RESEARCH-ARTICLE

Analysis of the Influencing Factors on the Financing Efficiency of High-Tech Listed Companies in Wuhan Based on the DEA Model

Published: 18 July 2025

GAITDI 2025: International Conference on Implementing Generative AI into Telecommunication and Digital Innovation
July 18 - 20, 2025
Beijing, China

GAITDI '25: Proceedings of the International Conference on Implementing Generative AI into Telecommunication and Digital Innovation 2025 (July 2025)
https://doi.org/10.1145/3771792.3773860
ISBN: 9798400714924

Analysis of the Influencing Factors on the Financing Efficiency of High-Tech Listed Companies in Wuhan Based on the DEA Model

Qiao Yang
School of Economics
Wuhan Business University
Wuhan, Hubei Province, China
cat_qiao@126.com

Xinru Liu*
School of Economics and Management
North China University of Water Resources and Electric Power
Zhengzhou, Henan Province, China
Z20251070708@stu.ncwu.edu.cn

Abstract

This paper analyzes the financing efficiency of 49 high-tech listed companies in Wuhan from both static and dynamic perspectives from 2020 to 2022, and finds that the financing efficiency of high-tech listed companies in Wuhan is showing a downward trend. Subsequently, using the grey relational model analysis, it was found that the main influencing factor on the financing efficiency of Wuhan high-tech listed companies is the circulation of market currency at the macro level and the profitability of enterprises at the micro level.

CCS Concepts

• **Applied computing**; • **Enterprise computing**; • **Service-oriented architectures**;

Keywords

High-tech listed companies, Financing efficiency

ACM Reference Format:
Qiao Yang and Xinru Liu. 2025. Analysis of the Influencing Factors on the Financing Efficiency of High-Tech Listed Companies in Wuhan Based on the DEA Model. In *International Conference on Implementing Generative AI into Telecommunication and Digital Innovation (GAITDI 2025), July 18–20, 2025, Beijing, China.* ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3771792.3773860

1 Introduction

Currently, high-tech industries, as an important engine driving economic growth, profoundly affect the comprehensive competitiveness and development potential of a country or region. Wuhan, as an important city in the central region, has attracted numerous high-tech enterprises to gather here due to its strong industrial foundation and favorable business environment. In recent years, the number of high-tech listed companies in Wuhan has grown rapidly, injecting new vitality into the high-quality development of Wuhan's economy. However, while high-tech enterprises are developing, they also face financing issues. The efficiency of financing directly affects the investment scale, technological innovation, and sustainable development of enterprises. Therefore, in-depth analysis of the factors that affect the financing efficiency of high-tech listed companies in Wuhan is of great significance for optimizing the financing structure of high-tech listed companies in Wuhan, improving the efficiency of fund utilization, and promoting the healthy and sustainable development of the company.

The issue of financing efficiency has also attracted the attention of many scholars at home and abroad. In terms of measuring financing efficiency, scholars have adopted methods such as Tobin's Q coefficient excessive debt, SFA method, DEA and Malmquist index to measure financing efficiency.[1–4] In terms of the influencing factors of financing efficiency, scholars' research has found that internal governance capability and financial reporting internal control capability, board independence.[5, 6] Internal factors such as profitability and debt repayment ability can all affect the efficiency of corporate financing.[7] Meanwhile, external factors such as digital transformation, industrial support from local governments, and the level of financial development will also have an impact on the efficiency of corporate financing.[8, 9] On the issue of how to improve the efficiency of corporate financing, some scholars have found that through market-oriented capital factors, optimizing the technology and financial environment, and optimizing the financing structure, the efficiency of corporate financing can be improved.[10–12]

In summary, the academic community has achieved some enlightening results in the research on corporate financing efficiency. Currently, the factors affecting corporate financing efficiency mainly focus on analyzing from the perspectives of internal and external factors. Unlike the above research, this article analyzes the factors affecting corporate financing efficiency from two different levels: macro and micro. This can provide a more in-depth analysis of the factors that affect corporate financing efficiency.

