

Research on Technology Innovation Efficiency of Communication Enterprises Based on DEA Three Stage Model and Malmquist Index

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Abstract. The communication industry is a strategic, fundamental, and leading industry that builds a new type of national digital infrastructure, provides network and information services, and comprehensively supports economic and social development. It plays a crucial role in the national economy. This article takes 81 listed companies in the communication industry in China from 2017 to 2021 as the research object, and uses the three-stage DEA and Malmquist index method to measure the dynamic efficiency of industry development. The research results indicate that the overall development of technological innovation efficiency in communication enterprises is poor, with only 13.6% of enterprises at the forefront of efficiency; There is redundancy in the investment between per capita GDP and the proportion of tertiary industry to GDP, resulting in unreasonable resource allocation; The overall efficiency improvement after excluding environmental variables indicates that environmental factors have certain limitations in improving the technological innovation efficiency of communication enterprises.; From a time perspective, from 2017 to 2021, pure technological efficiency showed an upward trend, while scale efficiency and social technological changes showed a downward trend, and there is still great room for progress. In response to the above situation, it is proposed that enterprises need to strengthen their own management level and ability, focus on improving and digesting resources, improving investment decision-making, and improving the rational investment level and investment accuracy of enterprises.

Keywords: Three-stage DEA, Malmquist Index, communications industry.

1. Introduction

In recent years, with the rapid development of mobile internet, Internet of Things, and 5G technology, the communication industry has not only brought tremendous changes to people's lives, but also driven rapid socio-economic growth, playing a crucial role in promoting information exchange, innovation, and economic transformation. However, with the continuous innovation of communication technology and the changing social needs, the communication industry is also facing a series of challenges and problems. This article reflects the development of China's communication industry by evaluating the efficiency of listed companies. Intended to provide useful suggestions for the future development of the communication industry.

2. Literature Review

In recent years, the communication industry itself has been seeking breakthroughs in both technology and products. China's evaluation methods for innovation efficiency in the communication industry mainly include chain correlation network DEA, three-stage DEA, DEA Malmquist index method, etc. Du Yue et al. [1] conducted research using the DEA Malmquist index method and found that the main factor affecting innovation efficiency in the communications industry is technological

progress efficiency, while the main factor affecting technological efficiency is scale efficiency; Han Jingjing et al. [2] found through constructing a chain two-stage DEA model that the efficiency of China's communication manufacturing enterprises in the technology research and development stage is generally higher than that in the transformation stage, and the difference in efficiency in the transformation stage is greater than that in the research and development stage; He Tianying et al. [3] used the super efficiency DEA-SBM model, Malmquist index analysis method, and Tobit model to analyze, and concluded that the overall technological innovation efficiency of the communication industry has been tortuously improved. They also proposed that regions should pay attention to attracting and cultivating R&D personnel, and the government should focus more on policy formulation and other aspects, rather than directly providing financial support and other suggestions; Based on DEA Malmquist analysis, Wang Mingliang et al. [4] found that the dynamic trend of innovation efficiency is directly related to the evolution of the spatial concentration of the industry; Wang Yan et al. [5] constructed a chain correlation network DEA model and found that the innovation efficiency of China's communication equipment manufacturing industry is generally low, manifested as low management efficiency or profit efficiency.

They proposed to monitor the various stages of innovation and continuously expand existing marketing channels and sales networks. Comparing the above literature, it was found that the above methods are prone to ignoring the effects of environmental factors and random disturbances, and the efficiency values calculated have limitations. However, the three-stage DEA method can eliminate these effects on the basis of traditional DEA, and more accurately reflect the efficiency of decision-making units. Therefore, this study adopts a three-stage DEA method to study the efficiency of technological innovation in communication enterprises.

In addition, relevant indicators can be divided into absolute indicators that reflect the overall level and relative indicators obtained by comparing multiple indicators. At present, domestic research mainly adopts absolute indicators, and the effectiveness and reliability of this method have been fully confirmed. Therefore, this study adopts absolute indicators. According to Wang Wenbo's discussion [6], although many such studies use the number of patents as an output indicator, patents are only a means and intermediate product, and the goal of enterprises is ultimately to obtain economic benefits. Therefore, this study did not use patent data as an output indicator, but instead selected income and profit related data as output indicators.

