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Research on the Value of R&D and Innovation-Driven Growth in Technology Innovation-Oriented Enterprises

-- Case Analysis Based on Huawei & Hanwei

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Abstract: Under the national initiative to vigorously promote technological innovation and progress in order to achieve "high-level technological self-reliance and self-improvement," technology innovation-oriented enterprises need to build an endogenous economic engine suitable for their own growth. In the management of such enterprises, research and development (R&D) and innovation are critical factors driving their growth. This paper takes the R&D management of Huawei and Hanwei as typical cases, conducts a comparative analysis of the R&D investment models and innovation-driven mechanisms of technology innovation-oriented enterprises, and provides insights for the development of such enterprises at different growth stages.

Keywords: Technological innovation; Science and technology policy; R&D investment; Innovation-driven; Enterprise growth.

1. Introduction

In recent years, China has introduced a series of policies centered on technological innovation, with the core objective of achieving high-level self-reliance and strength in science and technology and developing new quality productive forces. Examples include *Several Opinions on Further Improving the Management of Central Government Funded Scientific Research Project Funds, Several Opinions on Reforming and Improving the Management of Central Government Scientific Research Funds, and the Law of the People's Republic of China on Scientific and Technological Progress. These policies cover multiple key areas such as research funding management, achievement transformation and incentives, talent cultivation, and the dominant role of enterprises in innovation. This clearly indicates the current national policy orientation: achieving "high-level self-reliance and strength in science and technology," leading the development of "new quality productive forces" through technological innovation, and providing strategic support for Chinese modernization. To align with national strategy and build endogenous economic growth, how technology innovation-oriented enterprises can find the core engine suitable for their own growth becomes a critical issue.

2. Literature Review

The theory of technological innovation aims to explain how technology is generated, developed, diffused, and ultimately drives economic growth and social change. Its research paradigm has undergone a profound shift from linear models to systemic models, expanding from a focus on single technological inventions to encompass complex interactive processes involving technology, market, organization, institution, and culture.

In the early 20th century, Joseph Schumpeter, in The Theory of Economic Development, first proposed the basic concept and idea of innovation, viewing it as a new production function, a "new combination" of production factors. Currently, domestic and international technological innovation theory has formed four theoretical schools: the Neoclassical School, the Neo-Schumpeterian School, the Institutional Innovation School, and the National Innovation Systems School. The Neoclassical School, represented by Solow et al., emphasizes that the rate of economic growth depends on the growth rates of capital and labor, their output elasticities, and technological innovation over time. The Neo-Schumpeterian School, represented by Mansfield, Kamien et al., emphasizes the core role of technological innovation in economic development. The Institutional Innovation School, represented by Lance E. Davis and Douglass C. North, emphasizes the impact of institutional arrangements on national economic growth. The National Innovation Systems School, represented by Christopher Freeman and Richard R. Nelson, posits that technological innovation development should be attributed to national innovation systems rather than the independent actions of entrepreneurs or firms [1]. Thomas Kuhn proposed the concept of original innovation, referring to paradigm shifts and the establishment of new theories brought about by crises [2]. It can be roughly divided into pure theoretical basic research not aimed at practical use (the Bohr Quadrant) and application-oriented basic research aimed at solving practical problems (the Pasteur Quadrant) [3]. Original innovation, as the core driving force of the national innovation system, is crucial for enterprise development and growth and a key guarantee for the continuity of enterprise vitality [4]. However, government R&D funding can have both an incentive effect and a crowding-out effect on firms' own R&D investment [5-8]. Regardless, strong government support for S&T R&D has become a "timing" factor for the rapid growth of technology-driven enterprises.

Currently, with the rapid development of digital technologies such as artificial intelligence, virtual reality, the Internet of Things, 3D printing, and blockchain, digital technology is driving transformations in enterprise productivity and innovation capability [9], which to some extent subverts traditional innovation processes [10] and supports the shift from systemic thinking to ecosystem thinking [11]. This serves as a "geographical advantage"

factor for the rapid growth of technology-driven enterprises.