2 Measurement of Financing Efficiency of High tech Listed Companies in Wuhan City

2.1 Model construction

Data Envelopment Analysis (DEA) is a research method for multi indicator input-output evaluation, which can calculate and compare the relative effectiveness of decision units. Due to the impact of uncertain factors such as economic and policy environments on enterprise operations, this article uses the variable scale return DEA-BCC model and DEA Malmquist model to evaluate the financing efficiency of Wuhan high-tech listed companies from both static and dynamic perspectives.

*Corresponding author

GAITDI 2025, Beijing, China

ACM ISBN 979-8-4007-1492-4/2025/07
https://doi.org/10.1145/3771792.3773860

2.1.1 Introduction to BCC Model. Compared with the CCR model, the BCC model adds convexity constraints, and the optimal solution obtained is pure technical efficiency (PTE), while comprehensive technical efficiency=pure technical efficiency * scale efficiency (TE=PTE * SE). Therefore, by combining the pure technical efficiency value calculated by the BCC model, the scale efficiency value can be solved.

Based on the CCR model, assuming $\sum_{j=1}^{n} \lambda_j = 1$, The BCC model can be represented as:

$$\begin{aligned} &\min[\theta - \varepsilon(\sum_{i=1}^{n} s_i^- + \sum_{r=1}^{n} s_i^+)] \\ &s.t. \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta c_{ij0}, i \in (1,2,\ldots m) \\ &\sum_{j=1}^{n} y_{rj}\lambda_j + s_i^+ = y_{rj0}, r \in (1,2,\ldots m) \\ &\sum_{j=1}^{n} \lambda_j = 1 \end{aligned} \tag{1}$$

The conclusion of model (1) is that when θ =1, Si+=0, and Si-=0, the DMU achieves PTE effectiveness, and the pure technical efficiency reaches its optimum, with the highest level of technical efficiency.

When θ =1, Si+≠ 0, or Si-≠ 0, then the DMU satisfies PTE weak effectiveness. Although its technical level is at the forefront, there is still room for improvement, making its technical level reach the highest level.

When 0<θ<1, the DMU is considered non-PTE effective, indicating that there is a waste of resources in the decision-making unit and the existing investment has not been fully utilized.

2.1.2 DEA Malmquist model. The DEA model can only obtain static efficiency values for each year and cannot observe the dynamic changes in efficiency over time. So we chose to add the Almquist index. The principle is: assuming that k=1,2, K decision units, each decision unit at t=1,2, T phase uses n=1,2, N inputs (k, t) n x, and obtain m=1,2, m types of outputs (k, t) n y,which is the total factor productivity index (TFPch).

$$\begin{aligned} &TFPch = M\left(x^{t+1}, y^{t+1}, x^t, y^t\right) \\ &= \left[\frac{D^t\left(x^{t+1}, y^{t+1}\right)}{D^t\left(x^t, y^t\right)} * \frac{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}\left(x^t, y^t\right)}\right]^{1/2} \end{aligned} \tag{2}$$

When the return to scale remains constant, TFPch is the Technical Efficiency Index (Effch) and the Technical Progress Index (Techch), which are:

$$\begin{aligned} &M\left(x^{t+1}, y^{t+1}, x^t, y^t\right) \\ &= \frac{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D^t\left(x^t, y^t\right)} * \left[\frac{D^t\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}\left(x^{t+1}, y^{t+1}\right)} * \frac{D^t\left(x^t, y^t\right)}{D^{t+1}\left(x^t, y^t\right)}\right]^{\frac{1}{2}} \\ &= Effch * Techch \end{aligned} \tag{3}$$

When the return to scale is variable, the Technical Efficiency Index (Effch) can be further decomposed into the Pure Technical Efficiency Index (Pech) and the Scale Efficiency Index (Sech). The relationship between the final technological progress index (Techch), pure technical efficiency index (Pech), and scale efficiency index (Sech) can be expressed as :TEPch=Techch*Effch =Techch*Pech *Sech

2.2 Indicator selection and sample selection

Following the financing channels of enterprises and drawing on the practices of scholars, the following input and output indicators have been selected .See Table 1 for details.

