INDUSTRY PERFORMANCE EVALUATION OF LISTED MILITARY ENTERPRISES BASED ON MINDS MODEL

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Abstract: *This paper takes 25 listed military enterprises as the research sample. According to the sample enterprise 2011-2015 years of financial data, the comprehensive technical efficiency, pure technical efficiency and scale effect are calculated by using the MinDS model, determine the size of the sample enterprise revenue stage, and in combination with the original data on the level of its real performance evaluation of the industry. The results show that: the overall performance level of the sample enterprise is not high. There are some differences between the performance level of different industries. It is suggested that the sample enterprises through reform and optimize the industrial structure, to achieve innovation driven development.*

Keywords: *MinDS model; military enterprises; performance evaluation*

1. THE ISSUE RAISED

Military enterprises as an important carrier of civil military integration depth development, shoulder the dual mission of improving national defense science and technology strength and promote the development of the national economy, that is the front position of state-owned enterprise reform. In the past, due to its special properties, military enterprises had to face some problems, such as the lack of effective competition in the industry, the administrative power to intervene, and other issues, that affected the power of enterprise reform to a certain extent. With the introduction of "*Guiding Opinions on Promoting The Shareholding System Reform of Military Enterprises*", "*Interim Measures for the Implementation of the Shareholding System Transformation of Military Enterprises*", "*Interim Provisions on the Administration of the Intermediary Institutions Involved in the Reform and Listing of Military Enterprises and Institutions*" and a series of policies, military enterprises began to take the initiative to adapt to the laws of market economic development, and promote enterprise reform and listing and financing, basically established a modern enterprise system. As of 2016, Chinese military asset securitization rate has exceeded 40%, military enterprises gradually become a real market players. Now, facing the new normal development of the national economy, national defense science and industry of listed enterprises are in the development trend? Real performance level of each industry is to achieve the desired standard? This has become a very concerned problem for decision makers.

For the performance evaluation of China's listed military enterprises, many scholars have done related research. Wu Qing (2007) used super efficiency DEA model to analyze the operational efficiency of listed military enterprises from the angle of input and output efficiency. The conclusion was that the operating conditions of listed military enterprises were mainly determined by the enterprise's own technological advantages, as well as the degree of conversion of technological advantages. Zhang Yong et al. (2014) used the DEA model to analyze the problems and causes of human, financial, scientific, technological, information and other resources in the western region, and gave the countermeasures and suggestions to improve the efficiency of civil military integration in the western region. Zhou Bin (2015) based on VRS conditions, used non - angle SE-SBM model to evaluate the economic efficiency of military and civilian integration industry demonstration base. He proposed that we should pay attention to the relationship between the leading industries and the non-leading industries, taking into account the continuous development of traditional industries and strategic emerging industries. Wang Haitao and Gu Chunwei (2016) studied the production efficiency and the influencing factors of China's military listed enterprises from 2005 to 2014 by using the DEA-Tobit two stage analysis method. The result of the study was that the value of pure technical efficiency was not high, the production efficiency difference between enterprises was more and more big, and the scale wasn't economic and so on. Zhang Ming and Zhang Yaya (2016) used DEA-Malmquist index to measure the efficiency of listed military enterprises restructuring. The results showed that before and after the reform of listed military enterprises, the upgrade in the allocation of resources, resource efficiency and other aspects was not obvious. They suggested that the military enterprises should continue to improve the efficiency through scientific and technological innovation and management and other measures in the process of restructuring.

On the basis of previous studies, this paper takes the 25 national defense science and industry listed enterprises as the research sample, and extracts the financial data of the sample enterprise 2011-2015. MinDS model is used to evaluate the performance level of the sample enterprises in order to provide some reference value for the reform of military enterprises.

2. THE INTRODUCTION OF DATA ENVELOPMENT ANALYSIS AND MINDS MODEL

2.1 **The introduction of Data Envelopment Analysis**

Data Envelopment Analysis (DEA) is a non-parametric technique efficiency analysis method which is used to compare the Decision Making Unit (DMU). It was first proposed in 1978 by Charnes, Cooper, and Rhodes in the United States, so the first model of DEA was named CCR model (Charnes A, et al., 1978). Technical efficiency refers to the extent to which the production process of a production unit reaches the technical level of the industry that reflect the level of the technical level of a production unit. Based on the assumption of constant returns to scale (CRS), the technical efficiency derived from the CCR model includes the component of scale efficiency (SE), which is often called comprehensive technical efficiency (TE). In 1984, Banker, Charnes and Cooper proposed a DEA model called BCC model based on Variable Returns to Scale (VRS).

