Research on the Measurement and Mechanism of Data Elements Enabling Breakthrough Innovation of Private Enterprises

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Abstract: This research endeavor holds a pivotal role in elucidating the measurement and underlying mechanisms of data elements, which have emerged as pivotal catalysts for fostering breakthrough innovations in private enterprises. Through a meticulous and rigorous analysis of the intricate utilization and integration patterns of these data elements, we aspire to offer a comprehensive and nuanced understanding of how private firms can harness the immense power of data to foster disruptive and transformative innovations. Our study focuses on identifying the crucial factors that underpin the successful execution of data-driven strategies. These strategies augment enterprises' innovative prowess and propel them to the forefront of their respective industries. The insights gained from our research transcend theoretical frameworks, offering practical strategies and profound understandings that serve as a compass for private enterprises navigating today's rapidly evolving, data-driven economy. By harnessing these insights, private enterprises can maintain their competitive edge, seizing growth opportunities in a fiercely competitive environment. Ultimately, this research holds tremendous potential in shaping the future of private enterprises, empowering them to leverage data as a strategic asset and transform their businesses for enduring growth and prosperity.

Keywords: Data Elements; Breakthrough Innovation; Measurements; Mechanisms; Private Enterprises

1. Introduction

Promoting the profound integration of digital technology and the real economy is essential to facilitate the transformation and upgrading of traditional industries, foster new industries, business models, and modalities, thus strengthening the novel driver of economic growth. Importance of cultivating a global digital transformation hub, encouraging the establishment of a novel digital industry ecosystem, and jointly shaping a new paradigm of digital integration is emphasized. In the era of digital empowerment, disruptive innovation emerges as a critical force for private enterprises to gain competitive edge in technology and market. The number of private enterprises among the top ranks in the country is significant, and the private sector's value-added contribution accounts for 67% of the country's gross domestic product in 2022. However, it's worth noting that the current innovation model of private enterprises, which primarily relies on incremental innovation, falls short of meeting the comprehensive development needs of the era and enterprises, both in terms of innovation speed and effectiveness. The focal point of societal attention now lies in how to enhance the disruptive innovation capability of private enterprises, ultimately catalyzing significant changes within enterprises, industries, and the overall industrial structure.

2. Measure and Effect of Breakthrough Innovation of Private Enterprises

With keen market insight and flexible operation mechanism, private enterprises have actively invested in research and development and achieved a number of technological breakthroughs, especially in the fields of advanced manufacturing and digital economy. As a private economy, attaches great importance to fostering an innovation ecology, and has built an innovation system with enterprises as the main body, the market as the orientation, and the deep integration of industry, university and research [1]. In addition, private enterprises also pay attention to cluster innovation, through the cooperation and competition between enterprises, accelerate the dissemination and application of

new technologies, and further enhance the overall innovation ability. These measures have enabled private enterprises to win competitive advantages in domestic and foreign markets and injected strong impetus into the sustainable and healthy development of economy.

2.1 Investment in Innovation and R&D

In recent years, private enterprises have been paying more attention to innovation, increasing R&D investment and strengthening R&D team building [2]. These enterprises not only focus on the introduction of high-end talents, but also commit to training internal R&D teams, forming a relatively complete R&D system. Continuous investment in capital, talent, equipment and other aspects provides a strong guarantee for private enterprises to carry out breakthrough innovation. At the same time, private enterprises also actively participate in the national, provincial and municipal levels of science and technology projects, through the project drive, improve their own research and development strength and innovation ability [3]. See Table 1 and Figure 1.