According to endogenous growth models, technological innovation is a new product created by R&D personnel using the existing stock of knowledge. When applied to the production of final goods, it can lead to a permanent increase in the output growth rate [10]. Among these, "R&D-based innovation" is more conducive to enhancing a firm's core competitiveness [12]. Furthermore, a founder's technological imprinting, formed through their technical development experience, shapes behavioral routines and cognitive preferences for technological innovation. They are adept at examining management decisions with a strategic intent favorable to technological innovation, can properly handle innovation failures, correct managerial opportunism, and make strategic decisions beneficial to long-term enterprise innovation [13, 14]. This constitutes a "human harmony" factor for the rapid growth of technology-driven enterprises.

3. Research Methodology

This paper employs the case study method. Analyzing specific cases to explore the nature and internal logic of complex phenomena is an appropriate method for conducting exploratory research and effectively solving practical problems. This paper aims to explore how technology innovation-oriented enterprises find their core growth engine, answering a "How" question. By selecting two enterprises with different growth stages, one large and one small in scale, but with typical development models and leading positions in their respective industries as case study subjects, it compares their R&D investment and innovation mechanisms to analyze the underlying characteristics.

Both Huawei and Hanwei belong to the category of technology innovation-oriented enterprises. They differ in growth stage and scale (one large, one small), yet both have typical development models, hold leading positions in their industries, and place high importance on technological innovation, making them highly relevant to the research question. This paper primarily obtains authoritative information and data from the official websites of Huawei and Hanwei, supplemented by journal literature, news reports, and R&D interview materials.

4. Enterprise R&D Investment Models and Innovation-Driven Mechanisms

As representatives of technology innovation-oriented enterprises in their respective industries, both Huawei and Hanwei continuously introduce new products and experience rapid growth in scale. The core reason for this high-speed growth lies in their R&D and innovation.

4.1. Analysis of Huawei's R&D Investment and Revenue

Table 1. Huawei's R&D Investment and Revenue

Year	R&D Investment (100 million CNY)	Revenue (100 million CNY)	% of Revenue	Remarks & Key Events
2008	100.1	1252	8.0%	
2009	133.4	1491	8.9%	
2010	176.6	1825	9.7%	First entry into Fortune Global 500
2011	236.9	2039	11.6%	Revenue first exceeded 200 billion CNY
2012	300.9	2202	13.7%	
2013	306.7	2390	12.8%	Revenue surpassed Ericsson for the first time, becoming the world's largest telecom equipment supplier
2014	408	2881	14.2%	Global LTE network construction presented significant opportunities
2015	596	3950	15.1%	Carrier business expanded globally; consumer business started
2016	764	5216	14.6%	Global smartphone market boom, becoming a main growth engine.
2017	897	6036	14.9%	Global smartphone market share entered top 3
2018	1015	7212	14.1%	Revenue first exceeded 100 billion USD; consumer business became largest revenue source
2019	1317	8588	15.3%	First year on the "Entity List," still maintained strong growth
2020	1419	8914	15.9%	Growth slowed significantly; sanctions impact began to fully manifest
2021	1427	6368	22.4%	First major decline; severely impacted by US sanctions; consumer business (phones) shrunk substantially
2022	1615	6423	25.1%	Stabilized under extreme pressure; carrier business stable; enterprise business grew
2023	1647	7042	23.4%	Stabilized and rebounded; terminal business grew; ICT infrastructure robust; new businesses like auto components grew.
2024	1797			