The technical efficiency derived from the BCC model excludes the impact of the scale economy, so it is called pure technical efficiency (PTE). The BCC model also provides a method for calculating the SE. By comparing the TE and the PTE, the SE can be separated, i.e. SE=TE/PTE.

According to the measurement of technical efficiency, DEA model can also be divided into input-oriented, output-oriented and non-oriented. The input-oriented model is to measure the invalid rate of DMU from the input point of view. It focuses on the extent of the input should be reduced under the circumstance of not reducing the output, to achieve the technique effectiveness. On the contrary, the output-oriented model focuses on the extent of the output should be increased under the circumstance of not increase the input, to achieve the technique effectiveness from the output point of view. The non-oriented model is both concerned about input and output.

2.2 The introduction of MinDS model

Due to the measure of the invalid rate from the CCR and the BCC model contain only the proportional reduction (increase) ratio of all input (output), this type of the DEA model is called the radial DEA model. For the inefficient evaluated DMU, the gap between the current state and the ideal state, not only contain the proportional improvement part, but also includes the slacked improvement part. Since this improvement part is not reflected in the efficiency measurement of the radial model, Tone Kaoru(2001) proposed the non-radial Slack Based Measure model (SBM). But the model also has obvious shortcomings. From the point of view of distance function, the projection point of the evaluated DMU is the farthest point from the evaluated DMU on the production frontier. Thus the input or output inefficiency is maximize, rather than minimize the path to the production frontier. To overcome it, Aparicio(2007) and Tone K.(2010) et al made some improvements. They employed the nearest point on the strong efficient frontier as the projection point, and proposed the Minimum Distance to Strong Efficiency Frontier model (MinDS).

The MinDS-CCR model (1) consists of three parts. The first part is the objective functions and the constraint a. The second part is the constraint b. The third part is the constraint. The common purpose of the constraint b and the constraint c is to make the reference benchmark located in a same hyper plane, where M is a positive number large enough. The MinDS model use to represent the technical efficiency of the evaluated DMU. It measured the invalid rate from the point of view of input and output at the same time, respectively as and . Therefore, it is called the non-oriented model. If , the evaluated DMU is high effective that hasn't the weak effective problem of the radial model, so the input-output efficiency reaches the optimal level. On the basis of the MinDS-CRS model (1), the MinDS-VRS model can be got by adding the constraint and the free variable . It should be pointed out that TE/PTE is the Scale Efficiency Score (SE) when using radial distance model, and TE/PTE is the Scale Effect Score (SE) when using non-radial distance model.

3. SAMPLE, INDEX AND DATA DESCRIPTION

3.1 Sample selection

This paper selects 25 listed national defense science and technology enterprises from Chinese Listed Enterprises Association defense industry sector as the DMU. And we obtain the financial data of the 25 enterprises in 2011-2015 from CSMAR. They are: 4 from electronics industry, 4 from aerospace, 6 from heavy industry, 4 from information technology, 3 from remote navigation and 4 from new materials, see Figure 1.