Table 1. Annual Income of R&D Yuan

Company	2018	2019	2020	2021	2022
Youngor	46415000	84912700	67178600	69931300	81925276.12
Zhejiang Medicine	321556410.4	450424835.6	546091345.8	806858993.1	809279317.2
Hanye company limited	105958920.2	49987882.48	176761402.8	19556095.55	13156334.23
Jinying company limited	5086582.79	10712381.69	15055276.32	17667778.57	20148802.21
Tiantong company limited	158560709.1	163190175.3	173409923.1	255473614	321691558.9
Zhejiang Longsheng	731546102.5	788934909.2	704449705.8	652528853	709411015.7
Ningbo Yunsheng	139939907.3	126940094.6	143790332	230872997.1	401359244.6
Shilanwei	349915476.9	425894831.5	485591034.9	627800018.4	743171925.3
Hangxiao steel structure	193728983.9	252394354.4	342120572.6	407480861.6	514634254.9
Longyuan Construction	54689648.58	73445089.16	74792080.36	122540199.6	101174799.1

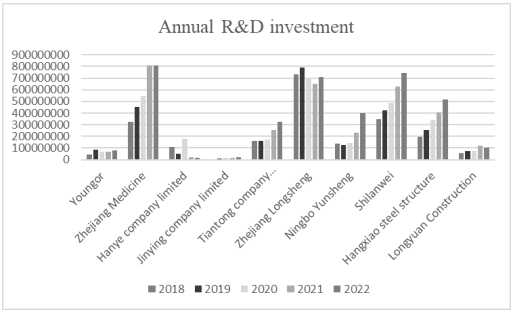

Figure 1. Annual R&D Investment

2.2 Innovation and Market Competitiveness

Private enterprises have made remarkable achievements in breakthrough innovation, and a number of core technologies and products with independent intellectual property rights have emerged in the market. These innovations have not only filled domestic gaps, but even reached the international advanced level, winning market share and competitive advantages for private enterprises [4]. For example, in the fields of new energy, new materials, intelligent manufacturing, private enterprises have made important breakthroughs, promoting the rapid development of related industries. See Table 2-Table 5 and Figure 2-Figure 5.

Table 2. Number of Patents

Company name	2018	2019	2020	2021	2022
Youngor	34	50	50	61	62
Zhejiang Medicine	48	54	67	79	78
Hanye company limited	41	43	43	43	43
Jinying company limited	9	12	16	20	20
Tiantong company limited	215	251	262	282	292
Zhejiang Longsheng	119	134	158	173	174
Ningbo Yunsheng	49	52	82	86	89
Shilanwei	575	620	673	725	732
Hangxiao steel structure	262	270	274	280	285
Longyuan Construction	28	39	49	53	55

Table 3. Numbers of Appearance Design

Company name	2018	2019	2020	2021	2022
Youngor	2	2	2	2	2
Zhejiang Medicine	3	8	28	34	34
Hanye company limited	2	2	2	2	2
Jinying company limited	1	1	1	1	1
Tiantong company limited	0	0	0	0	0
Zhejiang Longsheng	0	0	0	1	1
Ningbo Yunsheng	12	12	12	12	12
Shilanwei	30	45	67	79	84
Hangxiao steel structure	14	14	14	14	14
Longyuan Construction	0	0	0	0	0

Table 4. Patents for New Utility Design

Company	2018	2019	2020	2021	2022
Youngor	24	28	33	34	35
Zhejiang Medicine	6	6	6	8	8
Hanye company limited	36	36	36	37	37
Jinying company limited	38	38	63	77	77
Tiantong company limited	166	191	251	285	286
Zhejiang Longsheng	46	57	94	98	99
Ningbo Yunsheng	66	71	84	89	91
Shilanwei	319	357	438	498	508
Hangxiao steel structure	278	312	372	408	420
Longyuan Construction	33	64	101	151	157

Table 5. Proportion of Total R&D Investment to Operating Income

Company name	2018	2019	2020	2021	2022
Youngor	0.48	0.68	0.59	0.51	0.55
Zhejiang Medicine	4.69	6.39	7.45	8.84	9.97
Hanye company limited	10.79	6.21	31.81	2.87	2.19
Jinying company limited	0.42	0.86	1.49	1.46	1.55
Tiantong company limited	6.07	5.87	5.5	6.25	7.14
Zhejiang Longsheng	3.83	3.69	4.51	3.92	3.34
Ningbo Yunsheng	6.91	6.52	5.99	6.15	6.26
Shilanwei	11.56	13.69	11.34	8.73	8.97
Hangxiao steel structure	3.13	3.81	4.2	4.25	5.18
Longyuan Construction	0.27	0.34	0.42	0.63	0.71