3. Methodology

3.1. Three Stage DEA Model

The three-stage DEA method is a multi-input and multi output efficiency evaluation method formed by combining traditional data envelopment analysis (one-stage DEA model) and stochastic frontier analysis (SFA model). Compared with traditional DEA models, although they all evaluate the relative effectiveness between the same departments, the three-stage DEA method eliminates the impact of environmental variables and random noise on the results, making its calculation results more accurate. In the first stage, the traditional DEA model is chosen. In the second stage, a quasi-stochastic frontier model is used to eliminate environmental variables and statistical noise, and all decision-making units are placed in a consensus environment for efficiency calculation. The regression function is as follows:

$$S_{ni} = f(Z_i; \beta_n) + v_{ni} + \mu_{ni}; i = 1, 2, \dots, I; n = 1, 2, \dots, N \quad (1)$$

Where S_{ni} is the slack value of the n^{th} input of the i^{th} listed company, Z_i is the environmental variable, β_n is the coefficient of the environmental variable; and is the mixed error term, which indicates random disturbances, and indicates managerial inefficiency.

The data are processed through the SFA model and corrected with the following equation:

$$X_{ni}^A = X_{ni} + [\max(f(Z_i; \hat{\beta}_n)) - f(Z_i; \hat{\beta}_n)] + [\max(v_{ni}) - v_{ni}] \quad i = 1, 2, \dots, I; n = 1, 2, \dots, N \quad (2)$$

X_{ni}^A is the adjusted inputs; X_{ni} is the pre-adjusted inputs; $[\max(f(Z_i; \hat{\beta}_n)) - f(Z_i; \hat{\beta}_n)]$ adjusts for external environmental factors; $[\max(v_{ni}) - v_{ni}]$ puts the decision-making units in the same external environment. In the third stage, DEA is performed using the adjusted inputs and original outputs to arrive at the efficiency values excluding external influences.

3.2. Malmquist Index

The DEA model can be used to compare the relative efficiency between decision-making units in the same year, but due to the different efficiency frontiers between different years, it is not possible to compare the efficiency of the same decision-making unit in different years. This article conducts cross year analysis of each decision-making unit by constructing the Malmquist index, with the following formula:

$$M(x^t, y^t, x^{t+1}, y^{t+1}) = (M^t \times M^{t+1})^{\frac{1}{2}} = \left[\frac{D_C^t(x^{t+1}, y^{t+1})}{D_C^t(x^t, y^t)} \times \frac{D_C^{t+1}(x^{t+1}, y^{t+1})}{D_C^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}} \quad (3)$$

The Malmquist index can be decomposed into two parts: the Efficiency Change (EFFCH) and the Technical Change (TECHCH), where the EFFCH can be further decomposed into the Pure Efficiency Change (PECH) and the Scale Efficiency Change (SECH).

4. Indicator Selection

4.1. Selection of input-output indicators

For the efficiency of enterprise innovation, it is generally considered to measure it from two aspects: human investment and financial investment. From the perspective of manpower investment, this article uses the number of researchers to intuitively reflect the manpower investment of each company; From the perspective of capital investment, the R&D investment amount and net fixed assets are used to reflect the innovation situation of the enterprise. It should be noted that the DEA model requires positive input-output data, but the net profit and return on equity of certain companies are negative in certain years, making it impossible to directly adopt the DEA model. Therefore, based on the "transformation invariance" of the DEA model, each decision-making unit increases the same value, and the DEA effectiveness of the decision-making unit remains unchanged. This article will uniformly increase the total profit of each listed company from 2017 to 2021, to meet the requirement of data greater than 0 [7-8].

4.2. Selection of environmental variables

Table 1. Selection of indicators

Types of Indexes	Indexes
Input Indexes	Number of R&D personnel (Hundred People)
	R&D Investment Amount (Hundred Million Yuan)
	Net Fixed Assets (Hundred Million Yuan)
	Return on Equity (%)
Output Indexes	Operating Income (Hundred Million Yuan)
	Net Profit (Hundred Million Yuan)
	Governmental Subsidy (Million Yuan)
Environmental Indexes	GDP per Capita (Ten Thousand Yuan)
	The Proportion of Tertiary Industry in GDP (%)