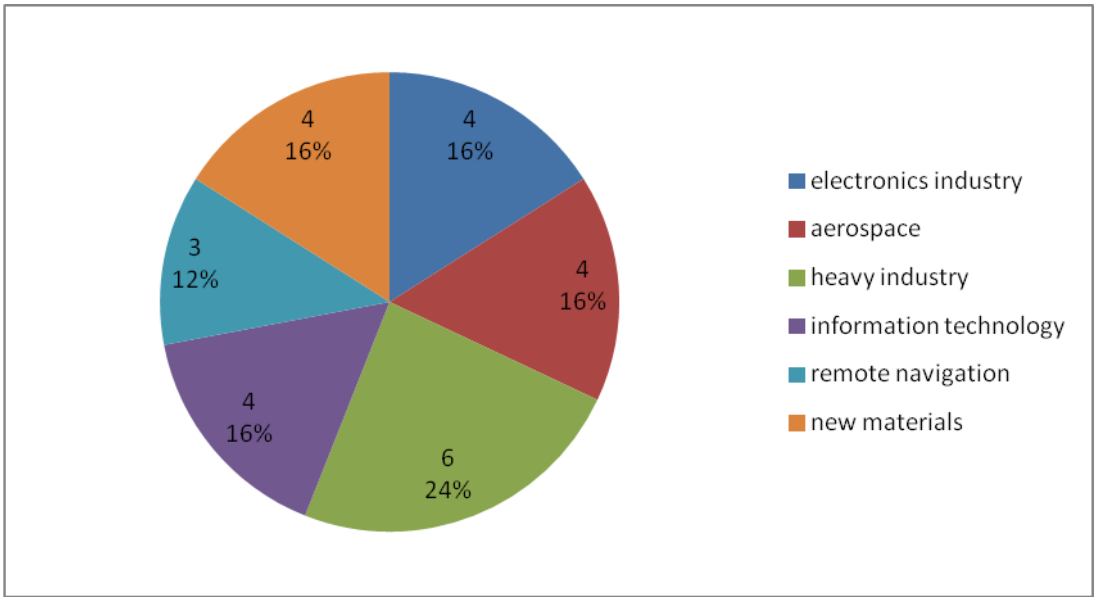

FIG.1 Type and quantity of listed national defense science and technology enterprises

2.2 Evaluation index selection

The input index of this paper is research investment, number of employees, operating costs, other inputs and cash paid for the purchase of fixed assets, intangible assets and other long-term assets. The output index of this paper is gross operating income and total profit. The research investment reflects the enterprises investment in scientific research projects, the number of employees reflects the enterprise investment in human resources, cash paid for the purchase of fixed assets, intangible assets and other long-term assets reflects the enterprise's capital investment, operating costs include the cost of selling goods or services as well as the purchase of raw materials, auxiliary materials fuel and other expenses, other inputs includes financial expenses, selling expenses and administrative expenses. The gross operating income reflects the growth of the enterprises, the total profit reflects the current production and operation efficiency of enterprises, see Table 1.

Table 1 Input index and output index

Input index	research investment (RI)
	number of employees (NE)
	cash paid for the purchase of fixed assets, intangible assets and other long-term assets (CPPFIO)
	operating costs (OC)
	other inputs (OI)
Output index	gross operating income (GOI)
	total profit (TP)

3.3 Data description

As can be seen in the input index from Table 2, the average RI, NE, OC and OI of the sample enterprises were increased year by year. In particular, the average RI was the largest, with an average increase of 36.41%, while the average CPPFIO was decreased with an average decline of 10.47%.

In the output index, the average GOI of the sample enterprises was raising steadily, with an average increase of 2.25%. The average TP was significantly decreased with an average decline of 32.06%.

In detail, except for a slight change in individual indicators in individual years, the situation of electronics industry and remote navigation were relatively steady, with an increase of almost the input and output index year by year. In addition to CPPFIO in the annual reduction, the other indexes of information technology were increased. The operation of the aerospace showed a little volatility that NE, OC, CPPFIO and GOI have a decline in 2015, though the others kept increasing. The volatility of new material was the most obvious. Except for NE and OI, the others all had a different degree of decreased in 2015 after a period of growth, such as CPPFIO had a largest decline of 52.46% in the input index, TP had a largest decline of 203.59% in the output index. The situation of heavy industry was relatively unsatisfactory. Its GOI and TP respectively had an average decline of 4.78% and 66.96%, as well as the input index except for RI were all decreased or stagnant. More details are shown in Table 3.

Table 2 Overall financial data (average value)

year	RI	NE	CPPFIO	OC	OI	GOI	TP
2011	43678544.04	5818.73	725690413.17	5086545153.93	760613425.78	6582009127.04	798853435.02
2012	75011046.36	6512.46	601263826.95	5156956140.55	871989635.45	6518645255.42	591500429.85
2013	88252239.05	6231.31	540963988.93	5675848017.82	948656621.11	7015851623.13	479583232.94
2014	107962677.20	7499.85	509335315.58	5934596685.53	1017132293.56	7264270784.31	370060246.36
2015	144589376.14	7511.85	464129787.89	5984013576.65	1111276494.55	7176322907.57	146148967.24

Note: Calculated in constant 2011 RMB

Table 3 Industry financial data (average value)