This article uses panel data from 49 high-tech listed companies in Wuhan , Considering the timeliness of financing efficiency issues, this article selects relevant data of high-tech listed companies in Wuhan from 2020 to 2022 for analysis.

2.2.1 Static analysis. Calculate the average comprehensive technical efficiency between 2020 and 2022, and rank them based on this standard. Here, only the overall financing situation of the top five and bottom five companies is displayed. From the table 2, it can be seen that the top ranked companies have consistently maintained effective financing and performed well. The scale efficiency of financing for the latter five companies is higher than pure technical efficiency.

2.2.1.1 Comprehensive technical efficiency evaluation

From the empirical results in table 3, it can be seen that from 2020 to 2022, there were 5, 3, and 5 high-tech enterprises in Wuhan that achieved effective comprehensive technical efficiency, respectively, with little overall change. At the same time, the number of enterprises with comprehensive technical efficiency in the range of [0.8,1) increased from 7 in 2020 to 10 in 2022, and the number of enterprises with comprehensive technical efficiency less than 0.5 increased from 8 in 2020 to 14 in 2022, an increase of 12.24%.

2.2.1.2 Scale efficiency evaluation

According to Table 4, from 2020 to 2022, the number of enterprises that have achieved effective scale efficiency has not changed significantly, with 5, 3, and 5 respectively, accounting for between 6% and 10%. The number of enterprises with scale efficiency values within the range of [0.8,1) was 7 in 2021, and 13 in 2020 and 2022, accounting for 27%. Most of the enterprises have scale efficiency values mainly concentrated in the range of [0.5,0.8). In 2021, the number of enterprises located in this range accounted for as high as 80%. Overall, some enterprises have experienced a decline in scale efficiency by one level in 2021, such as Liangpinpuzi, which has effectively decreased from scale efficiency value to 0.998. The average scale efficiency of the three years from 2020 to 2022 is around 0.7, lower than the pure technical efficiency value.

2.2.2 dynamic analysis. According to Table 5, the average total factor productivity index of high-tech enterprises in Wuhan from 2020 to 2022 is 0.907, indicating that the financing efficiency of high-tech enterprises in Wuhan is generally declining. To more clearly and intuitively reflect the changes in the Malmquist index of enterprises, a comparative analysis was conducted between the top five ranked enterprises and the bottom five ranked enterprises based on the Malmquist index.

As shown in Table 6, from the top five enterprises in terms of total factor productivity index, the Malmquist index of Guochuang High tech has reached 1.14. This indicates that from 2020 to 2022, the financing efficiency of Guochuang High tech enterprises has maintained an average growth rate of 14%, and its total factor productivity of enterprise financing is much higher than other enterprises. Through comparison, it is found that the technical efficiency index and technological progress index are both high,

Table 1: Input and Output Indicators of DEA Model

Evaluation and measurement indicators		
input indicators	Total Assets	Enterprise size
	Total operating cost	Application of Funds Integration
	Asset liability ratio	capital structure
output indicators	Roe	Profitability
	Total Asset turnover	operating capacity
	earnings per share	growth ability
	Operating profit margin	Market performance of enterprise value

Result and Conclusion Analysis

Table 2: Comparison of Average Financing Efficiency of Wuhan High tech Listed Companies from 2020 to 2022

Comprehensive TechnicalEfficiency Ranking	Company	Comprehensive technical efficiency	Pure Technical Efficiency	Scale efficiency
1	Mingde Biotechnology	1	1	1
2	Liyuan Information	1	1	1
3	Jiabiyou	1	1	1
4	Liangpinpuzi	0.992	0.993	0.999
5	Sifang Optoelectronics	0.963	1.000	0.963
45	Changfei Fiber Optic	0.382	0.593	0.643
46	Jiuzhou Tong	0.378	0.404	0.941
47	Donghu High tech	0.364	0.548	0.664
48	Aerospace Electronics	0.298	0.476	0.625
49	Fenghuo Communication	0.245	0.357	0.687
	average value	0.656	0.858	0.757