Data Source: Company Annual Reports, Financial Reports

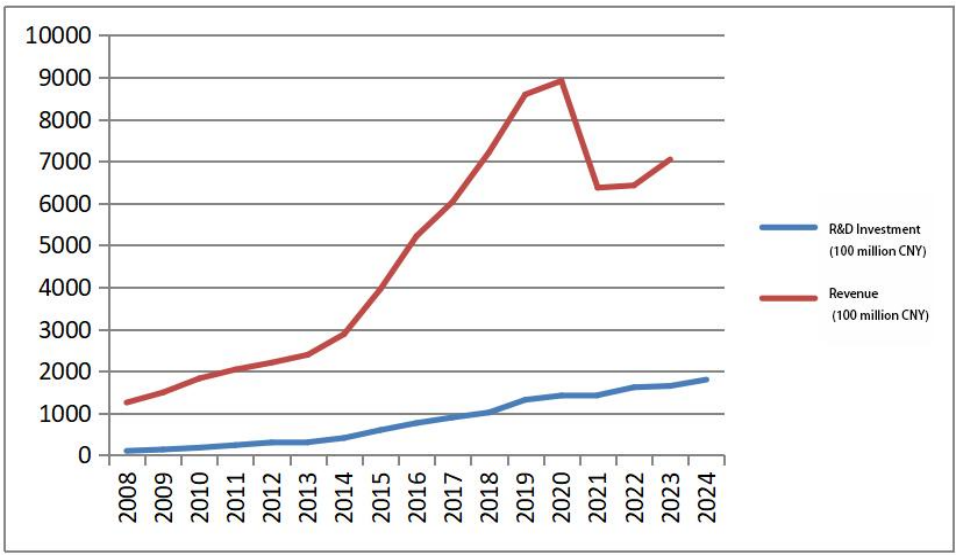


Figure 1. Huawei's R&D Investment and Revenue

(1) As shown in Table 1, Huawei ranks among the global top tier in R&D investment scale. Its R&D expenditure consistently leads Chinese private enterprises and is in the global first tier. According to the 2024 EU Industrial R&D Investment Scoreboard, Huawei's R&D investment ranks 6th globally, following Alphabet (Google), Meta, Microsoft, Apple, and Samsung, and is the only Chinese enterprise in the top 10.

(2) Huawei's R&D intensity far exceeds that of industry giants. The R&D expense ratio (R&D investment/revenue) is a key indicator of a company's commitment to innovation. Huawei's ratio has remained above 20% in recent years, a very high level. For comparison, according to public data, tech giants like Apple and Samsung typically have R&D expense ratios around 6%-8%. This means Huawei reinvests over one-fifth of its revenue into R&D.

(3) As shown in Figure 1, Huawei's cumulative R&D investment over the past decade exceeds 1.24 trillion CNY. ** Huawei's innovation is not a short-term endeavor but a long-term strategic commitment. The cumulative investment exceeding 1.24 trillion CNY in the past decade demonstrates its patience and resolve ("be willing to sit on a cold bench for ten years"). This sustained investment is the fundamental guarantee for its transition from catching up to leading in areas like 5G, optical transmission, smartphones, and the HarmonyOS.

(4) Huawei's R&D investment direction "sinks deep roots." A significant portion of Huawei's R&D is directed not only at product development but also towards basic research and cutting-edge technology. This exploratory work is primarily led by the "2012 Laboratories," focusing on areas like AI, chips, new materials, and algorithms that may determine competitiveness in the next 5-10 years. Examples include its self-developed Kirin chips, Ascend AI chips, HarmonyOS, and Euler server OS.

4.2. Huawei's Innovation-Driven Mechanisms

Huawei's innovation achievements are not merely the result of massive funding but also benefit from a unique set of driving mechanisms.

(1) "Dual Funnel" Model combining Basic Research and Product Development: Huawei allocates about one-third of its R&D funds to exploratory basic theoretical research. This work is mainly undertaken by the 2012 Laboratories, focusing on 5-10 year frontier technologies without short-term performance assessments. Meanwhile, product development teams are responsible for transforming generated knowledge into commercially valuable products, together forming a complete closed loop from theory to commerce.

(2) "Openness + Protection" Intellectual Property Strategy: Huawei actively opens its technology through open-source contributions (e.g., OpenHarmony, openEuler) and standard-setting participation (submitting over 10,000 technical proposals in 2024) to build industry ecosystems and de facto standards. On the other hand, Huawei strictly protects its own IP and obtains returns through patent licensing. Notably, adhering to a "balance" principle, Huawei states its cumulative patent licensing payments are about three times its cumulative income, reflecting respect for others' innovation.

(3) Ecological Collaboration with a "Chain Leader" Posture: Acting as a "chain master," Huawei fosters companies in key areas like chips through Hubble Investment, collaborates with universities on the "Genius Youth" program, and opens the "Huang Danian Chasi House" platform for global scholars to tackle difficult problems. This drives technological leaps for hundreds of local enterprises like SMIC and Canqin Technology, jointly enhancing supply chain autonomy and controllability.