Selection of indicators are shown in table 1. The selection of environmental variables is a factor that affects the efficiency of decision-making units but cannot be controlled by decision-making units. Due to the fact that the development of listed companies is not only influenced by the company itself,

but also by the external environment. Considering the rationality and availability of data, this article selects government subsidies from various companies, local per capita GDP, and the proportion of local tertiary industry to GDP as environmental variables for research from 2017 to 2021. Government subsidies can stimulate the innovative development of listed companies to a certain extent, and may also have a crowding out effect, which has a negative impact on the company's development; The per capita GDP of listed companies in the local area can represent the level of local economic development, and the infrastructure investment in the communication industry is theoretically related to the local economic level; the proportion of the tertiary industry to GDP can reflect the level of development of the tertiary industry in the local area [9-10].

4.3. Data sources

This study focuses on 81 listed companies in the communication industry in China, with data from the Guotai An database, the National Bureau of Statistics, and statistical yearbooks of various provinces.

5. Result

5.1. Stage 1 analysis

The DEA model has two modes: input-oriented and output-oriented. In order to reflect the cost control of listed companies, this article adopts an input-oriented DEA model and uses DEAP2.1 software to calculate efficiency values. Some results are shown in the following table 2. (taking 2017 as an example):

Table 2. Results of Efficiency Measurement for Selected Enterprises

DMU	crste	vrste	scale	
Zhongxing Telecommunication Equipment Co.	0.198	1	0.198	drs
Shenzhen SDG Information Co., Ltd.	0.41	0.437	0.94	drs
China Yangtze Power Co., Ltd.	1	1	1	--
Tianjin Xinmao Science and Technology Co., Ltd.	0.555	0.565	0.982	drs
Sichuan Zhongguang Lightning Protection Technologies Co., Ltd.	0.569	0.572	0.995	drs
Eastcompeace Smart Card Co., Ltd.	0.195	0.196	0.995	irs
Guomai Technologies, Inc.	0.433	0.444	0.975	drs
Hengbao Co., Ltd.	0.281	0.288	0.977	drs
Eoptolink Technology Inc., Ltd.	0.505	0.519	0.973	drs
Montnets Rongxin Technology Group Co., Ltd.	0.406	0.429	0.947	drs
Beijing Bewinner Communication Co., Ltd.	0.423	0.423	0.999	irs
Sichuan Tianyi Comheart Telecom Co., Ltd.	0.426	1	0.426	drs
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Shanghai AtHub Co., Ltd.	1	1	1	--
Average Value	0.537	0.612	0.9	

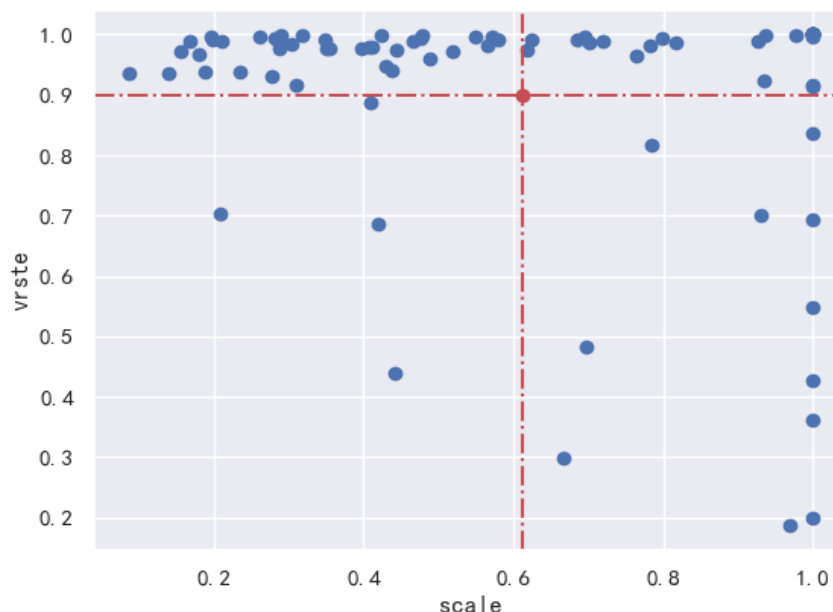


Figure 1. SECH and PECH of 81 listed communications companies

Crste means technical efficiency from CRS DEA, vrste means technical efficiency from VRS DEA, scale means SECH.