Table 3: Comprehensive Technical Efficiency of Wuhan High tech Listed Companies

Comprehensive technical efficiency	2020	2021	2022
1	5	3	5
	10.20%	6.12%	10.20%
[0.8,1)	7	6	10
	14.29%	12.24%	20.41%
[0.5,0.8)	28	27	20
	57.14%	55.10%	40.82%
<0.5	8	13	14
	16.33%	26.53%	28.57%
average value	0.67	0.629	0.668
Non effective proportion	89.80%	93.88%	89.80%

at 1.09 and 1.046, respectively. Further analysis of the technical efficiency index shows that its scale efficiency is only 0.97, which has not reached scale efficiency. Therefore, enterprises need to improve their financing scale to adapt to their technological level. The Malmquist index of Jiuzhou Tong is 1.064, ranking second. Compared with Guochuang High tech, technical efficiency is the main reason for its lower performance. Further research has found that the lowest Malmquist index among the top five companies is the pure technical efficiency index. Therefore, Jiuzhou Tong can improve its financing efficiency by improving its management level. The progress index of Changjiang Communication and Jinyun Laser Technology is relatively low, at 0.98 and 0.947 respectively, which is an important reason for the low total factor productivity index. Therefore, enterprises need to strengthen their investment in scientific research and improve their technological level. Except for the technical progress index reaching 1.128, none of the other indices of Fenghuo Communication have reached an effective value of 1 or above.

From the top five companies in terms of total factor productivity index, the two companies at the bottom, Hengli Drilling Tools and Changyuan Electric Power, have Malmquist indices of 0.755 and 0.766, respectively. Hengli Drilling Tools has a low technological

Table 4: Scale Efficiency of Wuhan High tech Listed Companies

Scale efficiency	2020	2021	2022
1	5	3	5
	10%	6%	10%
[0.8,1)	13	7	13
	27%	14%	27%
[0.5,0.8)	31	39	31
	63%	80%	63%
<0.5	0	0	0
	0%	0%	0%
average value	0.778	0.732	0.76
Non effective proportion	90%	94%	90%

Table 5: Almquist Index of Wuhan High tech Listed Companies

Year	Technical Efficiency Index	technical progress index	Pure technical efficiency index	Scale efficiency index	Total factor productivity index
2020-2021	0.93	0.977	0.99	0.94	0.909
2021-2022	1.051	0.86	1.014	1.037	0.904
average value	0.989	0.917	1.002	0.987	0.907

Table 6: The Top and Bottom Five Companies in the Total Factor Productivity Index of Wuhan High tech Listed Companies

corporate name	Technical Efficiency Index	technical progress index	Pure technical efficiency index	Scale efficiency index	Total factor productivity index
Guochuang High tech	1.09	1.046	1.124	0.97	1.14
Jiuzhou Tong	0.819	1.3	0.786	1.041	1.064
Changjiang Communication	1.079	0.98	1.002	1.078	1.058
Jinyun Laser	1.102	0.947	1.005	1.096	1.043
Fenghuo Communication	0.922	1.128	0.992	0.929	1.04
Sifang Optoelectronics	0.981	0.8	1	0.981	0.785
Weichuang Optoelectronics	0.91	0.857	1	0.91	0.78
Huisheng Biotechnology	0.969	0.798	0.991	0.978	0.774
Changyuan Electric Power	0.793	0.966	0.869	0.913	0.766
Hengli Drilling Tools	0.984	0.767	1	0.984	0.755

progress index of only 0.767, while Changyuan Electric Power has a pure technical efficiency index of only 0.869.

3 EMPIRICAL ANALYSIS OF FACTORS INFLUENCING FINANCING EFFICIENCY OF HIGH TECH LISTED COMPANIES IN WUHAN

Due to the influence of multiple factors on corporate financing efficiency, grey relational analysis has fewer sample requirements and unique advantages when dealing with small sample data with uncertain relationships and no statistical significance. So grey relational analysis is chosen for analysis.