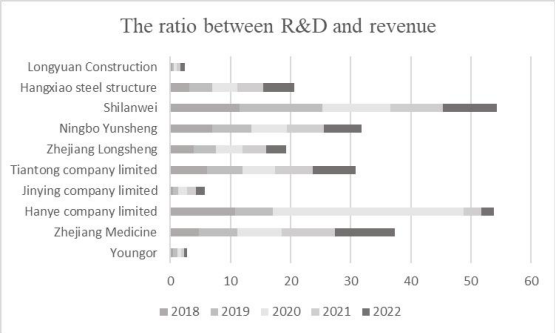

Figure 2. Number of Patents

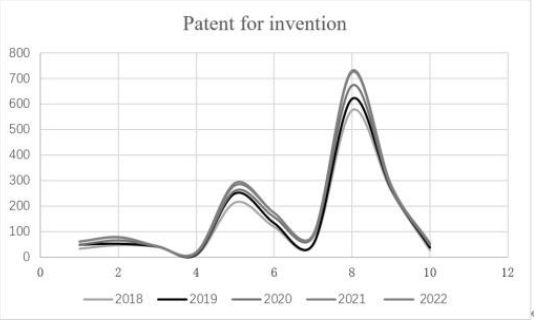

Figure 3. Numbers of Appearance Design

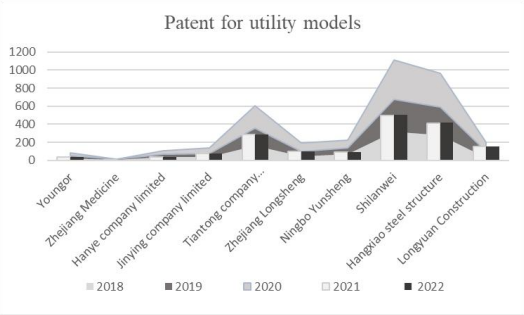

Figure 4. Patents for New Utility Design

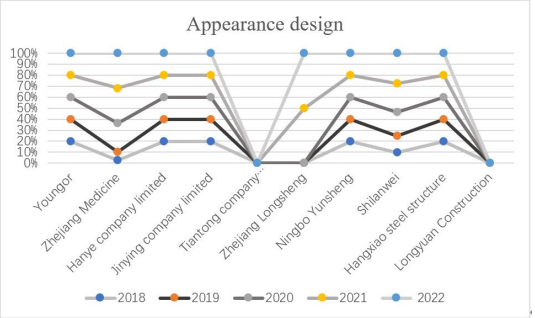

Figure 5. Proportion of Total R&D Investment to Operating Income

2.3 The Innovation Environment Optimization

The government attaches great importance to the innovation and development of private enterprises and has introduced a series of policies and measures to provide strong support for private enterprises to carry out breakthrough innovation. For example, increasing tax incentives for private

enterprises to invest in research and development and setting up innovation funds to support innovation projects of private enterprises. The implementation of these policies and measures has effectively reduced the innovation cost and innovation risk of private enterprises, and stimulated the innovation vitality of enterprises. At the same time, we established a relatively complete innovation service system, including science and technology intermediary, technology transfer, innovation incubation and other institutions, to provide a full range of innovation services for private enterprises [5]. In addition, we pay attention to fostering an innovation culture and encourages enterprises to take risks and innovate, forming a strong atmosphere of innovation.