4.3. Analysis of Hanwei's R&D Investment and Revenue

Table 2. Hanwei's R&D Investment and Revenue

Year	R&D Investment (10k CNY)	Revenue (10k CNY)	% of Revenue	Remarks & Key Events
2009	759.74	10800	7.0%	IPO year; main business: sensors and instruments
2010	1153.94	13800	8.4%	First full year post-IPO, using capital platform for expansion
2011	1747.35	19500	9.0%	Post-IPO fundraising projects effective; accelerated development
2012	2432.75	23500	10.4%	Steady business expansion; maintained good growth rate
2013	3341.89	31000	10.8%	Steady growth period: combining organic growth and M&A
2014	4370.47	37600	11.6%	Initiated M&A strategy; scale increased significantly
2015	5753.33	70300	8.2%	Acquired targets consolidated; revenue nearly doubled
2016	7406.36	107600	6.9%	Peak of external M&A; achieved revenue leap through large-scale acquisitions
2017	9173.47	140200	6.5%	Consolidation of acquired companies; continued scale expansion
2018	11441.8	151200	7.6%	Integration and deepening period: growth slowed; deepened internal integration
2019	14602.94	181900	8.0%	IoT solutions became core growth engine
2020	17998.59	194100	9.3%	Overcame pandemic impact; achieved steady growth
2021	22816.7	231600	9.9%	Post-pandemic demand recovery; IoT business continued momentum
2022	28279.66	228000	12.4%	Slight fluctuation due to macro-environment; core business stable
2023	31881.43	235800	13.5%	High-quality development; profit growth exceeded revenue; operational quality improved

Data Source: Company Annual Reports, Financial Reports

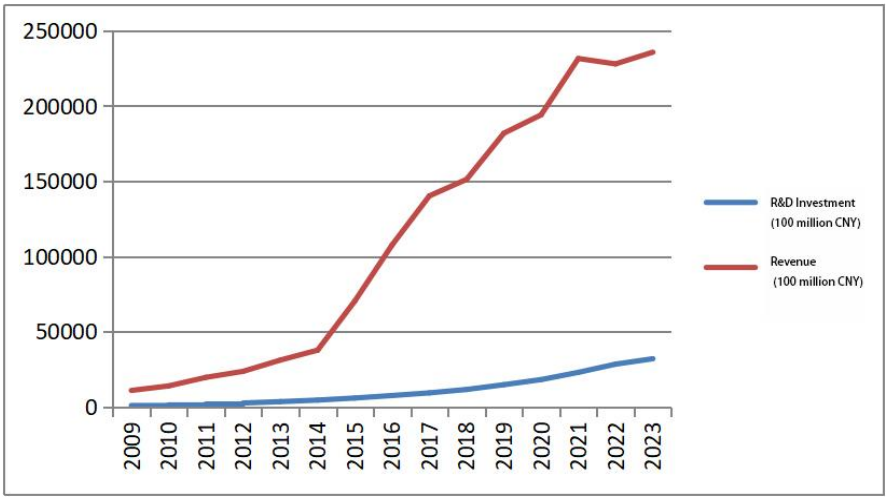


Figure 2. Hanwei's R&D Investment and Revenue

As shown in Table 2 and Figure 2, The data reveals several notable characteristics of Hanwei's R&D investment:

(1) Sustained high-speed growth: Since its IPO in 2009, Hanwei's R&D investment has increased year-on-year for 15 consecutive years without interruption. It grew from an initial 7.6 million CNY to nearly 320 million CNY in 2023, a cumulative increase exceeding 40 times, with a very high compound annual growth rate.

(2) Increasing R&D intensity: The ratio of R&D expense to revenue also steadily increased from 4.88% in 2009 to 12.94% in 2023. This ratio is relatively high among A-share manufacturing companies, fully reflecting the company's emphasis on technological R&D and its "technology-driven" development strategy.

(3) Strategic focus: Sustained R&D investment supports Hanwei's leading position in the gas sensor field and its continuous expansion into application areas like IoT, smart cities, and safety production. High-intensity R&D is key to building its technological moat and maintaining core competitiveness.

4.4. Hanwei's Innovation-Driven Mechanisms

Hanwei's R&D model is key to its core competitiveness.

(1) A multi-level, forward-looking, three-dimensional R&D system driven by both market and customer needs, with "independent R&D + open cooperation" as its dual wings.

(2) Industry-University-Research Collaboration: Establishing long-term partnerships with renowned domestic and international universities and research institutes like Tsinghua University, the Chinese Academy of Sciences, and Xi'an Jiaotong University, leveraging "external brainpower" for frontier technology exploration and high-end talent cultivation.