From Figure 1, we can see that based on the mean, it can be roughly divided into four types: dual low efficiency (low SECH, low PECH), low efficiency (low SECH, high PECH), high and low efficiency (high SECH, low PECH), and dual high efficiency (high SECH, high PECH). Among them, there are four dual low efficiency companies, which not only need to improve PECH, but also need to improve PECH, Improve management level, but also expand production scale and improve SECH; There are 11 low efficiency companies, and these companies should focus on expanding their production scale, improving SECH, and ultimately driving the improvement of overall efficiency; There are 38 high and low efficiency companies, and we should focus on improving PECH, enhancing technology management level, and allocating resources reasonably and effectively; There are 28 companies with dual high efficiency and 11 companies located at the forefront of efficiency. If they are located at the forefront of efficiency, they are in an ideal state. If they are not at the forefront of efficiency, they can appropriately expand the production scale of the enterprise or improve PECH to improve EFFCH and reach the forefront. It can be seen that the number of companies with high and low efficiency is the highest, reflecting that the PECH of listed companies in the communication industry is not as high as the SECH.

5.2. Stage 2 analysis

Using the input indicators obtained in the first stage as the dependent variable, SFA regression analysis was conducted using FRONTIER4.1 software to calculate the impact of three environmental variables on the relaxation variables of the three inputs. The results obtained are shown in Table 3 (taking 2021 as an example). In the SFA regression results, σ^2 passed the significance test at the 1% level, and all input variables also passed the LR test. Therefore, it is reasonable to adopt the SFA model to eliminate disturbances from environmental variables. The slack variable of investment represents the portion saved by the enterprise by improving organizational structure, improving management level, and promoting operational efficiency to reduce fixed assets, personnel, and capital investment, reaching the forefront of efficiency. If the coefficient of the input variable is negative, it means that the direction of change between this environmental variable and the input slack variable is opposite, that is, as the environmental variable increases, the input waste decreases; If the coefficient of the input variable is a positive number, it means that the direction of change of this environmental variable is the same as that of the input relaxation variable, that is, as the environmental variable increases, input waste also increases.

Table 3. Results of SFA regression analysis of variables for the sample communication firms

Items	Slack Variable of Net Fixed Assets	Slack Variable of Number of R&D personnel	Slack Variable of R&D Investment Amount
Constant	-11.3242	-3.9786	-1.4801
Governmental Subsidy	-0.0033	-0.0008	-0.0001
GDP per Capita	0.3135	0.1682	0.0356
The Proportion of Tertiary Industry in GDP	0.0948	0.0150	0.0124
σ^2	108.9858	44.6918	6.1313
γ	0.9999	0.9999	0.9999
LR test	67.8845	60.0439	68.2963

From Table 3, it can be seen that government subsidies are beneficial for reducing the waste of net fixed assets, the number of R&D personnel, and the amount of R&D investment. This may be because the purpose of subsidies itself is to achieve more effective resource allocation, promote more meaningful economic activities for society and provide economic and strategic incentives for high-tech industries such as the communication industry. Government subsidies usually have a series of restrictions, setting clear plans and ultimate goals, such as promoting innovation in communication technology, improving the competitiveness of the communication industry, or achieving a fixed output, profit margin, and technological level. Enterprises are often required to use funds to achieve these goals when receiving subsidies. And the financial support is not unlimited. Enterprises need to operate within a limited subsidy amount, so they will be more cautious in managing and utilizing these funds to avoid ineffective waste caused by arbitrary spending. The government usually supervises and audits the use of subsidy funds, requiring enterprises to report on the actual use of subsidy funds and measure the actual results achieved. Therefore, enterprises need to prove that the subsidy funds are used to effectively increase fixed assets and R&D investment, otherwise they may face a reduction or cancellation of the subsidy.

It can be seen that the increase in per capita GDP in the region actually increases the waste of communication enterprises in net fixed assets, number of R&D personnel, and R&D investment amount, which is contrary to the general understanding of the public. Although the increase in per capita GDP is usually positive, its impact also depends on a series of other factors. The increase in per capita GDP may lead enterprises to make irrational decisions under the pressure of pursuing short-term profits. High per capita GDP will trigger more intense market competition, and companies may try to maintain a competitive advantage and seize market share by expanding fixed assets and R&D investment, thus falling into the trap of excessive investment. When per capita GDP increases, companies may aggressively invest in larger and more expensive projects, expanding without sufficient strategic considerations. Communication companies may increase the number of R&D personnel and investment in the absence of effective R&D plans, ultimately leading to resource waste and unnecessary expenses.