3. The Challenge of Private Enterprises' Breakthrough Innovation

In recent years, focusing on promoting the high-quality development of the private economy, the government has issued a series of policy dividends to promote the improvement of the quality and efficiency of the private economy. Among them, the proposal of "two health" has far-reaching significance for consolidating and developing the private economy in the new era. The problems encountered in the development of private enterprises in need to be solved by the joint efforts of the government and enterprises to make breakthroughs and innovations, change the status quo and achieve better development [6]. Most enterprises in our country, especially small and medium-sized private enterprises, have obvious shortcomings in strategic management. Some enterprises due to the lack of long-term planning and clear strategy, resulting in a passive position in the market competition, it is difficult to sustain healthy development. The reasons for the unsustainable development of private enterprises need to be considered from many aspects, which are mainly reflected in the difficulty of obtaining high-level talents, the difficulty of equal access to scientific and technological innovation resources, the constraint of capital shortage in innovation investment, the need to strengthen the protection of intellectual property rights and institutional innovation [7].

3.1 Lack of Breakthrough Innovation Talents

Talent is the core driving force of scientific and technological innovation. At present, the challenges encountered by private enterprises in talent recruitment, especially the problem of attracting and retaining high-level talents, have become an important factor restricting enterprise innovation. It is mainly manifested in four aspects: First, talent recruitment "cold". Public opinion believes that private enterprises work is not decent, unstable employment, low retirement benefits, including "double first-class" college graduates, outstanding talents generally tend to choose to go to the government, public institutions and state-owned enterprises, do not want to work in private enterprises. Equal access to scientific and technological innovation resources is crucial to the innovation and development of private enterprises [8]. However, in reality, private enterprises do face the problem of inequality in access to national science and technology innovation projects, participation in national or local laboratory construction and participation in technology alliances. Second, the unequal access to information in the application of scientific research projects. Some places are accustomed to giving priority to resources to state-owned enterprises, and relevant departments will first ask the cooperation willingness of central enterprises and state-owned enterprises, and private enterprises will obtain declaration information late and prepare data short. Third, the setting of declaration conditions and evaluation standards is not conducive to private enterprises. Fourth, it lags far behind state-owned enterprises in terms of fund allocation, research and development subsidies, awards and excellence evaluation. Data show that in the past 10 years, private enterprises' R&D spending from government departments accounted for less than 2%, significantly lower than state-owned enterprises. Today's market is in short supply, but there is no shortage of technical talent, the shortage is the technical team and business alignment, drive process innovation and business automation, use technology to reduce costs and reduce customer delivery time, which is one of the challenges of the digital process. Therefore, private enterprises are unable to form a diverse innovation team that can promote cooperation

and information sharing among team members, which is an important problem facing breakthrough innovation.

3.2 Insufficient Allocation of Breakthrough Innovation Resources

Some private enterprises still have a wrong understanding of digital transformation and fail to fully realize the importance of digital development. Although private enterprises have made some achievements in innovation, compared with some international leading enterprises, the allocation of innovation resources is still insufficient. Some private enterprises lack sufficient research and development funds, high-end talents and advanced equipment, resulting in limited research and development capabilities, and it is difficult to make breakthroughs in key technology fields [9]. In addition, some enterprises rely too much on the introduction of external technology, while ignoring the cultivation and promotion of internal research and development capabilities, which also limits their ability to breakthrough innovation. For small and medium-sized enterprises in science and technology, their characteristics of small scale, light asset and high technology make them face many challenges in the financing process. Even though these enterprises have fast development speed and great potential, they often find it difficult to obtain sufficient loan support from traditional financial institutions such as banks due to the lack of sufficient physical assets as collateral or government credit endorsement. At the same time, the current venture capital market is not mature, especially the problem of poor exit mechanism and weak anti-risk ability, which limits venture capital investment in seed stage and early-stage innovative enterprises. This further aggravates the financial difficulties of these enterprises and hinders their innovation and development.

