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EMPIRICAL RESEARCH ON PERFORMANCE INFLUENCE FACTORS OF LISTED LOGISTIC ENTERPRISES

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Abstract. *With rapid development of logistic enterprise, how to promote the performance levels has become an urgent problem. This paper constructs performance input-output and influence factors evaluation indicators system. By the methodologies for data envelopment analysis (DEA) and multiple regression analysis, this paper empirically analyzes the performance level of the Listed Logistic Enterprises, and tests performance influence factors sensitivity. The results show most of Listed Logistic Enterprises are less efficient. Some influence factors including technical factor, financial factor and infrastructure factor all have significant positive correlation with performance of Listed Logistic Enterprises. Based on the empirical studying results, some valuable suggestions are provided.*

Keywords: Performance, Influence factors, Data envelopment analysis (DEA), Listed Logistic Enterprises, Empirical research

1. **Introduction.** The Listed Logistic Enterprises develop quickly in recent years. It has a hot problem on how to promote higher performance. Some researchers are analyzing the impact of innovation network, and examining innovations as the result of collaborations between various Listed Logistic Enterprises. Other researchers are committed to analyzing the internal factors, for example, analyzing the business strategy, corporate culture, team collaboration and technological capability [1-3]. Yamin et al. examined the relationships between organizational innovation and organizational performance in Australian Best Practice Companies, and the results show that organizational performance is related to organizational innovation, which consists of administrative, technical and product innovation [4]. In domestic and foreign reference research, there are many methods to evaluate enterprise innovation performance. Farrell et al. first proposed the frontier method of technical efficiency, and obtained wide recognition, which has become the foundation to measure the efficiency [5]. Min and Joo evaluated the international container port and America third party logistics performance by using the DEA analysis method [6]. Hamdan and Rogers analyzed American port by using DEA method [7]. Li made use of BSC (Balanced Score Card) method to analyze logistics enterprise performance [8]. Zhang and Wei analyzed logistics enterprise performance by hierarchy process method [9]. Ceng and Zeng built the factor analysis method to analyze logistics enterprise performance [10]. Lin and Wen researched the 11 listed logistics companies by establishing the comprehensive performance evaluation system including total assets, main business cost, quick ratio, the worker number as input indicators, main business income and net profit [11]. The previous literature research always went out of its way to study affecting factors in the port performance by statistic, but it is still not comprehensive. Due

to indicators system complexity and the more multi-target appraisal method, the paper analyzes comprehensively the affecting factors of Listed Logistic Enterprises performance by the improved data envelopment method and multiple regression analysis. In practice, we may choose different evaluation methods according to the different emphases for each method. The paper chooses data envelopment method to analyze performance level of Listed Logistic Enterprises. At first, the function form is to solve the problem of the parameter reliance, mainly depending on the concrete form; second, it cannot determine the relative importance of input and output and solve the efficiency evaluation problem for more output and more investment [12], thus to solve the subjective weighting sum and decision problems.

2. The Methodologies.

2.1. **Data envelopment analysis (DEA).** It is a kind of the most commonly used non parametric frontier efficiency analysis method by using linear programming technique. Charnes et al. proposed relative efficiency analysis based on the same type of department performance evaluation [13]. According to data envelopment analysis model, decision-makers pursue the maximization of the output variable, so for the efficiency model of a decision-making unit U_{j_0} $(j_0 = 1, \ldots, n)$, one can get the following programming equation:

$$\begin{cases} \max eff_{j_0} = \dfrac{u^T Y_0}{v^T Y_0} \\ \text{s.t. } eff_{j_0} = \dfrac{u^T Y_j}{v^T Y_j} \leq 1 \end{cases} \tag{1}$$

In Formula (1), $u \geq 0$, $v \geq 0$, eff_{j_0} is the comprehensive efficiency for the input-output values, $v^T Y_j$ is the outputs integrated weighted value, and $u^T Y_j$ is the inputs integrated value. In this paper, $n = 16$. If $eff_{j_0} = 1$, the decision-making unit U_{j_0} is full of performance; if $eff_{j_0} < 1$, the decision-making unit U_{j_0} is not effective. Formula (1) can be transformed by Charnes-Cooper transformation process, and the equation includes the input slack variable $s^- \geq 0$, the output slack variable $s^+ \geq 0$ and the infinitesimal value, which can be equivalently transformed into a linear programming model as follows:

$$\begin{aligned} &\min \left[\theta - \varepsilon(e^t s^- + e^t s^+)\right] \\ &\text{s.t.} \begin{cases} \sum\limits_{j=1}^{n} \eta_j x_j + s^- = \theta x_{j_0} \\ \sum\limits_{j=1}^{n} \eta_j y_j - s^+ = y_{j_0} \\ s^-,\ s^+,\ \eta_j \geq 0,\ j = 1, 2, \ldots, n \end{cases} \end{aligned} \tag{2}$$

