

Research on the Decision Method of R&D Investment in State Owned Enterprises Considering Multiple Factors

Yongjuan Zhu^{1,*}, Longfeng Wang¹, and Wenying Shang²

¹State Grid Energy Research Institute Co., Ltd., Beijing, China

²State Grid Liaoning Electric Power Co., Ltd. Economic and Technological Research Institute, Shenyang, China

Abstract: Research and development investment is a necessary resource guarantee for technological innovation and progress. Increasing research and development investment to promote production efficiency and gain competitive advantages is a strategic choice for many state-owned enterprises in China. The R&D investment of state-owned enterprises is the decision result of balancing external market demand and internal resource environment. Research suggests that state-owned enterprises should increase R&D investment in core business areas and strategic emerging areas, strengthen cooperation with external advantageous technological resources, form a virtuous cycle of "R&D - technological progress - dividend generation - R&D", and achieve long-term sustainable development.

1. Page layout

Resource investment with R&D investment as the core is a necessary condition and important guarantee for producing scientific and technological innovation results. Increasing R&D innovation to improve total factor productivity and promote high-quality business development has become a consistent strategic choice for leading enterprises in the industry. According to data from the National Bureau of Statistics of China, in 2022, Chinese enterprises invested 238.786 billion yuan in research and development, accounting for 84% of the total national R&D investment, 44 times that of 2000, with an average annual growth rate of 19.8%, becoming the main force of national innovation and development. The purpose of enterprise operation is profit, and only when there is sufficient funds and clear development needs for the future, will R&D innovation activities be carried out. Factors such as business strategy, property rights attributes, and financial constraints may affect enterprise R&D investment. This raises questions about how state-owned enterprises make R&D investment decisions under the influence of multiple factors? The study will analyze the deep-seated factors in the decision-making of R&D investment in state-owned enterprises from the dimensions of demand and resources, based on the property rights nature, technological level, supervision and regulation of state-owned enterprises.

2. Analysis of the influencing factors of R&D investment in state-owned enterprises

The theoretical and practical circles generally recognize the promoting role of innovation activities in the development of enterprises, society, and economy. Economist Joseph Alois Schumpeter first proposed the concept of "innovation" in 1912. Schumpeter believed that companies innovate in order to achieve monopoly profits, in order to produce new products or discover new methods; Innovation is the recombination of production factors and the establishment of a new production function; The competitive advantage generated by successful enterprise innovation will squeeze competitors out of the market, thereby obtaining monopoly profits. The monopoly brought about by this innovation success is temporary and will also be squeezed out of the market by other successful enterprises in the future. Cohen & Levinthal published "Innovation and Learning: The Dual Role of Research and Development", which is one of the most influential classic literature in the field of innovation and learning in 1989. They believe that the ability of enterprises to evaluate, acquire, digest, accumulate external knowledge and commercialize it on the basis of existing knowledge determines their innovation ability, which in turn affects innovation performance. They emphasize that enterprises can enhance their ability to learn and absorb external information and knowledge through R&D investment. The learning and absorption ability of individuals and organizations has knowledge accumulation and path dependence [1]. It is crucial for organizations to establish internal learning mechanisms. At the same time, they propose that R&D investment can promote knowledge sharing and experience accumulation within the organization, which is beneficial for enterprises to better grasp the future development direction of science and technology.

* Corresponding author: adgh99@aliyun.com

The most prominent characteristics of R&D innovation activities are high investment, high risk, and often difficult to see benefits in the short term. State owned enterprises consider various factors when making decisions on R&D investment[2], including micro environment such as business strategy, property rights attributes, enterprise size, financial constraints, meso factors such as technology competition, industry regulation [3], as well as macro environment such as financial and tax policies and economic development level. Therefore, there are significant individual differences in R&D investment of enterprises, and their decisions are a comprehensive result of balancing internal resources and external environment.

2.1. Technological breakthroughs drive the growth of R&D investment in state-owned enterprises driven by demand

Most state-owned enterprises have obvious competitive advantages in terms of capital and scale in the domestic market, and are gradually expanding in terms of technological level and global layout. However, at the same time, state-owned enterprises also face fierce market competition pressure. Consumer demand is diverse, and in order for state-owned enterprises to achieve and maintain a leading position, they must track changes in market demand, continuously pinpoint demand points, improve product quality, reduce production costs, and enhance quality services. To achieve this goal, the most fundamental approach is to start with improving production and business technology, continuously innovating resource supply, achieving leading production technology levels, continuously improving operational efficiency, and leading the domestic market through guiding design or innovative standards. On this basis, actively promoting the global diffusion of new technologies, expanding the reputation and impact of products and services, striving for a competitive advantage in the global market, and achieving a global leading advantage in the continuous innovation cycle.