Ind.	year	RI	NE	CPPFIO	OC	OI	GOI	TP
Electronics industry	2011	20403163.41	769.50	156592737.66	331402965.77	83729543.24	498529208.74	87317022.51
	2012	73117728.29	1239.50	141375853.06	397315108.93	117116530.29	594760093.78	99171083.59
	2013	43353547.61	1309.50	124567374.15	499289902.14	149056557.35	730776362.95	122175105.23
	2014	64788606.15	1420.75	136761204.44	590604698.80	187831068.80	904317775.11	154946439.31
	2015	97501990.04	1825.75	163936739.29	780551165.30	251353193.48	1217425537.65	215776098.56
Aerospace	2011	13415476.97	6601.75	155231354.02	2899052994.84	320121054.22	3404681511.35	193821633.79
	2012	20899249.64	6555.75	242532446.74	3293235502.08	355009590.52	3850573962.73	218347424.84
	2013	2708987 6.25	6264.25	737835618.11	7673623829.03	949649249.26	8934898715.02	417048824.17
	2014	4938568 3.22	13723.25	957267280.28	8004708202.60	1028824895.76	9347297175.33	465712389.16
	2015	8852386 5.74	13566.00	860327833.36	7256872544.01	1075953379.26	8702246204.50	513974893.83

New materials	2011	11939721.95	1007.50	234349568.24	397017752.56	73765514.70	595074602.49	129534492.93
	2012	18160570.07	1011.00	389993547.95	442738435.12	80709562.46	590647217.62	82211448.36
	2013	12526394.48	1210.50	284225409.05	580536056.52	134011178.92	734665252.99	23659484.46
	2014	15248618.29	1258.75	216107274.30	603529530.28	152138374.35	826369395.43	92286075.84
	2015	11883582.31	1287.00	102735057.88	545235658.20	190157101.15	698465491.86	-95597948.57
Information technology	2011	99373857.04	1034.5	633746400.2	4564637325	785654045.1	5487675729	299905552.8
	2012	16906003.5	4591	500717522.5	5072859510	1023668793	6228514865	329609320.8
	2013	18936674 0.3	5371.75	404964264.6	4916322128	1187554393	6208388975	394224628.4
	2014	22473103 0.7	6151	311617183.9	5587319634	1399114249	7174674600	437162606.9
	2015	27775164 7.3	6151	389541040.6	6278108781	1667192426	8079356489	739028105.2
Remote navigation	2011	10253135 1.53	1991.33	197664189.23	544269223.80	193459206.27	809443438.34	76872469.27
	2012	10607624 9.95	1830.00	204340463.78	518156587.18	244236726.52	825578646.17	115048967.19
	2013	12054415 7.05	2054.33	194897096.23	730364597.36	326001009.29	1175263096.57	165975300.50
	2014	11039765 8.54	2103.33	273232703.62	895297751.00	433719369.00	1484616676.87	213976219.05
	2015	14254269 2.75	2745.33	375657644.56	1181926632.27	539801384.06	1887370620.84	225111181.17
Heavy industry	2011	39381467.31	17777.17	2242456124.40	16287964250.01	2348637206.22	21408883719.08	2929459312.74
	2012	77013103.38	18175.17	1623395694.85	15928613565.66	2594454325.26	20273939356.48	2008534772.95
	2013	12369567 1.62	16293.00	1168611017.38	15088589037.23	2311372832.48	18680906233.84	1347079281.25
	2014	16075256 7.20	16155.50	961871575.06	15375068467.92	2318443780.30	18499618826.34	716746699.21
	2015	21295161 1.55	15583.33	789174702.92	15372864096.16	2385422106.55	17579384879.19	-406286003.79

Note: Calculated in constant 2011 RMB

4. EMPIRICAL ANALYSIS

This paper regards the annual observations of each sample enterprise as a DMU. By using MinDS-CRS and MinDS-VRS model, TE and PTE can be calculated, and then SE can be calculated by TE/PTE. In the calculation results, TE represents the overall production efficiency of the sample enterprises, PTE represents the production technology and management level of the enterprises, and SE reflects the influence of scale economy [2]. Figure 2 shows the trend of the annual average of TE, PTE and SE of the sample enterprises in 2011-2015. Table 4 shows the industry average of TE, PTE and SE of the sample enterprises. Table 5 shows the returns to scale stage of the enterprises in the industry. For limited space, this paper does not list all the annual results of the sample companies.