The increase in the proportion of the tertiary industry to GDP has also increased the waste of fixed assets, R&D personnel, and R&D investment in communication enterprises. The increase in the proportion of the tertiary industry to gross domestic product (GDP) usually implies the development of technology, and innovation. With the development of the tertiary industry, communication companies may excessively pursue emerging technologies and invest a large amount of resources in research and development, but lack clear business models and channels. In this process, there will also be a large number of technological foam. People and enterprises often overestimate the commercial value and impact of new technologies. But may not ultimately achieve the expected results. At the same time, it is difficult for enterprises to effectively invest funds, manpower, and technology into promising projects, leading to excessive investment in certain fields and resource shortages in other fields. Moreover, the development of the tertiary industry is often accompanied by a rapidly changing society and a fiercely competitive market environment. At this point, enterprises

may be under pressure from short-term profits and market share, and in the absence of long-term planning, they may invest excessively in fixed assets and research and development.

5.3. Stage 3 analysis

5.3.1 Analysis of DEA model results after removing environmental variables

The analysis of the DEA model results after removing environmental variables is shown in Table 4. After removing the impact of environmental variables, the technological innovation efficiency of listed companies in China's communication industry in 2017 was measured again through DEAP2.1.

Table 4. Technological Innovation Efficiency of Listed Companies in China's Communication Industry in 2017 in Phase I and Phase III

Listed Companies	EFFCH		PECH		SECH	
	Before The Adjustment	After The Adjustment	Before The Adjustment	After The Adjustment	Before The Adjustment	After The Adjustment
Zhongxing Telecommunication Equipment Co.	0.162	0.388	1	1	0.162	0.388
Shenzhen SDG Information Co., Ltd.	0.271	0.415	0.302	0.466	0.897	0.891
China Yangtze Power Co., Ltd.	0.846	0.446	1	0.571	0.846	0.781
Tianjin Xinmao Science and Technology Co., Ltd.	0.421	0.447	0.431	0.453	0.975	0.986
Guizhou Dazhong No.7 Grainding Wheel Co., Ltd.	0.451	0.441	1	1	0.451	0.441
Eastcompeace Smart Card Co., Ltd.	0.251	0.377	0.259	0.382	0.967	0.988
Guomai Technologies, Inc.	0.309	0.324	0.313	0.326	0.985	0.992
Hengbao Co., Ltd.	0.243	0.266	0.248	0.267	0.98	0.997
Zhejiang Sunwave Communications Co., Ltd.	0.491	0.364	0.532	0.452	0.923	0.806
Montnets Rongxin Technology Group Co., Ltd.	0.332	0.289	0.343	0.311	0.968	0.928
Beijing Bewinner Communication Co., Ltd.	0.528	1	0.548	1	0.964	1
Wuhan Fingu Electronic Technology Co., Ltd.	0.259	0.467	1	0.938	0.259	0.498
``Average Value	0.39	0.491	0.545	0.595	0.801	0.87

From Table 4, it can be seen that after excluding the impact of environmental variables, the average EFFCH, PECH, and SECH of 81 listed companies in the Chinese communication industry have all changed from 2017 to 2021. Among them, the EFFCH increased by 25.9%, the PECH increased by 9.1%, and the SECH increased by 8.6%. Compared to before adjustment, the three efficiency values of the sample enterprises have overall improved, indicating that environmental factors have certain limitations in improving the technological innovation efficiency of communication enterprises. Considering the interference of environmental variables, the mean SECH is higher than the mean PECH, which means that compared to SECH, PECH is the main factor affecting the technological innovation efficiency of China's communication industry. After excluding the impact of

