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Article

Efficiency of financial support and factors influencing strategic emerging industries: Based on an empirical analysis of listed companies in China

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Abstract: This paper analyzes the characteristics and influence mechanisms of financial support for China's strategic emerging industries. Using a sample of 356 listed companies across nine major industries, we conduct an in-depth analysis of the efficiency of financial support and its influencing factors. In addition, this paper analyzes the influence mechanism of financial support for strategic emerging industries based on the relevant theory of financial support for industry development. It clarifies the internal and external influencing factors. Based on the theoretical analysis, a two-stage empirical investigation was conducted: The data of 356 listed companies in strategic emerging industries from 2010 to 2022 were selected as a sample, and the data envelopment analysis (DEA) method was applied to measure efficiency. The influencing factors were then analyzed using a Tobit regression and an intermediate effects test.

Keywords: strategic emerging industries; financial support efficiency; DEA model; Tobit & intermediary effect model

1. Introduction

After the financial crisis in 2008, the world economy went into a shock adjustment; countries actively sought new economic growth points, multinational high-tech, emerging industry development as a breakthrough point to establish competitive advantages in the field of emerging industries, crank up economic recoveries, such as the United States, Japan, and other developed economies to vigorously support the development of new energy automobile industry (Meng and Jin, 2019). In addition, in conjunction with China's economic development, optimizing the financial structure and industrial upgrading is the next step to promote better and faster economic development, as the energy-intensive, high-polluting extensive development model of reform and opening up is not adapted to the current stage of development in China (Xiao et al., 2018).

Based on the above background, China first introduced the concept of "strategic emerging industries" in 2009 (He and Zhu, 2022). Considering the national changes and industrial development, in 2018, the National Bureau of Statistics timely updated the "Strategic Emerging Industry Classification (2018)" to establish a new generation of information technology, new materials, high-end equipment, biological, new energy vehicles, energy conservation, environmental protection, digital creativity, related services and so on as nine strategic emerging industries (Huimin et al., 2018).

Although the concept of strategic emerging industries has not been known for a long time, it has experienced rapid development momentum and unique vitality

against the background of economic downturn through comprehensive policy promotion. It has begun to be a leading driving force for economic development. China has recently exerted significant efforts to establish a contemporary industrial structure, resulting in the rapid growth of emergent industries. The significance of critical emerging industries in fostering economic development is progressively growing. The contribution of China's strategic developing sectors to GDP increased from 4% in 2010 to over 8% in 2015, and the proportion of 2022 more than 13%; the "14th Five-Year Plan" and the 2035 vision outline target proportion of more than 17% (Shou and Chen, 2023), the proportion of GDP continues to improve, means that emerging industries always kept higher than the overall GDP growth rate.

In reality, the Chinese financial system is imperfect and is still dominated by indirect forms of financing such as bank loans (Zhang et al., 2012). There is still a long way to go before becoming the pillar of industry and an important growth point in the development of the national economy (Zhu, 2010). It is crucial to examine methods for enhancing the effectiveness of financial assistance in promoting the growth of strategic developing sectors. This study also recognizes the importance of supporting China's economic development, making it a key focus (Huang et al., 2023).

This paper uses the DEA (data envelopment analysis) method to measure the efficiency of financial support, which is helpful in finding the efficiency problems of the current financial system that supports industrial development and grasping the possible direction of the financial side to promote industrial development (Nguyen et al., 2016). Previous research of the influencing factors of financial support efficiency mainly focuses on the external influencing factors (Wei et al., 2022). This study believes that in the mechanism of generating financial support efficiency, the process of internal allocation of enterprise funds is equally important, such as innovation and R&D investment. Therefore, this paper considers the issue of internal allocation of enterprise funds in the empirical part to make up for the shortcomings of previous studies. The main innovation point of this paper lies in the innovation of research ideas, which examines the effects of receiving financial support—business innovation and R&D investment—on the efficiency of financial support. This paper in the analysis of external innovation factors, tests the intermediary effect to explore the financial system to support the development of strategic emerging industries, the rational allocation of financial resources to the importance of innovation activities, no longer limited to most research from the financial resources into an end analysis of how to improve the efficiency of financial support inherent thinking. The research scope of this paper is broader, the research subject is more comprehensive, and the conclusions drawn are more in line with reality.

2. Literature review

2.1. Related concepts

There are related concepts such as "emerging industries" and "strategic industries" abroad (Ma and Wu, 2018). In 2009, Wen Jiabao, then premier, pointed out that strategic emerging industries must master key core technologies and have market demand prospects. In general, Strategic emerging industries focus on innovation, strategic leadership, and industrial relevance (Yu et al., 2013). In 2018, the National

Bureau of Statistics released the "Strategic Emerging Industry Classification (2018)" which categorizes specific industrial divisions. These divisions include new generation information technology, new materials, high-end equipment manufacturing, new energy, new energy vehicles, biology, energy conservation, environmental protection, digital creativity, and related services. These are considered the nine major strategic emerging industries (Wang and Huang, 2023).

Financial support means that the financial system supports the development of the economy, industries, and enterprises by providing financial financing (Tu, 2023). From a macro perspective, the state introduces macroeconomic policies, especially financial policies, to regulate the national economic operation and support the capital accumulation of related industries, so as to promote the industrial development and the upgrading and optimization of the overall industrial structure. At the micro level, enterprises are the main body of market economic activities. The financial system is based on the development of the real economy, and its most important function is to provide financing for real enterprises and help their development (Allen et al., 2012). At present, the academic community has not reached a consensus on the definition of the scope of financial support. On the one hand, due to the differences in macro and micro perspectives and research perspectives, on the other hand, it is also related to the continuous development of the financial system and the continuous innovation of financial instruments.

The efficiency of industrial financial support refers to the efficiency level of financial resource input and output in the process of industrial evolution, including the efficiency of capital allocation when enterprises injecting financial support into production and the economic conversion efficiency of production and operation promoting output (Huang, 2020). Financial support efficiency includes comprehensive technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE) (Cao and Zhang, 2021). TE is the maximum output at the established input or the minimum input at the established output, indicating the most effective utilization level of resource efficiency of the industry; the efficiency of PTE, which can more truly reflect the efficiency level of the industry after removing the influence of scale; SE is the efficiency level of the scale factor, which reflects the change caused by the change of industrial scale. In this paper, the final presented efficiency value is TE. Strategic emerging industries enterprise financial support efficiency reflects the policy support, financial institutions, and capital market in strategic emerging industries between enterprises to realize the degree of optimal allocation of capital resources; its connotation is the strategic emerging industries enterprises with the lowest transaction cost for financial resources and use of financial resources to realize the ability to maximize output (Yang et al., 2023).