2.2. Mission oriented responsibility drives the growth of R&D investment in state-owned enterprises

The attributes of state-owned property rights, industry infrastructure, and product public attributes determine that state-owned enterprises bear the mission and responsibility of ensuring national economic security, promoting industrial transformation and upgrading, and leading future technological development directions in China's innovation system. This also makes the innovation and development strategies of state-owned enterprises more long-term and strategic compared to other ownership enterprises [4]. This requires state-owned enterprises to actively implement the national innovation strategy, use research and development innovation as a necessary condition to drive sustainable development, focus on forward-looking areas, cutting-

edge technologies, key materials, advanced processes, etc. in the national economic industry, increase investment in research and innovation resources, achieve technological breakthroughs in core areas, master advanced production technologies and processes, promote the optimization of enterprise operation quality, drive industrial transformation and upgrading through innovation, and ultimately achieve the goal of ensuring high-quality development of the national economy.

2.3. Challenges to R&D investment growth brought by resource based capabilities

There is a certain limit to the economic resources that a subject can possess or control. Good profitability and a certain profit scale are important prerequisites for state-owned enterprises to make R&D investment decisions [5]. The state-owned assets and infrastructure attributes of state-owned enterprises determine that their existence is aimed at promoting fairness and stability in various regions and fields of society, sharing the dividends of national economic development, and not primarily for profit. The government also strictly regulates monopolistic state-owned enterprises. The vast majority of funding for research and development activities in state-owned enterprises comes from self-financing, i.e. self-owned funds, and the scale of profits determines the level of self-owned funds in the enterprise. The reasonable upper limit of R&D investment decisions in state-owned enterprises is greatly influenced by the performance level allowed by regulations.

2.4. Challenges posed by R&D performance level to the growth of R&D investment

State-owned enterprises allocate economic resources among production factors such as labor, assets, technology, and data, taking into account both the cost of the project itself and the opportunity cost of investment in other projects. Research and development activities are highly uncertain, requiring multiple stages such as research, development, application, experimentation, trial production, trial production, etc., with a long path and cycle. Each stage requires repeated design, observation, measurement, experimentation, evaluation, improvement, etc. The entire process also faces various limiting factors such as safety, efficiency, market, and society. Taking invention patents as an example, they are often the output of the application research and experimental development stage, and the period from acceptance to authorization of invention patents is usually 2-3 years. Under the long cycle of research and development and the high risk of the formation and application of results, state-owned enterprises are more cautious in their decision-making on research and development investment.

3. Approach to decision-making methods for research and development investment in state-owned enterprises

R&D decision-making is essentially a resource allocation behavior of economic entities. The prerequisite for R&D investment to bring sustained competitive advantages to state-owned enterprises is that the resource investment creates value, and the formation of technological factors can generate synergy with other production factors, which can reduce production costs or enhance customer value. Therefore, the decision-making of R&D investment in state-owned enterprises needs to consider the marginal returns of innovative assets and the synergistic benefits of productive assets, balance the resources of future development and current development stages, and ultimately achieve the maximization of long-term benefits.

3.1. By steadily increasing the scale of research and development investment, ensure innovation advantages in relevant fields both domestically and internationally

For innovation activities, only continuous high investment is possible to produce valuable innovative results that can bring value to state-owned enterprises and the country, improve production efficiency, enhance state-owned enterprise performance, and increase overall social welfare through technological progress. Not investing in innovation activities and low investment will greatly reduce the probability of enterprises seeking development through innovation. As mentioned earlier, investing in research and development activities by state-owned enterprises can promote learning and absorption of external information and knowledge, thereby achieving continuous innovative improvement and enhancement through continuous accumulation of knowledge and technology, and helping to adapt to economic uncertainty [6]. State owned enterprises should reach the average level of R&D investment scale of enterprises in the same industry or business type.

3.2. R&D investment should cover the core technology frontier areas of enterprise production

The self-reliance and industry leadership of core technologies are the long-term foundation of an enterprise. For state-owned enterprises that shoulder the responsibility of national innovation, the research and development of key core technologies is particularly important. Guided by national and industry development planning strategies, conduct basic research, forward-looking research, and applied technology breakthroughs to provide sufficient technological supply for development. The invention and discovery of technology cannot be separated from the support of continuous scientific and technological resources and R&D funds. Considering the international competition in science and technology, the accelerated development of Chinese path to modernization, and the urgent requirements of "carbon peaking, carbon neutrality", to achieve and maintain the leading position in the industry, the annual growth rate of state-owned enterprises' R&D investment

scale should not be lower than the profit growth rate of the same period.