Here, θ is the decision-making unit's performance value, and η is the vector parameter. When $\theta = 1$, $s^- = 0$, $s^+ = 0$, it is technology and scale efficiency, and at the same time, the decision-making unit is full of performance. The decision-making unit is weak efficiency when $\theta = 1$, $s^- \neq 0$, $s^+ \neq 0$; the decision making unit is invalid when $\theta < 1$. By using Formula (2), the industrial comprehensive performance value (C) can be calculated. Moreover, it can be decomposed into both scale efficiency (S') and technical efficiency (T') as follows.

$$C = T' \times S' \tag{3}$$

2.2. **Multiple regression analysis.** Multiple regression models further are used for testing the sensitivity for influencing performance factors of Listed Logistic Enterprises. Multiple regression models are built as follows:

$$C_{ijt} = \beta_{0ijt} + \beta_{1ijt} \ln X_{1ijt} + \beta_{2ijt} \ln X_{2ijt} + \beta_{3ijt} \ln X_{3ijt} + \beta_{4ijt} \ln X_{4ijt} + \varepsilon_{ijt} \tag{4}$$

where, i is performance factor, j is Listed Corporation, t is the time, ε_{ijt} is random error with zero mean and variance, β_{0ijt} is the regression constant, β_{1ijt}, β_{2ijt}, β_{3ijt} and β_{4ijt} are the regression coefficients. X_i $(i = 1, 2, 3, 4)$ are performance factors for technical factor (X_1), human factor (X_2), financial factor (X_3) and infrastructure factor (X_4). In further study, it needs multicollinearity test; variance inflation factor (VIF) is expressed as follows.

$$VIF = \frac{1}{1 - r^2} \tag{5}$$

From (5), it is clear that if r^2 value is closer to 1, VIF value is larger, and multicollinearity is more serious. On the other hand, if it is closer to 0, VIF value is closer to 1. $VIF < 10$, the multicollinearity is less and passes the test.

3. **Empirical Analysis.** This paper takes 16 Chinese Listed Logistic Enterprises as the samples, and these companies represent a cross-section of various process types and characteristics. Most of the companies have been established for more than 10 years.

3.1. **Input indicators analysis.** In this paper, these input indicators which were selected are mainly involved in enterprise asset indicators [14], including the total assets, the main business cost. Please see Table 1.

Table 1. The mean value table of the input data in 2011-2013

Listed Corporation	The total assets (Million yuan)	Business cost (Million yuan)
Yantian Port	543130.1	13147.4
Yingkou Port	1606628	220840.3
Jinzhou port	643282.2	90318.8
Hong Kong Group	8632404	1658101.1
Chiwan A	688929.6	84092.5
Tianjin Port	2606115	831449.7
Rizhao Port	1200127	359133.3
Tielong Logistics	475308.3	305600.4
Magicstor	211162	167203.3
Sunning Logistics	204815.2	21185.4
Bohai ferry	261790.4	75362.1
Yatong stocks	128869	35590.1
Guang-Shen railway	3276884	1295233.1
Reservoir shares	1226535	2497095.8
Baorui-Keji	216877.6	7710.8
Sinoair	671377.2	365204.1

Further, the data in Table 1 were transformed into standardization of logarithm and gained the line chart. Seen from Figure 1, it is the stacked line that the input standard value waves of the total assets indicator in 2011-2013 are stable. The total assets of Hong Kong Group and Guang-Shen railway are higher than other Listed Corporations. The input total assets of Jinzhou port and Yatong stocks are lower than other Listed Corporations.

The output standard value waves of the business cost indicator in 2011-2013 are stable. The total assets indicator is still the highest for Hong Kong Group, and Guang-Shen railway. The input total assets of Jinzhou port and Yatong stocks are lower than other regions.

3.2. **Output indicators analysis.** This paper chooses three output indicators involved in corporate profitability which are the main business income, net profit and per share earning. According to these indicators, the data are shown in Table 2.

