processing of Agricultural Food	0.58	0.66	0.88	drs	0.46	0.34	0.34	0.65	0.07	-
Manufacture of Food	0.65	0.72	0.90	drs	0.59	0.28	0.28	0.76	0.15	-
Manufacture of Beverage	0.54	0.57	0.95	drs	0.43	0.43	0.43	0.84	-	-
Manufacture of Tobacco	0.96	1.00	0.96	irs	-	-	-	-	-	-
Manufacture of Textile	0.72	1.00	0.72	irs	-	-	-	-	-	-
Clothes, shoes and Caps	0.75	0.81	0.94	irs	0.20	0.20	0.20	0.20	0.13	-
Leather, Fur, Feather	0.56	0.57	0.99	drs	0.50	0.43	0.43	0.78	-	0.02
Processing of Timber, Wood, Bamboo, Cane, Grass Products	0.50	0.50	1.00	irs	0.50	0.50	0.50	0.86	-	0.05
Manufacture of Furniture	0.51	0.61	0.83	irs	0.39	0.39	0.39	0.30	-	-
Manufacture of Paper and Paper Products	0.56	0.62	0.91	drs	0.38	0.38	0.38	0.59	0.05	-
Printing and Copying of Medium for Record	0.66	0.71	0.93	irs	0.29	0.53	0.29	0.72	0.13	-
Processing of Oil, Coking and Nuclear Fuel	0.76	0.78	0.98	drs	0.22	0.22	0.22	0.79	0.11	-
Raw Chemical Material and Products	0.79	1.00	0.79	irs	-	-	-	-	-	-
Manufacture of Medicine	0.78	0.79	0.98	drs	0.21	0.21	0.21	0.82	0.01	-
Manufacture of Chemical Fiber	0.57	0.64	0.88	drs	0.44	0.36	0.36	0.74	0.11	-
Manufacture of Rubber Products	0.91	0.93	0.97	drs	0.07	0.07	0.07	0.20	0.01	-
Manufacture of Plastic Products	0.92	0.92	1.00	irs	0.08	0.08	0.08	0.70	0.10	-
Manufacture of Nonmetal Mineral Products	0.81	0.81	0.99	irs	0.19	0.19	0.19	0.63	-	0.03
Smelting and Pressing of Ferrous Metals	0.76	0.77	1.00	drs	0.25l	0.23	0.23	0.79	-	0.05
Smelting and Pressing of Nonferrous Metals	0.58	0.59	0.98	irs	0.63	0.51	0.41	0.80	0.11	-
Manufacture of Metal Products	0.42	0.86	0.48	irs	0.14	0.80	0.01	0.16	0.24	0.05
Manufacture of General Machinery	0.46	0.48	0.96	drs	0.63	0.08	0.52	0.59	0.06	-
Manufacture of Special Machinery	0.63	0.64	0.98	irs	0.38	0.73	0.36	0.68	-	0.02
Manufacture of Transport Equipment	0.45	0.53	0.83	irs	0.47	0.94	0.47	0.62	-	-
mean	0.71	0.76	0.92	-	0.36	0.34	0.28	0.63	0.09	0.03

Note: X1=Working capital X2=Fixed Assets X3=Cost from Principal Business
X4=Total Employed Persons Y1=Cost from Principal Business
Y2=Gross industrial Output Value

In Xinjiang of China, the industry economy department of high efficiency is mainly based on the resources profession, which is in primary industry chain, while the downstream industry chain efficiency is low. Therefore the Xinjiang industry economy achieves the prosperous common people, and the

long-term peace and good government, must develop the downstream industry. Consolidating basic industry, Xinjiang should develop the downstream industry vigorously, to realize the full scale development of industry economy.

The Xinjiang industry economy has been relatively surplus in the resources investment, has the increasing income scale industry and the progressive decrease one. Therefore we should adjust the structure of industry economy, to raise use efficiency of the resources by many kinds of methods. Meanwhile we should take the different measures regarding the different industry, it means, we should increases the investment on the scale income increasing industry, otherwise, control resources investment on the scale income decreasing industry.

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