4.1 The overview

On the whole, the average TE of the sample enterprises is 0.867, with a median of $0.901 from 2011 to 2015. From the result that the median is greater than the average, it can be concluded that the overall production efficiency of most sample enterprises is above the average level, which reflects that the overall production efficiency of the 25 sample enterprises is ideal.

As we can see from Figure 2, in the meantime, the maximum of TE of the sample enterprises is 0.9049 in 2015, followed by 0.9045 in 2012 and the minimum is 0.756 in 2013. The overall trend of TE is roughly "M" font, same as the trend of SE, while the trend of PTE is a weak "Z" font. Specific speaking, from 2011 to 2012, PTE and SE of the sample enterprises are both in growth, and PTE is lower than SE. In 2013, the PTE and SE both drop to the minimum in five years, but the PTE's decline is smaller so that PTE exceeds SE. In 2014, the PTE and SE rise again. The SE achieves the maximum in five years over the PTE again. In 2015, the SE has a decline, but the PTE keeps increasing to maximum in five years over the SE.

The phenomenon shows that the overall production efficiency of the sample enterprises is greatly influenced by the SE. In general, each industry has not been able to completely get rid of the previous development mode that investment driven. However, by observing the trend line (Figure 2) we can find that the overall production efficiency of the sample enterprises is more influence by PTE since 2013. The trend of technical progress and management improvement gradually appears. The reasons for this phenomenon may be the Communist Party of China announced a series of important policies in the third Plenary Session of the 18th CPC Central Committee in 2013. A comprehensive reform of the economy and society, including the reform of the market economy, the reform of state-owned enterprises, etc. has begun. Especially the promulgation of "The Guiding Opinions on Promoting the Shareholding System Reform of Military Enterprises (hereinafter referred to as the *Guiding Opinions*)" has a fundamental influence on the organization structure and production management of the listed military enterprises. It promotes the listed military enterprises to actively adjust the development direction, optimize the industrial structure, and actively adapt to the needs of the army and the new national economic development.

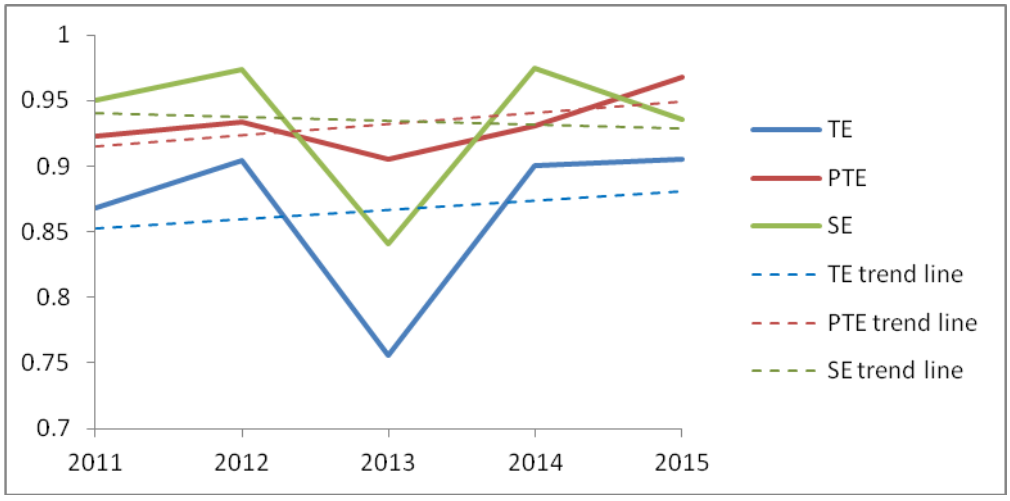

FIG. 2 Overall TE, PTE and SE (average value)

4.2 The industry situation

From the type of industry, the average TE, PTE and SE of the sample enterprises have different degrees of difference in different types.

The average industry TE ranking first is heavy industry. Although its TE only ranks first in 2013 (also the minimum), the rest of the years rank in the top which are never less than 0.85 with a relatively stable trend. Besides, its average SE also ranks first with an industry average of more than 1. On the contrary, its average PTE only ranks fourth in the lower-middle level. This shows that the overall production efficiency of heavy industry is obviously affected by the scale of economic factors, and heavy industry is a typical investment driven industry. It is worth noting that after a period of stagnant growth, its average PTE rises by 11.4% in 2015 and exceeded the average SE. This reflects the industry's emphasis on technological progress and management improvement. The industry has emerged in the transformation of the development trend.