2.2. Related research

2.2.1. Research on strategic emerging industries

The latest international research on emerging industries is focused on technology (Horii, 2012). Combined with the endogenous growth theory to explain the emergence process of emerging industries: the knowledge accumulation of traditional industries reduces production costs, but at the same time, with the decrease of learning income,

some companies in the industry begin to develop new technologies and tap potential consumer demand, so that the industry enters a new growth cycle. Yun et al. (2019) empirically studied the different roles of technology and business models in the development of transition and emerging industries. For emerging industries such as intelligent robots, focusing on the industrial development in the early stage. After the industry is relatively mature, we can strengthen the relationship between the business model and strengthen the business model, change customer perception, stimulate new demand, and occupy the market.

In 2009, China first proposed the concept of "strategic emerging industries", and scholars mainly conducted relevant research on development strategies in order to accelerate the development of the industry. Li and Lv (2010) pointed out that the current international competition pattern has undergone profound changes, knowledge and technology have become the key elements, and the global production and innovation network has been reshaped. China needs to seize the opportunity to realize the open development of strategic emerging industries by combining its comparative advantages with traditional industries. Zhang et al. (2018) argued that strategic emerging industry has become China's new economic era is an important part of the modern economic system, but the innovation ability, lack of core technology is still outstanding, and industry cluster innovation network to promote strategic emerging industry cluster collaborative innovation ability and competitive advantage plays an important role. Wang and Wang (2020) measured the spatial agglomeration level of strategic emerging industries in the 11 provinces, and found that the characteristics between 2012 to 2016; human capital and industrial correlation play a positive role in promoting the spatial agglomeration level (Wang et al., 2021) analyzed the diffusion process of new material industry related policies in 31 provinces and cities in mainland China in 2005–2018. The results showed that the local "local ability" affected the diffusion of relevant policies, among which the resource endowment, industrial development, and knowledge and skills had a positive impact on the policy diffusion, and the institutional environment was negatively related.

2.2.2. Research on finance in promoting the development of strategic emerging industries

Foreign countries have studied the development relationship between finance and science and technology industries and emerging industries earlier. Schumpeter has suggested that the banking system can effectively promote the development of these companies by identifying quality enterprises and providing financial support (Schumpeter, 1954). But there are scholars who hold different opinions, such as Morck and Nakamura (1999); Weinstein and Yafeh (1998), the bank for security and profit maximization, when lending risk aversion, reluctant to capital development prospects are not clear industry, support for industry innovation activities is not active, so the bank dominated financial system will inhibit industrial innovation. The debate has subsided as emerging industries thrive with the support of the financial system. Guariglia and Liu (2014) have identified the important promoting role of financial support through empirical research in the UK. Pradhan et al. (2018) have investigated the venture capital institutions in 23 European countries and found that they have significantly improved the innovation ability of enterprises. Sun et al. (2019)

investigated the impact of consumer subsidies and manufacturer subsidies on the electric vehicle industry based on the data of the US automobile industry in 2010. The results show that consumer subsidies can better promote the development of the electric vehicle industry, among which the intensity and duration of subsidies are important factors.

In China, research on finance to promote the development of strategic emerging industries is more systematic and in-depth. Since the concept was first proposed in 2009, the academic community has discussed how to play the financial system in supporting the development of strategic emerging industries from various aspects. Zheng (2009) proposed that emerging industries need a good financing environment in their development process to upgrade and optimize their industrial structures. Qian (2020), based on the data of biomedical enterprises on the New Third Board, empirically studied the impact of venture capital on the growth of emerging industries. Venture capital plays a significant role in promoting it, among which government background, specialization, and joint investment play a more significant role in promoting it. As for the traditional bank credit system, Hu (2021) found that the key to the bank-enterprise game lies in the measurement of the risk degree of banks. It can solve the problem of information asymmetry to a certain extent by establishing an information exchange platform and an effective default punishment mechanism. In general, the existing research mainly focuses on the problems existing in the process of financial support between the government and the financial market, and has little research on the role and problems of enterprises and their behaviors in the process of improving the efficiency of financial support.

2.2.3. Research on the measurement of financial support efficiency

Financial support efficiency refers to the efficiency level between financial resource input and industrial output in the process of industrial development. It can be further decomposed into the efficiency of the process of industrial acquisition of financial resources, as well as the transformation efficiency of financial resources in promoting the improvement of industrial output in the specific production and operation process.

For the problem of efficiency measurement, the total factor productivity index method proposed by Solow (1957) was first used, which was widely used in the measurement and calculation of production efficiency. However, this method has its limitations: the efficiency calculation process is more complicated, and the labor, capital, and other factors involved in the calculation process lack unified measurement standards, which are more subjective and affect the accuracy of the measurement results. Subsequently, Charnes et al. (1978) proposed a new calculation method: data envelopment analysis (DEA), which evaluates the relative effectiveness of the same units based on multiple input and output indicators. DEA method breaks the limitation of single input-single output mode and is used for the measurement of multi-input-multiple output, which is closer to the actual situation. At the same time, the index selection also avoids the subjective problem. After its launch, this method is widely used in the efficiency evaluation of different industries and departments, involving more input and more output. Currently, the DEA method has become the main measure of financial support efficiency.

Financial support efficiency in the process of measurement, input and output index selection about efficiency index accuracy, the study for output index selection idea is more consistent, more return on assets, main business income growth rate and other general output index, and for the choice of input index differences between different studies, involves the financial support scope. Li and Yang (2017) selected the shareholder equity ratio, asset-liability ratio, and financial deepening index as input indicators for the measurement of financial support efficiency. The financial deepening index was expressed as the ratio of M2/GDP to measure the degree of government relaxation of financial intervention and reflect the strength of policy support in financial support. Shen's (2019) research in energy conservation and environmental protection industry financial support efficiency measurement, in the direct financial measurement, but also attaches great importance to the role of government support, in the income statement of operating income as a government subsidy index to measure the government in the form of incentives and subsidies to provide financial support.