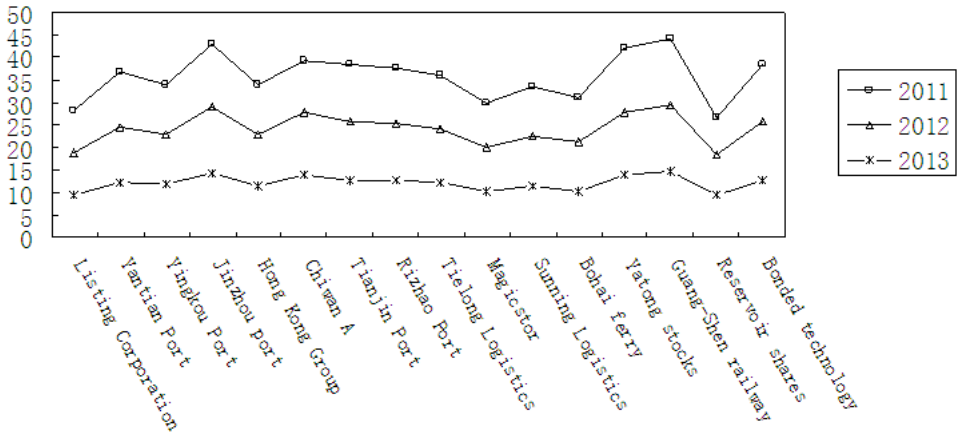

FIGURE 1. The wave of the total assets in 2011-2013

TABLE 2. The mean value table of the output data in 2011-2013

Listed Corporation	The main business income (Million yuan)	Net profit (Million yuan)	Per share earning (yuan)
Yantian Port	32830.6	37495.2	0.21
Yingkou Port	346324.0	49292.5	0.23
Jinzhou port	140046.8	17877.0	0.11
Hong Kong Group	1957372.6	501632.8	0.22
Chiwan A	175758.7	49188.1	0.76
Tianjin Port	1428083.7	100049.5	0.60
Rizhao Port	494932.5	72120.8	0.24
Tielong Logistics	376710.2	46239.0	0.35
Magicstor	208782.1	6297.1	0.15
Sunning Logistics	32751.7	777.1	0.08
Bohai ferry	109082.0	24105.8	0.58
Yatong stocks	45330.0	1651.2	0.05
Guang-Shen railway	1519446.9	146562.9	0.21
Reservoir shares	2601099.6	37924.1	0.38
Baorui-Keji	25207.7	16019.4	0.47
Sinoair	403950.4	62422.1	0.66

3.3. **Performance value analysis.** Based on the performance value results of Listed Logistic Enterprises in China obtained by data envelopment analysis model, we know that most of Listed Logistic Enterprises are less efficient; only the performance value is 1 for Hong Kong Group value, Yantian Port and Magicstor. The performance value is between 0.75-1 for Rizhao Port, Yingkou Port, Chiwan A, Guang-Shen railway, Sinoair, Tielong Logistics, Reservoir shares, Baorui-Keji, Yatong stocks and Sunning Logistics. The performance value is between 0.55-0.75 for Jinzhou port and Bohai ferry. See Table 3.

Most of Listed Logistic Enterprises in China have maintained a relatively stable growth wave; see Figure 2.

3.4. **Multiple regression test analysis.** It gives the t-statistics constant term and significance probability p values in Table 4. It also can be seen that the t-statistics for constant term is -3.729, and significance probability p value is 0.000, which indicate that the constant term has significant differences. Furthermore, by using non standard regression equation, the values of t-statistics obtained for $\ln X_1$, $\ln X_2$, $\ln X_3$ and $\ln X_4$

TABLE 3. The performance value of the Listed Logistic Enterprises in 2011-2013

	Year	2013			2012			2011		
	Performance value	C'	S'	T'	C'	S'	T'	C'	S'	T'
Ports	Hong Kong Group	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Yantian Port	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Rizhao Port	0.99	1.00	0.99	1.00	1.00	1.00	0.93	0.98	0.95
	Yingkou Port	0.82	0.87	0.94	1.00	1.00	1.00	0.89	0.91	0.98
	Chiwan A	0.95	1.00	0.95	0.92	0.94	0.98	0.82	0.91	0.90
	Tianjin Port	1.00	1.00	1.00	0.92	0.93	0.99	0.92	0.96	0.96
	Jinzhou port	0.56	0.74	0.76	0.74	0.86	0.62	0.40	0.52	0.76
Ports means		0.84	0.56	0.78	0.72	0.61	0.38	0.83	0.55	0.75
Transports	Guang-Shen railway	0.84	0.91	0.91	0.89	0.87	0.92	0.78	0.86	0.90
	Sinoair	0.92	0.98	0.94	0.69	0.84	0.82	0.62	0.87	0.71
	Tielong Logistics	0.95	0.99	0.96	1.00	1.00	1.00	0.84	0.89	0.94
	Reservoir shares	0.91	0.92	0.99	0.82	0.89	0.92	0.82	0.91	0.90
	Bohai ferry	0.61	0.69	0.88	0.62	0.71	0.87	0.61	0.72	0.85
	Baorui-Keji	1.00	1.00	1.00	0.86	0.89	0.97	0.66	0.69	0.96
	Magicstor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Yatong stocks	0.61	0.86	0.71	0.70	0.86	0.81	0.66	0.76	0.87
	Sunning Logistics	1.00	1.00	1.00	0.82	0.86	0.95	0.78	0.88	0.88
Transport means		0.8137	0.33	0.69	0.48	0.51	0.71	0.72	0.59	0.80
Total means		0.8252	0.81	0.90	0.88	0.78	0.86	0.90	0.73	0.84