The average industry TE ranking second is aerospace. The situation of production efficiency of aerospace is similar to heavy industry. Its average SE ranks second in the upper level but average PTE ranks fifth in the downstream level. However after a period of decline, its PTE has begun to increase since 2014, and exceeds the average SE in 2015. This shows that although the industry is a typical investment driven industries and the overall production efficiency is obviously influenced by the scale of economic factors, it has the trend of innovation driven development.

The average industry TE ranking third is electronics industry. The trend of its average TE has a strong volatility that presents "V" with a minimum of 0.721 in 2013 and a maximum of 1 in 2015. Its average PTE ranks second in the upper level but average SE ranks fourth in the lower-middle level. It can be seen that the overall production efficiency of electronic industry is greatly influenced by the production technology and management level. In 2015, the average TE, PTE and SE are all 1, indicating that the overall production efficiency of the industry has reached the optimal level, and all kinds of influencing factors have played a positive role.

The average industry TE ranking fourth is information technology. Its average PTE ranks first that has equal to 1 four years. In the opposite, its average SE only ranks fifth in the downstream level. This reflects that information technology is a typical industry of technological progress, the production technology and management level has a significant impact on the overall production efficiency.

The average industry TE ranking fifth is new materials. The general performance of new material is not so good. Its average PTE ranks third in the middle level, and its average SE ranks sixth that is the lowest in all industries. This reflects that the industry needs to continue to improve the production technology and management level, but also need to enlarge the overall investment, and develop the scale economy effect.

The average industry TE ranking sixth is remote navigation. The overall performance of remote navigation is not ideal. Its average PTE ranks sixth that is the lowest rank, and its average SE ranks third in the middle level. This shows that the industry needs to continue to increase investment and enlarge industrial scale on the one hand. On the other hand, it is urgent to improve the level of management so as to walk into innovation driven development way.

Table 4 Industry TE, PTE and SE (average value)

Ind.	year	TE	PTE	SE	Ind.	year	TE	PTE	SE
Electronics industry	2011	0.91133875	1	0.91133875	Information technology	2011	0.83544225	1	0.83544225
	2012	0.8710055	0.9283695	0.9471995		2012	1	1	1
	2013	0.7213675	0.95360175	0.758415		2013	0.728127	0.94478825	0.787725
	2014	0.94725725	0.94818475	0.99883		2014	0.855133	1	0.855133
	2015	1	1	1		2015	0.8835485	1	0.8835485
Industry average		**0.890194 (3)**	**0.966031 (2)**	**0.923156 (4)**	**Industry average**		**0.860450 (4)**	**0.988958 (1)**	**0.872370 (5)**
Aerospace	2011	0.95587175	0.920569	1.0517425	Remote navigation	2011	0.653150333	0.678866	1.000924
	2012	0.8582005	0.87116875	0.97367675		2012	0.816388333	0.853311333	0.96445367
	2013	0.8193742 5	0.83475175	0.9879875		2013	0.798854667	0.925314333	0.862901
	2014	0.9525715	0.94109	1.01502125		2014	0.872124667	0.862661	1.01221467
	2015	0.92066625	0.9862775	0.93412525		2015	0.862211333	0.870434667	0.98972067
Industry average		**0.901337 (2)**	**0.910771 (5)**	**0.992511 (2)**	**Industry average**		**0.800546 (6)**	**0.838117 (6)**	**0.966043 (3)**
New materials	2011	0.8690825	0.95269975	0.906827	Heavy industry	2011	0.886938333	0.912473	0.9809575
	2012	0.872524	1	0.872524		2012	0.9436685	0.92028	1.039766 33
	2013	0.6106475	0.868708	0.6997645		2013	0.869290333	0.891716	0.967992
	2014	0.89664975	1	0.89664975		2014	0.928039	0.8907545	1.05934667
	2015	0.8183365	0.991962	0.8260335		2015	0.974675	0.992250667	0.98209467
Industry average		**0.813448 (5)**	**0.962674 (3)**	**0.840360 (6)**	**Industry average**		**0.920522 (1)**	**0.92149 (4)**	**1.006 (1)**

Note: Because the data in the table is the average, rather than the value of a single enterprise (DMU), so it is only approximate to meet the TE=PTE*SE. The number of brackets for the industry's overall ranking. Ranking are shown in parentheses.