3.3. R&D investment should achieve a scale that is among the top or leading in the same industry

Internationally, leading companies in the industry often engage in large-scale research and development investments to consolidate their technological advantages. According to EU data, in 2022, among the 2500 industrial enterprises with the largest R&D investment in the world, the enterprises with R&D investment scale ranked in the top 1% and top 10%, accounting for 28% and 68% of the total amount, respectively. State owned enterprises take technological innovation as their core, world-class enterprises as their development goals, and core technologies in key areas of the national economy as their cornerstone. This means that state-owned enterprises must invest more in maintaining a leading level compared to other domestic and foreign enterprises. Compared to domestic and foreign enterprises in the same industry, the core investment in research and development activities of state-owned enterprises should achieve steady growth year by year in the future, gradually reaching the leading level in scale among domestic and foreign enterprises of the same business type and scale during the same period.

3.4. Market oriented optimization of input structure and improvement of output efficiency

The innovative achievements brought about by research and development activities can only be combined with real production and operation activities to achieve progress in production technology, generate synergistic benefits, and bring innovation dividends to enterprises and the country; These dividends, in turn, will promote greater R&D investment, forming a virtuous cycle of "R&D - technological progress - dividend generation - R&D" from R&D to R&D. In order to maintain a continuous leading position in technological innovation capabilities, state-owned enterprises need to pay more attention to the quality of research and development innovation and the transformation of related achievements compared to stabilizing the scale of research and development investment. The low-quality results generated by blindly shortening the innovation cycle are highly likely not to be accepted by the market, and there is an "acceleration trap" phenomenon caused by the asymmetry between the continuous expansion of R&D investment scale and the growth of product sales revenue and profit. State owned enterprises need to start from market demand and industry development technology demand, pay more attention to the quality of research and development innovation achievements, improve the construction of relevant processes and incentive mechanisms for the transformation of research and development innovation achievements from laboratory to market, and achieve the goal of innovation driven development by increasing research and

development investment and achieving a dual improvement in the quantity and quality of innovative achievements.

4. Conclusion and recommendations

Enhance product profitability. Adequate profits are the foundation for enterprises to increase their research and development investment. The government promotes state-owned enterprises to better provide convenient and basic public welfare to the public through regulation, promoting the overall level of social welfare. At the same time, it also forces state-owned enterprises to achieve transformation and upgrading of related technologies through research and development innovation, and achieve efficient utilization of resources. By improving and enhancing existing production technologies, business efficiency can be enhanced, and higher profits can in turn promote higher R&D investment, forming a virtuous cycle of innovation driven development.

Improve the construction of innovative achievement mechanisms. R&D innovation can only be transformed into tangible productivity that meets market demand to promote the increase of enterprise profits, and the promotion of results is the last crucial kilometer from laboratory to marketization of R&D innovation achievements. This requires R&D innovation to have substantial improvements in production and pay more attention to output quality. By providing strong support for the application of research and development innovation achievements, promoting the process from new discoveries and new technologies from laboratory development to production technology transformation and application, and accelerating the speed of research and development empowering production.

Increase cooperation with excellent scientific research resources both domestically and internationally. State owned enterprises should fully utilize national government and social research funds and resources, strengthen their own research and development capabilities and output levels. In today's society, where multiple industries and technologies are integrated, innovation and discovery cannot be achieved without the collaborative cooperation of experts in multiple technical fields. The future research and innovation of state-owned enterprises urgently need to strengthen cooperation with external research institutions. Research has shown that research and development cooperation always promotes business performance [7]. If social funds and resources such as government and external enterprises can be attracted to enter the research system of state-owned enterprises [8], it can not only stimulate and drive innovation vitality in all sectors of society, but also improve the utilization efficiency of social research resources to a certain extent, create a good external environment, reduce research and development costs of state-owned enterprises, assist in sustainable growth of research and development investment, and provide guarantees for sustainable innovation.

Acknowledgments

This work was financially supported by the Science and Technology Project of SGCC, " Research on Key Technologies for Strategic Decision Support of Power Grid Enterprises Based on Coordination of Regulatory and Business Goals " (Project No.: SGLNJY00ZLS2310022).

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