3. Methodology

3.1. Data sources

This article aims to analyze the overall situation of financial support for strategic emerging industries and based on the availability of data, select listed companies in strategic emerging industries as the research object to explore the current multi-level financial system, strategic emerging industry financial support of listed companies is effective, change, and the factors affecting the efficiency of financial support. As a result, it is feasible to estimate the effectiveness of financial support in strategic emerging industries using the financial support performance of listed businesses in those areas. The primary sources of data used in this article are the CSMAR database, the Shenzhen Stock Exchange, and the Shanghai Stock Exchange.

3.2. Sample selection

Sample sources and statistics of listed companies of strategic emerging industries are shown in **Table 1**. This paper selects a total of 356 sample stock companies included in the "China Strategic Emerging Industries Composite Index" as of 28 September 2023. The sample stock companies are A-shares of listed companies.

Table 1. Sample sources and statistics of listed companies of strategic emerging industries.

Exchange	Number
Shanghai Stock Exchange	189
Shenzhen Stock Exchange	167
Total	356

3.3. Research hypotheses

Hypothesis 1: The comprehensive input of financial support is directly proportional to the efficiency of financial support.

Hypothesis 2: The intensity of R&D and innovation investment is directly proportional to the efficiency of financial support.

Hypothesis 3: The profit margin of the main business is directly proportional to the efficiency of financial support.

Hypothesis 4: The equity balance index is directly proportional to the efficiency of financial support.

Hypothesis 5: The operating mechanism between the investment in financial support, the intensity of investment in R&D and innovation, and the efficiency of financial support differs among firms with different ownership rights.

3.4. Research models and indicators

3.4.1. DEA model

This paper selects the DEA method to calculate the financial support efficiency in China's strategic emerging industries. Choosing the appropriate input and output index to define is the primary problem of DEA measurement (Zhang et al., 2023). The characteristics of strategic emerging industries should be combined in the selection of input and output indicators. Strategic emerging industries listed companies compared with non-strategic emerging industries listed companies, showing high investment, high profitability, high risk, strong innovation, knowledge-intensive, and integration characteristics, and these characteristics in this paper select the efficiency of strategic emerging industry financial support index has an important guiding role (Guan et al., 2022). Based on the above for the strategic emerging industry development in the process of financing demand and supply path analysis, and after reading the literature, this paper selects the internal financing rate, bank lending rate, equity financing rate, debt financing rate, and government subsidies as input index, output index is set for return on equity and the main business income growth rate. **Table 2** shows the calculation method of specific indicators.

Table 2. Input-output indicators.

Input-output indicators	Name of indicator	Method of calculation
Input indicators	internal financing ratio	(Surplus reserves + undistributed profits)/Total assets (Li, 2020)
	Bank lending rate	(Short-term loans + long-term loans)/Total assets (Cottarelli and Kourelis, 1994)
	Equity financing ratio	(Paid-in capital + capital reserve)/total assets (Müller and Zimmermann, 2009)
	Bond financing ratio	Total bonds/assets payable (Morellec et al., 2015)
	Government support rate	Government subsidies/total assets (Doh and Kim, 2014)
Output indicators	Return on equity	Net profit/total net assets (Kijewska, 2016)
	Growth rate of main business income	Current year's main business income/previous year's main business income − 1 (Diewert, 2005)

3.4.2. Tobit model & mediation effect model

The DEA model measures the relative efficiency by comparing and evaluating multiple input and multiple output DMU (Decision Making Unit), not considering the degree of environmental factors on the efficiency, and the Tobit model can effectively fill this gap. (Tobin, 1958) proposed a Tobit regression model to solve the existing limitations and extreme values of the explained variables in the empirical analysis,

which is suitable for continuous variables with positive values, and some of the variables are 0. After development, the Tobit model was developed, forming two forms of the discrete data model and a restricted continuous variable model; the latter is widely used (Amemiya, 1984). Since the value of the explanatory variables in this paper comes from the efficiency value calculated by the DEA in the previous stage, showing cut-off characteristics. In order to explore the factors influencing the efficiency of China's financial support for strategic emerging industries, the restrictive continuous variable Tobit model is selected to conduct an empirical analysis of the factors influencing financial support efficiency.

The Tobit basic model is expressed as:

$$Y_i = \beta_0 + \beta^T X_i + \mu_i \quad (1)$$

if $Y_i > 0$, $Y = Y_i$; if $Y_i \leq 0$, $Y = 0$.

In the model, the Y_i for the explained variable, representing the integrated efficiency, X_i for the explanatory variable, representing the influence factor value, β^T for the estimated parameter vectors, μ_i for random errors.

The mediation effect model is applicable to the analysis of the specific influence mechanism of explanatory variables—Compared with traditional regression analysis, mediation effect analysis can get more in-depth analysis results, which is widely used in economics, psychology, and other fields (Fairchild and MacKinnon, 2009). The basic model and model path diagram are shown in **Figure 1**:

$$Y = cX + e_1 \quad (2)$$

$$M = aX + e_2 \quad (3)$$

$$Y = c'X + bM + e_3 \quad (4)$$

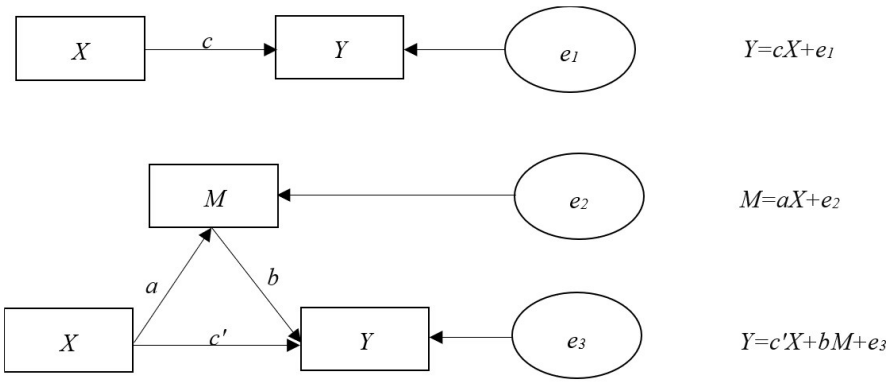

Figure 1. Mediation effect model path.