3.1 Analysis process

3.1.1 Determine reference data and measurement data. By reviewing existing relevant literature, the factors affecting the financing efficiency of high-tech listed companies are divided into two categories: internal factors and external factors. Among them, internal factors mainly include financing costs, financing structure, corporate growth, corporate size, and profitability. External factors include the macroeconomic environment, the development of financial institutions and capital markets.

3.1.2 Non dimensionalization of data. Negative indicator:

$$\frac{Max_j - x_{ij}}{Max_j - Min_j} \tag{4}$$

Table 7: Macro Grey Correlation Degree of Wuhan High tech Listed Companies

macro index	GDP	currency in circulation	interest rate
Grey correlation degree	0.561	0.598	0.526

Table 8: Micro Grey Correlation Degree of Wuhan High tech Listed Companies

Micro indicators	Total Assets	Total operating cost	Asset liability ratio	Roe	Total Asset turnover rate	Revenue rate
Grey correlation degree	0.5363	0.5631	0.7568	0.7813	0.6456	0.5757

Positive indicators:

$$\frac{x_{ij} - Min_j}{Max_j - Min_j} \tag{5}$$

$$\xi_{ij} = \frac{minmin\left|x_{ij} - x_{0j}\right| + \rho maxmax\left|x_{ij} - x_{0j}\right|}{\left|x_{ij} - x_{0j}\right| + \rho maxmax\left|x_{ij} - x_{0j}\right|} \tag{6}$$

Equation 3 calculate the correlation coefficient corresponding to each reference data and measurement data. In equation 6, ρ is the resolution coefficient, usually set to 0.5; x_{0j} and x_{ij} are reference data and comparative data respectively; ξ_{ij} is the correlation coefficient, which is a positive number less than 1. Equation 4Take the average of the obtained correlation coefficients, and the average obtained is the Grey Relational Degree (GRD).

3.2 Result analysis

3.2.1 Macro analysis. According to Table 7, the correlation ranking of macro indicators of financing efficiency for high-tech enterprises in Wuhan is:currency in circulation>GDP>interest rate.

The grey correlation coefficients of circulating currency and GDP are 0.598 and 0.561 respectively, ranking first and second. Empirical evidence shows that an increase in the amount of circulating currency is the biggest factor in improving the financing efficiency of Wuhan high-tech listed companies, as it leads to a decrease in interest rates or relaxation of loan conditions. When funds are abundant, it can reduce financing costs and improve financing efficiency; GDP is a secondary factor affecting financing efficiency. GDP growth attracts more capital into the market, expands financing sources, and provides diversified financing options for enterprises. The grey correlation degree of interest rates is only 0.536, ranking last. Although high interest rates increase financing costs, high-tech enterprises have a strong demand for funds, and their impact is relatively small.

3.2.2 Microscopic analysis. From Table 8, it can be seen that the correlation ranking of micro indicators of financing efficiency for high-tech enterprises in Wuhan is as follows: Roe>asset liability ratio>total asset turnover rate> revenue rate>total operating costs>total assets.

The grey correlation degree of the Roe is 0.7823, which is higher than other indicators. The profitability of a company is the most important factor affecting the financing efficiency of high-tech enterprises. The asset liability ratio is the proportion of total liabilities to total assets, which reflects the financing structure of a company. The grey correlation degree of the asset liability ratio is 0.7568, second only to the Roe, and is an important factor affecting the financing efficiency of high-tech enterprises.

The grey correlation degree of total asset turnover rate is 0.6456, ranking third. The total asset turnover rate is an important indicator for evaluating the efficiency of enterprise asset utilization, which reflects that the improvement of enterprise asset utilization efficiency can lead to a significant increase in financing efficiency. The grey correlation degree of revenue rate and total operating cost is 0.5757 and 0.5631 respectively, ranking fourth and fifth. These two indicators have a relatively small impact on the financing efficiency of Wuhan high-tech listed companies.

The grey correlation degree of total assets is 0.5363, ranking last. The total assets reflect the size of the company and have the least impact on the financing efficiency of high-tech companies.