(3) Industrial Ecosystem Cooperation: Collaborating with upstream and downstream enterprises and IoT platform companies (e.g., Huawei, Alibaba Cloud) to jointly develop industry solutions, ensuring its sensors and solutions integrate seamlessly into larger ecosystems.

(4) R&D-Driven Ecosystem Layout: Centered on independent sensor R&D, it extends downstream to form a

complete industrial chain of "sensors - monitoring equipment - IoT solutions," building a comprehensive IoT application ecosystem layer. Its R&D model is highly representative, demonstrating the strategic evolution from single products to a system ecosystem.

(5) High Barriers and High Stickiness: Through full-chain R&D from core sensors to industry solutions, it constructs extremely high technological barriers and customer stickiness. Once customers adopt its ecosystem, switching costs become very high.

5. Case Insights

Currently, in many industries, technological innovation has become a primary driver for firms to achieve competitive success [15]. In many industries, sales or profits from products developed by some companies within the past 5 years account for over one-third of their total sales or profits [16]. For example, Johnson & Johnson exceeds 30%, and 3M once reached 45%.

Indeed, R&D and innovation can promote sustained and rapid enterprise growth. However, in practice, it should be noted that R&D is also a high-risk investment; most innovative ideas do not translate into new products, exhibiting an "innovation funnel" [15], as shown in Figure 3. Therefore, enterprises need to form comprehensive support in strategic direction, R&D model, organizational structure, incentive schemes, and resource allocation.

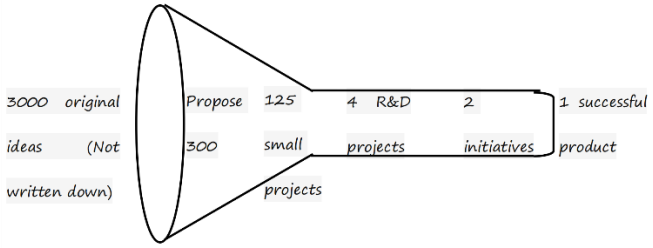


Figure 3. Innovation Funnel

Table 3. Comparative Case Analysis

	Huawei	Hanwei	Comparative Analysis
R&D Investment Scale	Ranks among the top globally	Maintains rapid and continuous growth	Both are willing to invest financial resources
R&D Investment Intensity	R&D expense ratio consistently exceeds 20%, far surpassing industry giants	Steadily increased from 4.88% in 2009 to 12.94% in 2023	Both demonstrate strong R&D investment intensity
R&D Investment Continuity	Sustained over ten years, exceeding ¥1.24 trillion	Maintained positive growth for 15 consecutive years	Both commit to continuous investment
R&D Investment Model	A "dual-funnel" model integrating basic research and product development, with Huawei allocating approximately one-third of its R&D funding to exploratory basic theoretical research	A market- and customer demand-driven, multi-layered, and forward-looking three-dimensional product R&D system	The models differ: the former allocates significant resources to basic theoretical research, while the latter focuses on market- and customer-driven product development
Innovation-Driven Mechanism	An "open + protection" intellectual property strategy, with Huawei actively opening technologies through open-source contributions and standards-setting to build an industrial ecosystem and de facto standards	A "self-development + open cooperation" approach, collaborating with upstream and downstream enterprises and IoT platform companies to co-develop industry solutions, ensuring seamless integration of its sensors and solutions into broader ecosystems	Similar in approach: both emphasize self-development and openness, aiming to build ecosystems
R&D Pathway	Ecosystem collaboration with a "chain-leader" posture, investing in key area enterprises, partnering with universities, and opening global challenges to scholars	Industry-academia-research collaboration: establishing long-term partnerships with renowned domestic and international universities and research institutions, leveraging external expertise for cutting-edge technology exploration and high-end talent cultivation	Similar in approach: both emphasize open cooperation, actively introducing external resources, and cultivating high-end talent

Through the analysis of Huawei and Hanwei, as shown in Table 3, we observe:

Huawei's R&D focuses on basic research and original innovation. Its long-term, sustained, high-intensity R&D investment, coupled with unique R&D models and innovation mechanisms, serves as the core engine for its sustained rapid growth. It has achieved breakthroughs in many leading technologies, such as the decade-long effort on 5G, developing the "heart" of smartphones—Kirin chips, the life-or-death move for ecosystem breakthrough—HarmonyOS, and the "hidden champion"—optical technology. In 2024, it newly disclosed 37,000 patents; globally valid authorized patents exceed 150,000, topping the World Intellectual Property Organization (WIPO) PCT international patent applications ranking for ten consecutive years. These also bring significant commercial value, with patent licensing revenue reaching a record high of $630 million in 2024.