The mediation effect model is not complicated, and the model focuses on the test of the mediation effect. At present, there are many test methods proposed by the academic circle, such as the stepwise method, Bootstrap method, Sobel method, etc. After integrating recent studies, this paper decided to use the inspection process of comprehensive test and Bootstrap method to conduct the intermediary effect test (Wen and Ye, 2014b). The inspection procedure is shown in **Figure 2**.

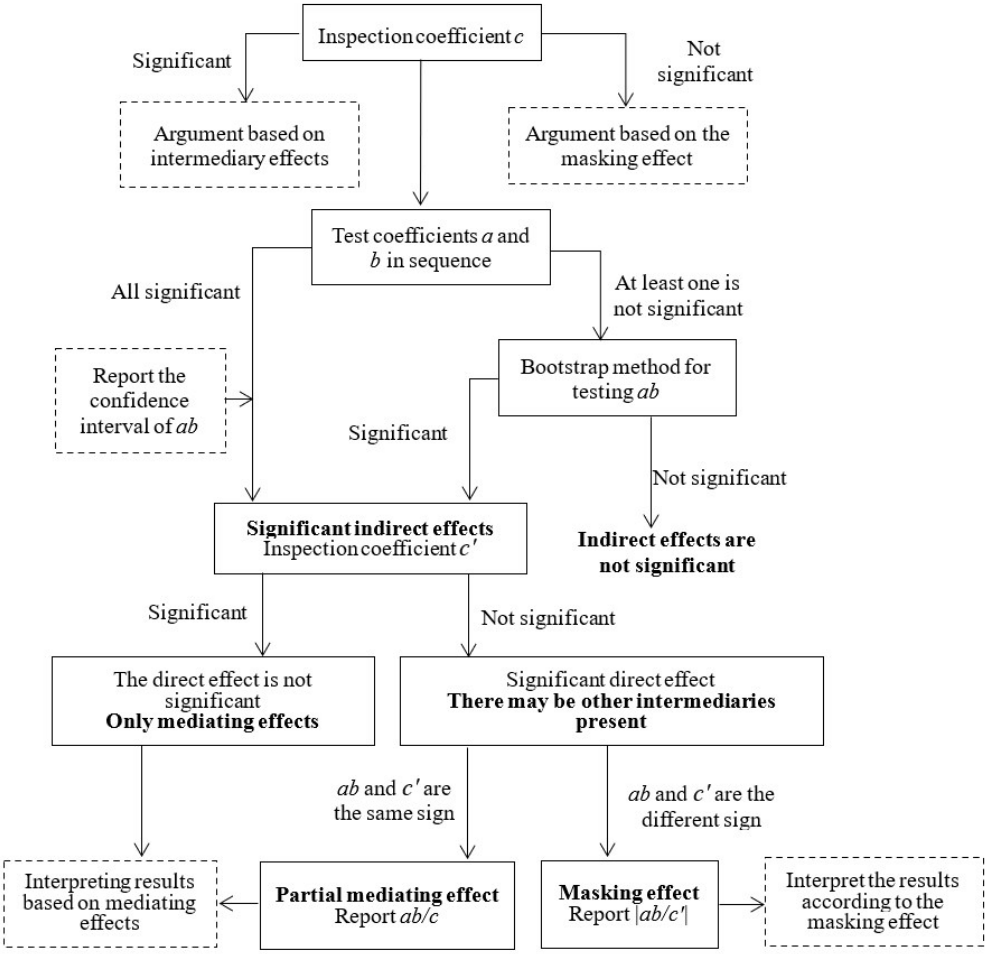

Figure 2. Test process of mediation effect.

The factors affecting financial support efficiency are as follows: The financial support efficiency value (FSE) calculated by the empirical research DEA method is selected for the explained variables.

The explanatory variables include: integrated financial support investment (Inv), operation profit of entirety (OPE), and equity balance degree (ED). Inv reflects the investment intensity of financial support obtained by enterprises, which is divided by the financing amount of policy, credit, capital market, and other aspects obtained by enterprises by the total assets of the enterprise. At the same time, it corresponds to the "financing scale" factor obtained from the theoretical analysis of the influencing factors of financial support efficiency. OPE and ED reflect the operation and management situation of enterprises, which correspond to the two influencing factors of "market competition degree" and "equity structure" respectively.

The intermediary variable selects the R&D innovation investment intensity (RI), which expresses the ratio between the R&D investment and the financial support obtained by the enterprise, measures the proportion of the enterprise invested in the R&D activities after obtaining financial support, and corresponds to the influencing factors of "capital allocation" in the theoretical analysis part of the influencing factors (Leung and Sharma, 2021).

The control variables choose the enterprise ownership nature (Own), and the Own

variable corresponds to the influencing factors of the "enterprise ownership nature" in the theoretical analysis part. There may be significant differences in measuring the efficiency of financial support between state-owned and non-state-owned enterprises. In this part, we will understand whether there is any difference in efficiency influence mechanism through regression analysis of property rights. The model variables and variables are defined in the following **Table 3**.

Table 3. Tobit & mediation effect model indicators.

Types	Variables	Indicator symbol	Value of variables
Dependent variables	Financial support efficiency	FSE	DEA method calculation results (Doan et al., 2023)
Intermediate variables	Investment in R&D and innovation	RI	R&D investment/Financial support (Fabrizio and Tsolmon, 2014)
Independent variables	Financial support investment intensity	Inv	Comprehensive investment in financial support obtained by enterprises/Total assets (Hu and Yang, 2022)
	Operation profit of entirety	OPE	Main business profit/Main business income (Nuryani et al., 2015)
	Equity balance degree	ED	Shareholding ratio of the second and third major shareholders/ Shareholding ratio of the largest shareholder (Zhu et al., 2020)
Control variables	Nature of enterprise ownership	Own	Dummy variable, 1 for state-owned enterprises and 0 for private enterprises (Dewenter and Malatesta, 1997)

The following regression model can be established accordingly:

$$FSE = c\text{In}v + \gamma_1 OPE + \delta_1 ED + \varepsilon_1 \quad (5)$$

$$RI = a\text{In}v + \gamma_2 OPE + \delta_2 ED + \varepsilon_2 \quad (6)$$

$$FSE = c'\text{In}v + bRI + \gamma_3 OPE + \delta_3 ED + \varepsilon_3 \quad (7)$$