environmental variables, 10 companies are at the forefront of overall technical efficiency. 55 enterprises have seen an increase in EFFCH, with 263 Network Communication Co., Ltd. experiencing an increase from 0.251 to 1. This indicates that the impact of environmental variables is severely underestimated. In addition, 57% of companies have a EFFCH of no more than 0.5, indicating that the level of technological innovation efficiency in China's communication industry is relatively low and there is still great room for improvement. From the perspective of efficiency decomposition, after adjustment, the average PECH of each enterprise increased from 0.564 to 0.624. The PECH of 13 companies such as ZTE remained unchanged and at the forefront. Before adjustment, 18 companies had a PECH of 1 (22.2%), while 19 companies had a PECH of 1 after adjustment (23.5%). After excluding the impact of environmental variables, the pure technological efficiency of 45 enterprises was lower than the average, indicating that their technological innovation efficiency was at a relatively low level. In terms of SECH, the SECH of each enterprise has increased from 0.821 to 0.854. Before the adjustment, there were 9 enterprises with a SECH of 1 (accounting for 11.1%), and after the adjustment, there were 11 enterprises (accounting for 13.6%). There are 26 enterprises with SECH below the average, and production scale should be expanded to improve production efficiency.

5.3.2 Efficiency analysis based on Malmquist index

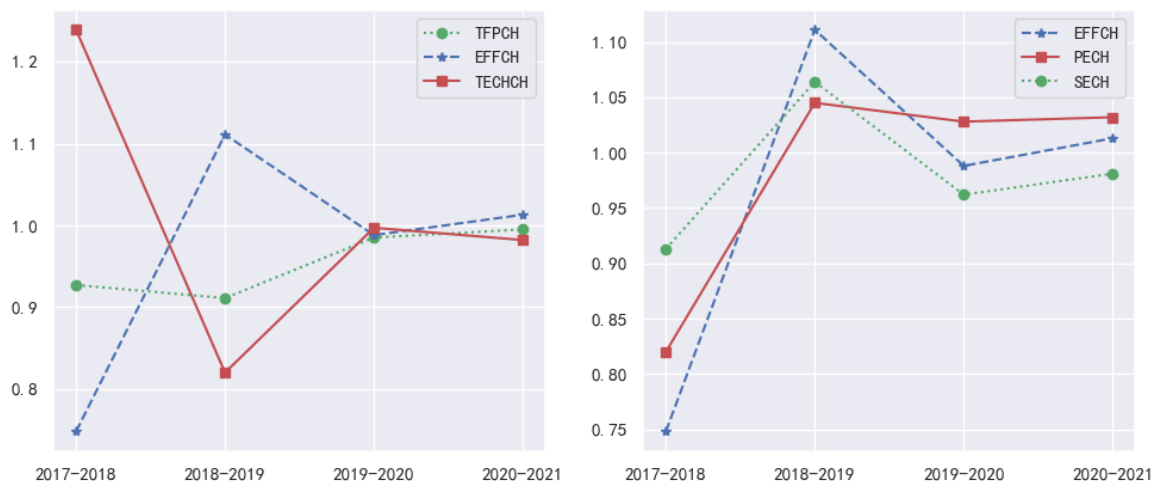


Figure 2. Malmquist index and its decomposition of Chinese communication enterprises in 2017-2021

The conclusions drawn from Table 2 are as follows:

(1) From 2017 to 2021, the Total Factor Productivity Change (TFPCH) of China's communication industry's technological innovation efficiency showed an upward trend, with an average of 0.955. The overall increase was 0.068, but still less than 1, indicating a low overall resource utilization efficiency in the production process.

(2) From 2017 to 2018, the TECHCH of Chinese communication enterprises exceeded 1.20 and reached its highest value of 1.239 in 2018. Between 2018 and 2021, the change remained below 1. The change has been showing an upward trend for two years, while a downward trend has been observed for two years, indicating that the technological level of China's communication industry is fluctuating and declining. The reason for the decline may be related to the insufficient coverage and application of the new generation communication network. The reason for the decline in this change may be related to the insufficient coverage and application of new generation communication networks (such as 5G), and the impact of the epidemic.

(3) From 2017 to 2018, the EFFCH was 0.748, and from 2020 to 2021, it was 1.013, with an average value of 0.965, indicating an upward trend in overall technical efficiency. The reasons for the decline in the EFFCH in 2018 and 2020 may be due to the impact of the 2018 Sino US trade dispute and the pandemic, respectively. The improvement of EFFCH is mainly due to the improvement of PECH and SECH, among which the improvement effect of PECH is more significant,

indicating that the resource allocation efficiency of Chinese communication enterprises is better. From 2017 to 2018, PECH was 0.8, and from 2020 to 2021, it was 1.032, with an average value of 0.981, indicating an upward trend in PECH.