4 Suggestions for improving the financing efficiency of high-tech listed companies in Wuhan

4.1 At the government level

Firstly, develop supportive policies and create a favorable financing environment. On the one hand, targeted fiscal subsidies and tax reduction policies are introduced to directly alleviate the financial pressure on enterprises; On the other hand, collaborating with relevant institutions to use big data technology to build an exclusive credit evaluation and guarantee system aims to enhance banks' credit confidence in high-tech enterprises. This not only helps to reduce financing costs for enterprises, but also effectively drives the steady progress of the economy.

Secondly, Strengthen supervision and services. The government can help businesses understand more financing channels by providing financing consultation and guidance services. Simultaneously building a platform for communication between enterprises and financial institutions, promoting cooperation and exchange between investors and enterprises. In addition, the bond market can be developed to simplify the financing process, increase financing options, and improve financing efficiency and flexibility.

4.2 At the enterprise level

Firstly, Optimize corporate governance structure. Institutional and technological innovation is an important way for high-tech listed companies to optimize internal governance efficiency and improve

financing structure. We can improve the internal decision-making mechanism through institutional reform. In addition, strengthening internal control mechanisms, including measures such as financial auditing, risk management, and compliance supervision, can reduce operational risks, enhance investors' confidence in the company, and thus reduce financing costs.

Secondly, Strengthen the ability of scientific and technological innovation and the transformation of scientific research achievements. Technology is the core competitiveness for the successful financing of high-tech listed companies, so enterprises need to strengthen their technological innovation capabilities, continuously improve their core competitiveness, enhance operational efficiency, and thus continuously improve their financing efficiency.

References

[1] Troplini R.The Determinants of Bank Capital Ratio on the Market Efficiency of Albanian Banks[J].Folia Pomeranae Universitatis Technologiae Stetinensis,2013,15(7):199-209.

[2] Wang Yufeng, Zhang Shuqin .The Impact of Green Finance Reform and Innovation on Investment and Financing of Environmental Protection Enterprises: Empirical Evidence Based on the Green Finance Reform and Innovation Pilot Zone [J] China Circulation Economy, 2023, 37 (5): 118-128

[3] Othman N., Abdul-Majid M., Abdul-Rahman A. Partnership Financing and Bank Efficiency[J]. Pacific-Basin Finance Journal, 2017,2(46):1-13.

[4] Wang Min, Li Huayu, Fu Lei, etc Research on Financing Efficiency and Influencing Factors of Chinese Port Listed Enterprises [J] Operations Research and Management, 2023, 32 (5): 204-210.

[5] Andrey Simonov. The Effect of Board Governance and Internal Control on Investment

[6] Efficiency[J]. Journal of Economics, Business and Management,2020,8(3).

[7] Hyejeong S.,Seun-Young P..The association between board gender diversity and corporate investment efficiency[J]. Korean Accounting Review,2021,46(4).

[8] Wang Wei, Dong Dengxin. Analysis of Financing Efficiency of Technology oriented Small and Medium sized Enterprises in the Ne Third Board Market: An Empirical Study Based on Panel Data of Enterprises in Hubei Province [J]. Securities Market Guide, 2022 (2): 7.

[9] Ma Xinxin, Yin Weiwei.The impact of digital transformation on the financing efficiency of circulation enterprises - based on the perspective of supply chain integration [J] Business Economics Research, 2022 (19): 25-28.

[10] Lei Hui, Liu Qiaoyun.Research on Financing Efficiency of Green and Low Carbon Enterprises Based on Four Stage DEA Model [J].Financial Theory and Practice, 2020,41 (03): 72-78.

[11] Hao Jing.Research on the Impact Mechanism of Capital Factor Marketization on Enterprise Financing Efficiency [J]. Finance and Economics, 2023 (23): 42-44.

[12] Guo Jinlu, Jin Ning, Zhang Jie, etc.Technology Finance and Enterprise Financing Efficiency: Empirical Evidence from High tech Enterprises in the Yangtze River Delta Urban Agglomeration [J] Journal of Central University of Finance and Economics, 2023 (10): 68-80.