4. Results

4.1. Sample statistical distribution

In terms of sample data, in order to compare and study the development trends of strategic emerging industries, this article selects data from 2010 to 2022 for comprehensive research. The data is sourced from the CSMAR database, as well as the Shanghai Stock Exchange and Shenzhen Stock Exchange. The measurement of financial support efficiency needs to ensure the continuity of sample data over time (Liu et al., 2020). Therefore, based on 2010 as the benchmark and the condition of continuous operation and availability of data from 2010 to 2022, a total of 356 listed companies were selected as samples. According to the classification of exchanges, there are 189 on the Shanghai Stock Exchange and 167 on the Shenzhen Stock Exchange. According to the nature of enterprise ownership, there are 238 state-owned enterprises and 118 non-state-owned enterprises. The Shanghai Stock Exchange mainly focuses on state-owned enterprises, with state-owned enterprises accounting for 5.5 times more than non-state-owned enterprises; the Shenzhen Stock Exchange mainly focuses on non-state-owned enterprises, with slightly more non-state-owned enterprises than state-owned enterprises. The specific distribution of sample companies is shown in **Table 4**.

Table 4. Distribution of sample companies.

Exchange	State-owned enterprise	Non state-owned enterprises	Total
Shanghai Stock Exchange	160	29	189
Shenzhen Stock Exchange	78	89	167
Total	238	118	356

4.2. Efficiency value and trend of financial support for strategic emerging industries

The Stata16 software was used to measure the efficiency of financial support from 2010 to 2022. The results are shown in **Figure 3**. The figure shows the overall sample of strategic emerging industries from 2010 to 2022, as well as the changing trends in financial support efficiency. The analysis of the trends shows that the trends in financial support efficiency of the Shanghai Stock Exchange and Shenzhen Stock Exchange are basically consistent, with the highest being 0.37 and the lowest being 0.10. The overall financial support efficiency of the Shanghai Stock Exchange is higher than that of the Shenzhen Stock Exchange. The efficiency of financial support fluctuated greatly from 2010 to 2014, showing an overall upward trend after 2014, and began to rapidly decline after 2019.

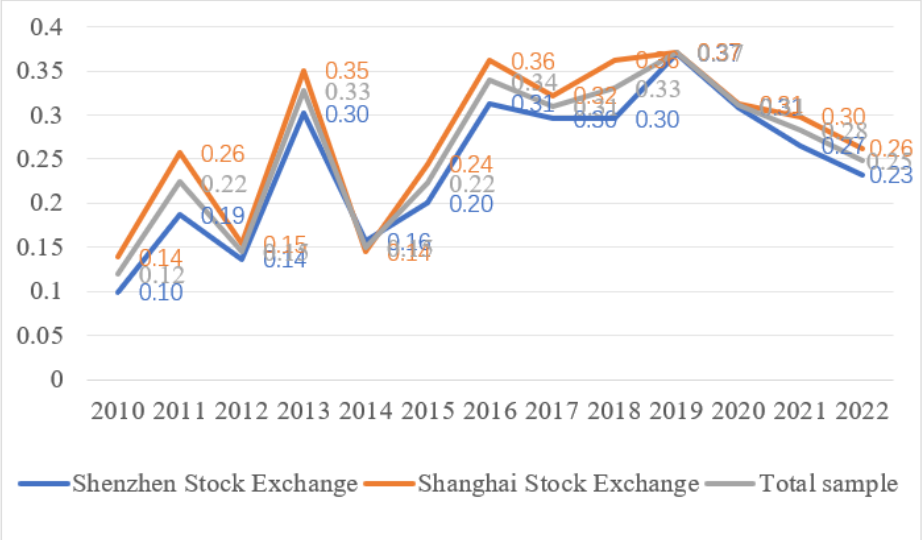

Figure 3. Comparative analysis of financial support efficiency between Shanghai Stock Exchange and Shenzhen Stock Exchange.

The economic crisis began to erupt in 2008 (Stiglitz, 2009), and in 2010, the country started to clarify the concept of strategic emerging industry development and encourage its development. It can be seen that under the guidance of national policies, the efficiency of financial support for strategic emerging industries began to increase. However, due to various factors, such as the continued impact of the financial crisis, the level of technological innovation, and the decline in concept popularity, the operation and profitability of strategic emerging industries have been affected to a certain extent, resulting in significant fluctuations in financial support efficiency. From 2010 to 2014, the efficiency of financial support fluctuated significantly, with

the maximum difference exceeding 0.2. After 2014, industrial development entered a period of adjustment. During this period, there were powerful measures by the government to encourage industrial structure adjustment and upgrading and to continuously encourage the development of strategic emerging industries (Hong, 2017). However, due to unfavorable factors such as technological innovation and US suppression, the efficiency of financial support fluctuated after a rapid increase but overall showed an upward trend, maintaining a relatively high and stable level. The outbreak of the pandemic began at the end of 2019, and the efficiency of financial support continued to decline due to the impact of the pandemic, dropping from the highest point of 0.37 to 0.23, indicating that the pandemic has a significant impact on the efficiency of financial support.

4.3. Ownership nature of enterprises financial support efficiency value and trend of changes

The Stata16 software was used to measure the efficiency of financial support for different types of enterprises from 2010 to 2022, as shown in **Figure 4**. From the perspective of enterprise nature classification, the number of state-owned enterprises has a significant advantage, accounting for 238 (about 67%), and the number of non-state-owned enterprises is about half of the number of state-owned enterprises. This distribution also reflects the "emerging" attribute of strategic emerging industries, which face greater uncertainty in the development process and require strong support from state-owned capital and national level support (Ke et al., 2023).