Huawei's revenue journey epitomizes the globalization of Chinese high-tech enterprises, transitioning from a follower to a leader, and then becoming a model for survival and development under extreme pressure. Despite unprecedented challenges, Huawei, through continuous R&D investment, open innovation mechanisms, and active business transformation, is carving new growth paths. Its future growth will rely more on breakthroughs in new fields and self-reliance in core technologies.

Hanwei Technology's R&D is centered on application value. In its initial phase, the company focused on developing single products before extending its efforts to technological R&D across the upstream and downstream industrial chains.

Ultimately, it evolved from point-based innovations to a networked approach, offering comprehensive IoT system solutions. As a typical representative of the growth trajectory of small and medium-sized technology enterprises in China, Hanwei Technology stands as a leading player in the country's sensor and IoT sectors. Its R&D model provides a highly successful blueprint for Chinese technology enterprises, especially for those seeking to transition from single-product manufacturers to system solution providers. It demonstrates that building lasting competitiveness can be effectively achieved by grounding efforts in core R&D and innovation, accelerating strategic expansion through capital means, and directing full-chain R&D investment toward end-use application value, thereby creating industry system solutions characterized by high barriers to entry and strong customer stickiness.

From an initial R&D investment of a few million yuan during its early listing period to an annual R&D budget now exceeding 300 million yuan, this growth not only reflects the rapid expansion of the company's business but also underscores its long-term commitment to deepening its expertise in the sensor and IoT industries. This emphasis on R&D has been a critical factor in sustaining its development amid intense market competition. Hanwei's revenue scale has also achieved remarkable growth, soaring from over 100 million yuan to nearly 2.4 billion yuan—a leap spanning two orders of magnitude.

Based on the analysis of these two enterprise case studies, the growth of technology innovation-oriented enterprises is a long-term, systematic engineering project. It requires:

(1) Strategic Focus and "Top Leader Project": Technology innovation-oriented enterprises must stay true to their original aspirations and not blindly chase "hot trends," such as real estate or internet booms. The enterprise founder or top management must act as the lead, providing sufficient attention and commitment.

(2) Technology innovation-oriented enterprises require long-term, strong support for research and development (R&D): the enterprises themselves must maintain sustained and high-intensity R&D investment. However, the direction of R&D investment varies for companies of different scales. For small-scale enterprises in the startup phase, where R&D involves high risks and long return cycles, the focus should be on product research "centered around customer and market needs." In contrast, leading enterprises should be bold in investing in basic research, allocating resources strategically in areas such as organizational structure, incentive measures, innovation mechanisms, high fault-tolerance mechanisms, flexible objectives, and delegation of funding authority. In the initial stages of R&D investment, commercial value may not be immediately apparent. Yet, with long-term persistence, its commercial value grows exponentially.

(3) R&D Starting from Market and Customers, Aiming to Build an Ecosystem: Persist in combining independent R&D with open cooperation, deeply integrating industry, academia, and research. Examples include joint R&D with universities and research institutes, collaborative R&D within the industry chain, open platform R&D, and establishing R&D alliances.

6. Conclusion

This study, using Huawei and Hanwei as cases, delves into how technology innovation-oriented enterprises drive sustained growth through R&D and innovation. Under the guidance of national science and technology innovation policies, both companies treat R&D investment as a core strategy, albeit with different emphases: Huawei builds global competitiveness from technological breakthroughs to ecological synergy through a long-term, high-intensity "Dual Funnel" model combining basic research and product development. Hanwei, guided by market demand, achieves industrial chain extension from sensors to IoT solutions through a "Independent R&D + Open Cooperation" three-dimensional R&D system. The case analysis indicates that sustained R&D investment, strategic focus, basic research layout, open innovation mechanisms, and ecosystem expansion are key for such enterprises to achieve technological self-reliance and growth. These practices provide a replicable paradigm for Chinese technology innovation-oriented enterprises to align with national strategy and build their core growth engines, while also confirming the fundamental role of R&D innovation in driving long-term enterprise development.

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