Data resources: Based on the empirical results of MinDS-CRS model and MinDS-VRS model.

4.3 The returns to scale stage

As we can see from Table 5, the enterprises of electronics industry are almost in the stage of constant returns to scale. Although the enterprise 300101 and 002190 have been in the stage of increasing returns to scale over a period of time, they all entered the constant returns to scale in 2015. The enterprise of aerospace are in the stage of constant or increasing returns to scale, where enterprise 000901 and 600316 are in the stage of increasing returns to scale at a long time. The situation of new materials is similar to remote navigation. They are basically in the stage of increasing returns to the scale. The enterprises of information technology are almost in the stage of constant returns to scale. Only enterprise 002253 is in the stage of increasing returns to scale at a long time.

The enterprises of heavy industry are also basically in the stage of constant returns to scale, where enterprise 600590 has been in the stage of increasing returns to scale after the situation of decreasing returns to scale since 2011. However enterprise 300185's situation is relatively complex and has certain volatility, even emerges the situation of decreasing returns to scale in 2015.

Table 5 The returns to scale stage of the enterprises in the industry

Industry	Enterprises (Stock code)	2011	2012	2013	2014	2015
Electronics industry	300101	Increasing	Increasing	Increasing	Constant	Constant
	002339	Constant	Constant	Constant	Constant	Constant
	002190	Increasing	Increasing	Increasing	Increasing	Constant
	002049	Constant	Constant	Constant	Constant	Constant
Aerospace	000901	Constant	Increasing	Increasing	Increasing	Increasing
	600316	Increasing	Increasing	Increasing	Constant	Increasing
	600118	Constant	Constant	Constant	Constant	Constant
	600893	Constant	Constant	Constant	Constant	Constant
New materials	002167	Increasing	Increasing	Increasing	Constant	Constant
	002297	Increasing	Increasing	Increasing	Increasing	Increasing
	601208	Constant	Constant	Increasing	Constant	Increasing
	002428	Constant	Constant	Constant	Constant	Increasing
Remote navigation	600435	Increasing	Decreasing	Increasing	Increasing	Increasing
	002151	Increasing	Increasing	Increasing	Increasing	Increasing
	002230	Constant	Constant	Constant	Constant	Constant
Information technology	002446	Increasing	Constant	Increasing	Increasing	Constant
	002439	Constant	Constant	Constant	Constant	Constant
	002253	Increasing	Constant	Increasing	Increasing	Increasing
	600100	Constant	Constant	Decreasing	Constant	Constant
Heavy industry	002037	Constant	Constant	Constant	Constant	Constant
	600031	Constant	Constant	Constant	Constant	Constant
	600590	Decreasing	Increasing	Increasing	Increasing	Increasing
	300185	Increasing	Decreasing	Increasing	Increasing	Decreasing
	600416	Constant	Constant	Constant	Constant	Constant
	601989	Constant	Constant	Constant	Constant	Constant

4. CONCLUSION

Based on the evaluation of the performance of 25 listed military enterprises, the following conclusions can be drawn.

1. The overall production efficiency of sample enterprises is ideal. Their TE is in a high level and keeps growing momentum as a whole. However, the overall economic benefits of the sample enterprises are declining year by year, and even a large area of loss of business situation happened in individual industries in 2015. This shows that good production efficiency does not bring good economic benefits.

2. The situation of production and management has certain differences in diverse industries. (1) Electronic industry and aerospace are basically in the stage of constant returns to scale. Their TE is in an upper level, and their PTE and SE is balance for comparison. In addition, their GOI and TP are both increasing year by year that is description of the industry is in a golden age of growth and development. (2) Information technology and remote navigation both has the characteristics of better economic efficiency and relatively high production efficiency.