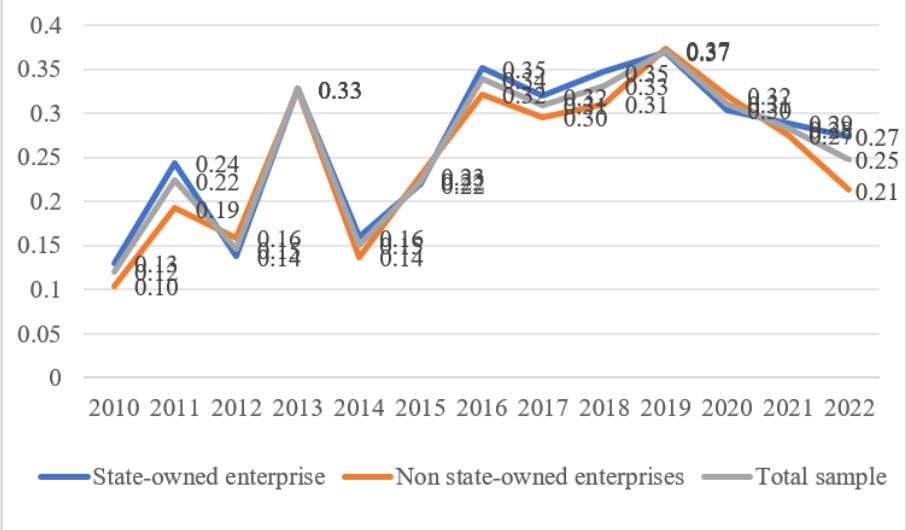

Figure 4. Comparative analysis of financial support efficiency between state-owned and non-state-owned enterprises.

From **Figure 4**, it can be seen that according to the nature of enterprise ownership, state-owned enterprises have slightly higher financial support efficiency values than non-state-owned enterprises throughout the statistical period, and state-owned enterprises are better at utilizing financial support than non state-owned enterprises (Assagaf and Ali, 2017). Comparing efficiency values, it can be seen that during the period of steady increase in financial support efficiency from 2014 to 2019, state-

owned enterprises had higher efficiency values than non-state-owned enterprises. During the period of efficiency decline from 2019 to 2022, non-state-owned enterprises also experienced a greater decline than state-owned enterprises. The previous analysis showed that state-owned enterprises, due to their ownership nature and scale, are more likely to gain the favor of financial capital. Therefore, they have shown better efficiency in utilizing financial support most of the time. At the same time, they have been less impacted during the industry development and adjustment period of financial support development (Fan and Hope, 2013).

4.4. Empirical analysis of factors influencing the efficiency of financial support for strategic emerging industries

4.4.1. Analysis of regression results

Descriptive statistics were conducted on the model using Stata16 software, and the results are shown in **Table 5**.

Table 5. Descriptive statistics of Tobit & mediation effect model.

Variable	Mean	s.d.	Min	Max
FSE	0.26	0.284	0	1
Inv	1.35	0.175	0.855	1.792
ED	0.49	0.42	0.00425	2
OPE	0.229	0.194	−6.019	1.069
RI	0.00133	0.00682	0.00024	0.121

A regression analysis was conducted on the factors that influence financial support efficiency using Stata16 software based on the Tobit model. The results are shown in **Table 6**.

Table 6. Regression results.

	(1) FSE	(2) RI	(3) FSE
Inv	0.263***	0.00195***	0.261***
	[0.0199]	[0.0006]	[0.0199]
RI			1.237***
			[0.4573]
OPE	0.0448*	0.00197**	0.0423*
	[0.0247]	[0.0008]	[0.0247]
ED	0.0506***	−0.00286***	0.0541***
	[0.0183]	[0.0006]	[0.0183]
_cons	−0.379***	−0.00111	−0.377***
	[0.0273]	[0.0009]	[0.0272]
LR	3263.60	53.82	3270.90
P	0	0	0

Note: Standard errors in brackets; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

On the one hand, referring to the mediation effect testing method proposed by

(Wen and Ye, 2014a), the first step is to test Equation (1): the coefficients *c* and *c* are significant, indicating the existence of mediation effects. The second step is to sequentially test the coefficients a in Equation (2) and *b* in Equation (3), both of which are significant, indicating a significant indirect effect; The third step is to test the coefficient *c'* in Equation (3), and the result is significant, indicating that apart from indirect effects, direct effects exist and are significant; Step 4, compare the symbols *ab* and *c'*, both positive, indicating partial mediation effect, hypothesis 2 holds. According to the regression results in **Table 6**, after calculation, the ratio of the mediating effect to the total effect is $ab/c = 0.92\%$. The above results indicate that the efficiency of financial support is not only directly influenced by financial resource support but also influenced by the mediating effect of investment in research and development innovation activities (Liao and Rice, 2010).

On the other hand, the regression results also showed the degree to which the five major variables, including explanatory variables, mediating variables, and control variables, affect the efficiency of financial support. The analysis is as follows:

For the comprehensive investment in financial support, the regression results of Equations (1) and (3) are significantly positive, and hypothesis 1 holds. A large coefficient indicates that the level of investment in financial support will significantly affect the efficiency of financial support. The more investment, the more significant the improvement in efficiency (Kivijärvi and Saarinen, 1995). Meanwhile, compared to Equation (1), after introducing the variable of R&D investment intensity, the coefficient of comprehensive financial support investment in Equation (3) slightly decreases and is smaller than the absolute value of R&D innovation investment intensity coefficient, indicating that financial support investment plays a significant role in improving output efficiency. If it can be effectively allocated to R&D innovation activities, the comprehensive efficiency of financial support will be significantly improved (Hong et al., 2015).

For the main business profit margin, the regression result is significantly positive, and hypothesis 3 holds. The profit margin of the main business reflects the profitability of the enterprise and is strongly correlated with the level of competition. Generally speaking, strategic emerging industries, due to their advanced technology and low market competition, have higher profit margins for their main businesses, stronger profitability, and market competitiveness. Companies have more financing channels and are more likely to be favored by capital (Claessens and Perotti, 2007). Therefore, the profit margins of their main businesses are positively correlated with the efficiency of financial support.

For the degree of equity balance, the regression result is significantly positive, and the absolute value of the coefficient is relatively small. Hypothesis 4 is valid. The higher the degree of equity balance, the more dispersed the rights of shareholders, the more balanced the power of major shareholders, and the easier it is for shareholders to supervise each other and make joint decisions, avoiding “one talk” (Xu et al., 2019). At the same time, the allocation, use, and supervision of financial resources are more efficient, which can promote the improvement of financial support efficiency (Guo et al., 2020).

4.4.2. Robustness testing

This study used two methods for robustness testing (Fernandez et al., 2005). One is to change the regression method and replace Tobit regression with OLS regression; The second is to replace variables: replacing the comprehensive financial support investment with narrow financial support investment, only summing up the financial support investment in the three major channels of credit, stocks, and bonds, reducing internal financing and government support investment compared to the original model's comprehensive financial support investment variables.