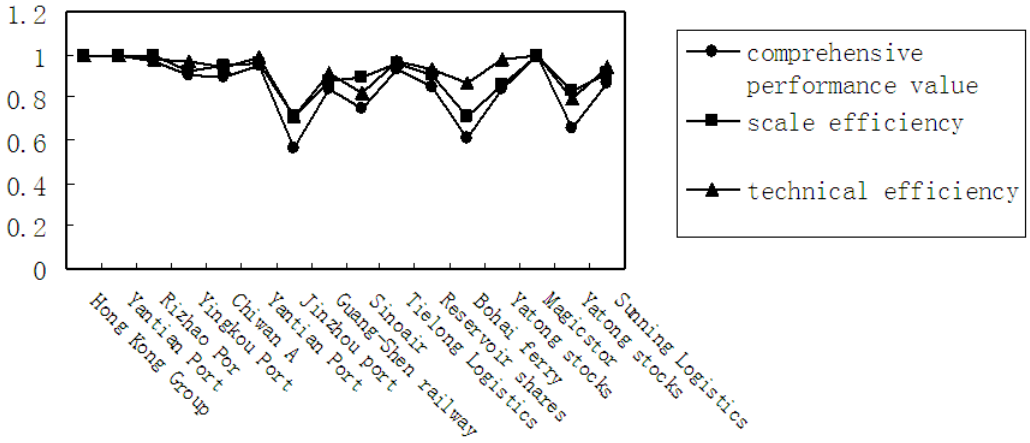

FIGURE 2. The mean performance value wave of Listed Logistic Enterprises in 2011-2013

TABLE 4. Regression coefficients and significance tests

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	−.731	.181		−3.729	.000
	$\ln X_1$	.187	.041	.404	4.220	.015
	$\ln X_2$	.022	.019	.093	1.232	.271
	$\ln X_3$	−.041	.021	−.192	2.003	.039
	$\ln X_4$	.138	.036	.307	2.975	.000

TABLE 5. Multicollinearity test

Model		Collinearity Statistics	
		Tolerance	*VIF*
	$\ln X_1$	.579	1.711
	$\ln X_2$	.501	2.311
	$\ln X_3$	.716	1.368
	$\ln X_4$	.795	1.229

are 4.22, 1.232, 2.003 and 2.975 respectively, and corresponding significant probability p values are 0.015, 0.271, 0.039, 0.000, respectively. These values show that X_1, X_4 pass t-statistics and there is a significant positive correlation with performance of Listed Logistic Enterprises. In addition, X_2 and performance value of Listed Logistic Enterprises are not significant correlation; X_3 and performance value wave of Listed Logistic Enterprises are normal significant correlation.

(2) Multicollinearity test. The values of the tolerances and VIF for $\ln X_1$, $\ln X_2$, $\ln X_3$ and $\ln X_4$ by Multicollinearity test are listed in Table 5. From Table 5, it can be seen that the *VIF*-Statistics of four performance indicators of Listed Logistic Enterprises system are $VIF < 10$. Therefore, it can be inferred that the model has no multicollinearity.

4. **Conclusions.** The results showed most of Listed Logistic Enterprises are less efficient. Some influence factors including technical factor, financial factor and infrastructure factor all have significant positive correlation with performance of Listed Logistic Enterprises. The proposed method is more effective through the empirical analysis, and some valuable suggestions are given as follows: (1) in order to strengthen innovation performance level of Logistic Enterprises, more attention will be paid to t technical factor; (2) implementing more infrastructure will help increase innovation performance; (3) human factor is very important to the development of Logistic Enterprises, in order to promote the performance level. The Logistic Enterprises need recruit more excellent talents.

Due to the limitation of ability, the lack of resource constraints and experience, this study has some further improvements: (1) the DEA calculation completely relies on objective data, not considering decision makers' ideas, and the method cannot compare the innovation performance value 1 of Listed Logistic Enterprises, which has brought much worry for policymakers; (2) small sample data characteristics brought about some shortcomings to analyze the innovation performance factors of Listed Logistic Enterprises.

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