But their overall performance level is not good. They are basically in the stage of constant or increasing returns to scale with a low level of TE. The difference is that the former belongs to the typical technological progress industry with the higher PTE, but the latter basically belongs to the investment driven industry with the higher SE. These two industries' GOI and TP are also in a sustained growth trend, especially the growth rate of TP was high, which reflected a huge potential for development contained in the enterprises in the industries. (3) The production efficiency of heavy industry is good, but the economic efficiency is not ideal, so its overall performance level is low. Heavy industry is in the stage of constant returns to scale, which belongs to the typical investment driven industry, and its TE and the SE of the industry are very high. Besides, the GOI and TP of heavy industry are decreasing year by year. This shows that the industry has encountered some resistance to the development and enterprises in the industry need to upgrade. (4) The production efficiency and economic benefit of the new material are not satisfactory, which leads to the low level of overall performance. The situation of new material is complex. On the one hand, its TE, PTE and SE are not high. On the other hand, its GOI and TP present the obvious volatility. Although it is almost in the stage of increasing returns to scale, the development prospects of the industry is difficult to accurately grasp. Countries and governments need to be supported and guided.

Based on the above conclusions, this paper puts forward some suggestions for the development of sample enterprises.

1. Control the scale and take the technological progress route. The results of this paper show that the size of the input of the sample enterprises is growing, but the GOI and TP are getting lower and lower, the SE trend line (Figure 2) is also in decline. As a result, the sample enterprises have already appeared the situation of diseconomies of scale in general, and have some negative effects on the whole production and operation efficiency. Therefore, it is an important measure to control the scale of investment, to improve the utilization of resources, to improve the management of enterprises and to implement the strategy of innovation driven development.

2. Timely adjust the direction of development. On the basis of the subjective and objective conditions, such as industrial base, industrial structure and policy environment, each industry need to make targeted changes. For the industry of good production efficiency and economic performance, such as electronic industry and aerospace, the recommendation is to maintain their current momentum of development, both taking into account "quality" and "quantity". For the industry of good economic performance but medium production efficiency, such as information technology and remote navigation, the suggestion is that the former appropriately promotes investment, and the latter need to improve innovation capacity on the basis of continuing to expand the scale of production. For the industry like heavy industry of good production efficiency and bad economic performance, the recommendation is to appropriate control scale, improve resource utilization, and accelerate the transformation and upgrading of the industry so as to break the bottleneck of the development of the industry. For the industry like new material of bad production efficiency and economic performance, it needs the support and guidance of the country and the government.

At the same time, the enterprises in the industry should improve the production technology, improve the level of management and broaden the market through their own efforts.

3. Facing the market and promoting the reform of military enterprise shareholding system. *Guiding Opinions* has indicated that promoting the joint-stock reform of military enterprises is a profound change in the field of national defense science and technology industry. It is conducive to break the industry, military and civilian and military enterprise ownership boundaries, broaden the financing channels, as well as establish a standardized corporate governance structure for military enterprises, transform the management mechanism and strengthen the internal vitality and the ability of independent development of military enterprises. It is an effective measure to solve the deep-seated contradictions and problems in the reform and development of military enterprises. However, due to the development of military enterprises greatly affected by the policy, such as in 2013(the *Guiding Opinions* issued), the overall productivity of the sample companies has declined significantly (Figure 2), the majority of military enterprises groups have chosen to take a cautious attitude to the military assets of joint-stock reform. Therefore, the enterprises must emancipate the mind and fully understand the importance and urgency of deepening reform of military enterprises. Only in this way can the military enterprises have a rational view of the "throes" of the reform process, face and adapt to the capital market through shareholding system reform and become a real market subject.

REFERENCES

[1] Chen Gang: *Data Envelopment Analysis and MaxDEA Software* [M]. Beijing: Intellectual Property Press, 2014.

[2] Bai Xuejie, Jiang Kai and Pang Ruizhi: *The Operational Efficiency and Upgrading Path Selection of China's Major National Development Zones: from the Perspective of Foreign Investment and Land Use* [J]. Beijing: Chinese Industrial Economy, 2008, 26-35.

[3] Wu Qing: *Efficiency Analysis of Listed Military Enterprises Based on Super Efficiency DEA Model* [J]. Changsha: Journal of Social Science of Hunan Normal University, 2007, 102-105.

[4] Zhang Yong, Li Haipeng and Yao Yaping: *Research on the Optimal Allocation of Military and Civilian Integration Industrial Resources in Western China Based on DEA* [J]. Beijing: Scientific and Technological Progress and Countermeasures, 2014, 89-93.

[5] Wang Haitao, Gu Chunwei: *Research on Production Efficiency and Its Influencing Factors of China's Military Listed Companies Under the Background of Military and Civilian Integration* [J]. Jinan: Industrial Economic Review, 2016,59-71.