After inspection, the results are shown in **Table 7**. In terms of variable significance, when testing after replacing variables, all variables were significant. The direction and degree of influence are basically consistent with the regression results. In terms of the core mediation effect test, it was found that the mediation effect was significantly established in both cases, with mediation effects accounting for 0.96% and 0.91% of the total effect, respectively (the original regression result was 0.92%).

In summary, the robustness test results are consistent with the main conclusions obtained, and the regression results have general applicability.

Table 7. Robustness test.

	OLS Regression			**Variable Substitution**		
	(1) FSE	**(2) RI**	**(3) FSE**	**(1) FSE**	**(2) RI**	**(3) FSE**
Inv	0.253***	0.00195***	0.251***	0.361***	0.00253***	0.357***
	[0.0189]	[0.0006]	[0.0189]	[0.0303]	[0.0010]	[0.0302]
RI			1.240***			1.300***
			[0.4391]			[0.4589]
OPE	0.0502**	0.00197**	0.0477**	0.0442*	0.00196**	0.0416*
	[0.0235]	[0.0008]	[0.0235]	[0.0248]	[0.0008]	[0.0248]
ED	0.0501***	−0.00286***	0.0537***	0.0516***	−0.00285***	0.0553***
	[0.0177]	[0.0006]	[0.0177]	[0.0184]	[0.0006]	[0.0184]
cons	−0.285***	−0.00111	−0.284***	−0.332***	−0.000656	−0.331***
	[0.0254]	[0.0009]	[0.0254]	[0.0262]	[0.0008]	[0.0262]
R^2	0.4967	0.0116	0.4976	3230.98	51.2	3238.98
P	0	0.002	0	0	0	0

Note: Standard errors in brackets; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.4.3. Analysis of the regulatory effect of ownership rights

In the measurement, it was found that there were obvious differences between enterprises with different ownership rights (He et al., 2015). Under the current financial system, there are differences in the difficulty for enterprises with different ownership types to obtain financial support. At the same time, based on the differences in ownership types, there are also differences in the allocation and utilization of financial resources and efficiency within enterprises (Wang et al., 2014). The regression results of the influencing factors of ownership rights are shown in **Table 8**.

Table 8. Regression results of ownership rights.

	State-owned enterprise			**Non state-owned enterprises**		
	(1) FSE	**(2) RI**	**(3) FSE**	**(1) FSE**	**(2) RI**	**(3) FSE**
Inv	0.340***	0.00194*	0.339***	0.135***	0.00147**	0.131***
	[0.0261]	[0.0010]	[0.0261]	[0.0336]	[0.0007]	[0.0336]
RI			0.906*			2.574**
			[0.5006]			[1.0595]
OPE	0.0538*	0.00163	0.0523*	0.0381	0.00283***	0.0308
	[0.0282]	[0.0011]	[0.0282]	[0.0494]	[0.0011]	[0.0494]
ED	0.0594**	−0.00412***	0.0631***	0.0335	−0.00114*	0.0365
	[0.0235]	[0.0009]	[0.0236]	[0.0291]	[0.0006]	[0.0291]
_cons	−0.475***	−0.000925	−0.474***	−0.233***	−0.000795	−0.231***
	[0.0364]	[0.0014]	[0.0364]	[0.0439]	[0.0009]	[0.0439]
LR	1951.03	32.08	1954.30	1339.15	32.82	1345.04
P	0	0.0063	0	0	0.0050	0

Note: Standard errors in brackets; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Firstly, a mediation effect test was conducted, and it was found that both state-owned and non-state-owned enterprises have partial mediation effects. Hypothesis 2 is valid. There is a difference in the ratio of intermediary effect to total effect, which is 0.52% and 2.8%, respectively, with non-state-owned enterprises having a larger proportion. This result indicates that due to the ease of obtaining financial support for state-owned enterprises, scale efficiency to some extent masks the lack of technical efficiency, and state-owned enterprises rely more on the scale of financial support investment in terms of financial support efficiency (Le et al., 2023); Non-state-owned enterprises receive less financial support, so the effectiveness of their utilization has become the key to improving the efficiency of financial support (Dai and Cheng, 2015).

In terms of the significance of each variable, there is a significant difference between the two types of enterprises. Based on the results of the mediation effect test, hypothesis 5 is valid. State-owned enterprises, all variables are significant, and the direction and degree of influence are consistent with the overall regression results. For non state-owned enterprises, the main business profit margin and equity balance are not significant variables, and the comprehensive investment coefficient of financial support for state-owned enterprises (0.339) is higher than that for non-state-owned enterprises (0.131). Once again, it should be noted that the financial support currently obtained by state-owned enterprises is strongly related to their nationalization nature, and there is an overall mismatch of financial resources between state-owned and non-state-owned enterprises (Khan et al., 2020).

5. Discussion

Based on relevant theoretical research, this paper conducts a theoretical analysis of the process of financial system supporting the development of strategic emerging industries and finds the internal and external factors that affect this process. According to the results of empirical research, the comprehensive input of financial support, the

intensity of R&D and innovation input, the profit margin of the main business, and the equity balance index are respectively proportional to the efficiency of financial support. The mechanism of action between financial support input, R&D and innovation input, and financial support efficiency varies among enterprises with different ownership rights. The comprehensive input of financial support reflects the intensity of financial support obtained by the enterprise. The more financial support an enterprise obtains from various channels, the more sufficient the financial resources invested in production activities are, and it is more conducive to improving the efficiency of financial support. R&D and innovation are the inherent driving forces for the development of strategic emerging industries. After obtaining corresponding financial support, enterprises will reasonably allocate funds to R&D and innovation activities, which are conducive to improving the technical level and core competitiveness of enterprises, and then to their production activities. Therefore, the greater the R&D and innovation investment, the higher the efficiency of financial support. The profit margin of main business reflects the profitability of the enterprise. The stronger the profitability and market competitiveness, and the easier it is for the enterprise to obtain financial support, which helps to further improve the efficiency of financial support. The degree of equity checks and balances reflects the degree of dispersion of the rights of shareholders. The larger the index, the more dispersed the shareholder rights, and the more shareholders constrain each other in the decision-making process of fund use. The possibility of funds being allocated to the future development direction of the enterprise is higher, which is more conducive to improving the efficiency of financial support. State-owned enterprises and non-state-owned enterprises have different ownership rights, and there are differences in governance structure, business objectives, and fund utilization methods. The difficulty of obtaining external financial support is also different. Therefore, the mechanism of action between financial support input, R&D and innovation input intensity and financial support efficiency is different between state-owned enterprises and non-state-owned enterprises.