(4) From 2017 to 2018, the SECH was 0.913 and 0.981 in 2021, with an average value of 0.980, indicating an upward trend in SECH. However, in the early stages of the epidemic, the PECH and SECH of enterprises decreased, indicating that the epidemic had a certain impact on the operation and manufacturing of communication enterprises, leading to other aspects of resource allocation ability, resource utilization efficiency, and the ability of enterprises to fully utilize existing resources for production activities. The production efficiency of enterprises is influenced by factors such as management, technology, and enterprise scale. This may be due to the failure of enterprises to timely follow up on the development of new technologies in the early stages of the epidemic, rising energy costs, and market changes caused by economic fluctuations, which may affect the demand and supply of the communication industry, making it difficult for enterprises to operate stably and thus affecting efficiency. However, communication companies optimized resource allocation in the second year of the epidemic, and the "14th Five Year Plan for the Development of the Information and Communication Industry" released by the Ministry of Industry and Information Technology in 2021 also had a certain impact on promoting high-quality development and resource allocation in the communication industry. PECH and SECH were improved, and EFFCH continued to progress, reaching 1.013 in 2021.

6. Conclusion and suggestions

This article takes the Chinese communication technology industry as an example and uses a three-stage DEA model to calculate the comprehensive efficiency, PECH, and SECH of 81 listed companies in the communication industry from 2017 to 2021. The Malmquist index is used to compare the annual efficiency values from 2017 to 2021, and the following conclusions are drawn:

By comparing the environmental variables that were not removed and those that were removed, it was found that after removing the environmental variables, the EFFCH, PECH, and SECH all improved to varying degrees, indicating that environmental factors constrain the improvement of enterprise efficiency. However, due to the inability of enterprises to be unaffected by environmental factors, they need to strengthen their management level and capabilities to minimize efficiency losses caused by environmental factors.

Government subsidies can reduce the waste of fixed assets and research and development investment by communication enterprises, mainly benefiting from strict regulation and detailed plans. Therefore, the government can further expand the subsidy intensity and scope for related enterprises, while improving regulatory level and reducing waste of funds. And we should focus on efficient and precise subsidies, rather than inefficient flooding, and prioritize subsidies for key projects closely related to the national economy, national security, and industrial upgrading. Finally, it is necessary to further improve the evaluation criteria and assessment mechanism to motivate enterprises to efficiently utilize funds. Increase subsidies for enterprises that complete industrial planning and achieve established goals; Reduce or even cancel subsidies for enterprises that lack results and fail to achieve their goals. In addition, a phased assessment system can also be implemented, dividing subsidies into multiple cycles. Only when the enterprise completes the goals of one cycle and passes the government and third-party review will it receive subsidies for the next cycle.

The increase in per capita GDP and the proportion of the tertiary industry to GDP in the region has actually increased the waste of fixed assets and research and development investment by communication enterprises, which is mainly affected by blind expansion and excessive investment by enterprises. Based on this, in the era of rapid economic development and continuous social change, only after building a smooth sales channel, having a clear project plan and business model, and determining the practicality of new technologies and the potential of the consumer market, can investment and expansion be carried out. In addition, relevant enterprises need to recognize the

characteristics of the communication industry, which emphasizes research and development, high investment, and slow return. They should always pay attention to the company's cash flow, construct long-term development plans, conduct sustainable scientific research investment, and avoid making irrational decisions in the mindset of pursuing short-term profits in a hurry for quick success.

There is significant room for improvement in both PECH and SECH of communication enterprises, with both showing a downward trend from 2017 to 2021, indicating that there are still many problems in the development of communication enterprises. In order to improve SECH, enterprises should grasp various types of market information and analyze it, focus on improving and digesting resources, and then improve the principles of investment decision-making, improve investment decision-making, enhance their own management and technical level, optimize the structure of innovative resource allocation, achieve collaborative improvement of technical level and SECH, and prevent blind investment. The phenomenon of disorderly expansion has been effectively avoided, effectively improving the rational investment level and investment accuracy of enterprises, and ensuring the healthy development of enterprises in the new era.

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