In the past, the research mainly includes the analysis of efficiency measurement and external influence factors (Xu et al., 2024). This paper is based on the influence mechanism of financial support-innovation R&D investment-the efficiency of financial support, and innovates in the research ideas. On the basis of considering the external influence factors, the innovative R&D input variable is introduced, and the influence of the rational allocation of internal financial resources on the efficiency of financial support is explored through the intermediary effect model (Zhu et al., 2020). At the same time, the scope of research was further expanded, and the latest classification standard for strategic emerging industries was adopted in 2018 (Miao et al., 2018). Due to the reasons of the pandemic, the efficiency of financial support for strategic emerging industries may also be affected (Wang et al., 2021). In terms of the time frame of the study, this paper separately studies the two time periods from 2010–2019 and 2020–2022 and makes a comparative analysis. This paper compares the financial support efficiency of listed companies, state-owned enterprises and non-state-owned enterprises in the Shanghai Stock Exchange and Shenzhen Stock Exchange respectively (Tang et al., 2024). Therefore, the research scope is wider, the research object is more comprehensive, and the conclusions drawn are more in line with the latest reality.

This paper also has some limitations in the study due to the data of the private companies of strategic emerging industry being non-public, data acquisition is difficult to ensure the sample time series data trend (Brown and Wiles, 2015), the study of listed companies as the research object to reflect the overall strategic emerging industry financial support efficiency, using the listed company data representing strategic emerging industries data may lead to some deviation estimation results (Chen and Wang, 2022).

The research limitations will improve with the development of China's strategic emerging industries and the improvement of statistical systems (Zhao et al., 2021). From the perspective of reflecting the financial support efficiency and the influencing factors of strategic emerging industries more comprehensively and systematically, the financial support efficiency of non-listed companies in the industry should be considered in future research (Lv, 2018). According to the Classification of Strategic Emerging Industries (2018), involving nine strategic emerging industries, the next research can be comparative analysis, putting forward suggestions that are more specific for different industries (Fleisher and Bensoussan, 2015). China has a vast territory and many urban clusters. Future research can classify strategic emerging industry companies according to the regions where their main businesses are located. This can better compare and analyze the efficiency of financial support for strategic emerging industries in various regions of China and make differentiated suggestions for different regions (Kamal-Chaoui et al., 2009).

6. Conclusion

6.1. Financial support issues for strategic emerging industries

At present, there are three major problems in the development of financial support for strategic emerging industries: the mismatch between the leading financing mode and the financing needs of strategic emerging industries, the support of venture capital and capital market to be strengthened, and the poor financial innovation environment (Owen et al., 2018). Among them, the poor financial innovation environment is manifested by low tolerance of financial innovation failure, underdeveloped intellectual property evaluation and trading market, poor channels of intellectual property transfer, weak coordination of relevant policies supporting the development of strategic emerging industrial clusters, and imperfect risk sharing mechanism (Conning and Udry, 2007).

6.2. Efficiency level of financial support for strategic emerging industries

This paper adopts the DEA index method to measure financial support efficiency (Liu et al., 2022), a measurement found during 2010–2022 China's strategic emerging industries' financial support efficiency overall performance, the Shanghai Stock Exchange, Shenzhen Stock Exchange financial support efficiency change trend, the Shanghai stock exchange financial support efficiency overall higher than the Shenzhen stock exchange. The efficiency of financial support fluctuated greatly from 2010 to 2014. After 2014, industrial development entered a period of adjustment. The country encouraged the adjustment and upgrading of industrial structures and continued to

introduce powerful measures to encourage the development of strategic emerging industries. Although the efficiency of financial support fluctuated, it showed an overall upward trend. At the end of 2019, the pandemic broke out. Due to the impact of the pandemic, the efficiency of financial support began to decline rapidly, indicating that the pandemic had a significant impact on the efficiency of financial support. When the nature of corporate ownership is different, there will also be differences in the efficiency of financial support. Due to the "emerging" attributes of strategic emerging industries, there is greater uncertainty in the development process, which requires strong support from state-owned capital and support at the national level. Due to their ownership nature and scale, state-owned enterprises are more likely to gain the favor of financial capital, showing better utilization efficiency of financial support most of the time (Li et al., 2018). At the same time, they are less affected by the industry development and adjustment period of financial support. The efficiency value of financial support for state-owned enterprises was slightly higher than that of non-state-owned enterprises during the whole statistical period (He et al., 2015). On the whole, the efficiency of financial support fluctuated greatly from 2010 to 2014, and after 2014, industrial development entered an adjustment period. Although the efficiency of financial support fluctuated after the rapid rise, it showed an overall upward trend and maintained at a relatively high and stable level. The pandemic began to appear at the end of 2019, and the efficiency of financial support began to decline continuously due to the pandemic, indicating that the pandemic has a significant impact on the efficiency of financial support for enterprises (Pu et al., 2021).

6.3. Factors affecting the efficiency of financial support for strategic emerging industries

This paper adopts Tobit & intermediary effect model, to measure the financial support efficiency value as the explanatory variable influence factor regression analysis (Chen and Wang, 2022), the results show that the financial support investment, R&D innovation investment, main business profit margins, equity checks and balances index is proportional to the financial support efficiency. The intensity of financial support investment significantly affects its efficiency. The more investment, the more obvious the improvement in efficiency. R&D innovation investment as financial support comprehensive investment and financial support efficiency between the intermediary variables play a role (Xu et al., 2019). In the process of improving output efficiency, capital allocation plays a major role in financial support input. If it can be effectively allocated to R&D and innovation activities, the overall efficiency of financial support will be significantly improved. The higher the profit margin of the main business, the more financial support is obtained, which helps to improve the efficiency of financial support. The higher the degree of equity checks and balances, the more scientific the capital allocation decision, and the higher the efficiency of financial support. The measurement results of the ownership nature show that there are differences in the mechanism of action between financial support input, R&D and innovation input, and financial support efficiency between state-owned enterprises and non-state-owned enterprises (Zhang et al., 2022).

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