3.3 Limited Internal and External Cooperation

Many private enterprises, especially small and medium-sized enterprises, have many shortcomings in the construction of internal innovation system. The lack of a full-time R&D department or technology center, as well as the lack of an effective management mechanism for innovative breakthroughs, have become important factors restricting the innovation and development of enterprises [10]. In order to solve these problems, it is necessary to conduct in-depth analysis and improvement from many levels. The problem of enterprise internal innovation incentive mechanism needs to be solved urgently. At present, the incentive means and methods adopted by many enterprises are relatively simple, which is not conducive to stimulating employees' innovation enthusiasm. At the same time, the incentive effect is too short-term, resulting in the relationship between employees and enterprises become like a "one-hammer sale", lack of long-term cooperation and win-win. In addition, the unscientific evaluation standard of human resources also affects the effectiveness of incentive mechanism. Secondly, the marketization degree of the external service system of enterprises' technological innovation needs to be improved. Many innovative service institutions have the color of government-run and semi-government-run, the service level and quality do not match the price, and the degree of dependence on the government is high, and the lack of innovation and service awareness. These problems have led to a large gap between the needs of service organizations and enterprises. In addition, the role of industry-university-research bridging has not yet been fully played. Although enterprises have a high enthusiasm for the combination of industry, university and research, innovation activities are still mainly confined to the enterprise due to poor information and other factors.

3.4 Insufficient Policy Support for Breakthrough Innovation

Government innovation policies mainly include financial, fiscal, tax, distribution, information, patent and other policies. According to the research situation, although the government has introduced many policies to support and encourage technological innovation of enterprises, there are also problems such as unsatisfactory policy implementation and insufficient support. There are still some deficiencies in the innovation management system of private enterprises. Some enterprises lack a scientific and systematic innovation management mechanism, resulting in the management and

execution efficiency of innovation projects is not high. At the same time, some enterprises have problems such as slow decision-making and cumbersome processes in the innovation process, which also affects the efficiency and effect of innovation. In addition, some enterprises also lack an effective innovation incentive mechanism, which cannot fully stimulate the innovation enthusiasm and creativity of employees. Breakthrough innovation is often accompanied by high risks, including technical risk, market risk, capital risk, etc. However, some private enterprises in lack sufficient risk awareness in the process of innovation, and lack sensitivity to market changes and competitive situation. This may lead to enterprises in the face of market changes cannot adjust the innovation strategy in time, and even into the innovation dilemma.

3.5 Mechanism of Breakthrough Innovation Data Elements

The ability of private enterprises to achieve breakthrough innovation by virtue of data element empowerment mainly depends on the following mechanisms: By building a digital platform and optimizing the accumulation of data elements, private enterprises can improve the scale and standard of digital transformation and build a solid foundation for innovation. The flow and sharing of data elements break the information silos and enhance the collaboration and innovation ability among enterprises. Data empowerment has promoted the improvement of precise decision-making, personalized services and production efficiency of private enterprises, and further enhanced market competitiveness. private enterprises actively embrace digital thinking, combine the entrepreneurial spirit of "daring to be the first", combine data elements with business model innovation, constantly stimulate the vitality of innovation and entrepreneurship, and achieve a significant improvement in breakthrough innovation ability.

4. Suggestions for Promoting Breakthrough Innovation in Private Enterprises

4.1 Data-driven Decision-Making, Accurately Grasp the Pulse of the Market

Private enterprises in are famous for their keen market insight and flexible management strategies. Empowered by data elements, these companies can more accurately grasp market dynamics and consumer demand by establishing data-driven decision-making mechanisms. As a pioneer of the digital economy, rich big data resources and advanced data analysis technologies, enabling private enterprises to take advantage of these resources and technological advantages to quickly respond to market changes and achieve innovative breakthroughs.

4.2 Sharing Data Resources to Promote Cross-border Integration

As a well-known gathering place of manufacturing and service industry in China, has close cooperation among private enterprises, and the industrial chain, supply chain and innovation chain are intertwined. Under the promotion of data resource sharing mechanism, private enterprises in can break data barriers and realize data interconnection and efficient flow. This mechanism helps enterprises to carry out cross-border cooperation and innovation, promote the upgrading and optimization of the industrial chain and supply chain, and enhance the overall competitiveness.

4.3 Talent Agglomeration Effect, Cultivating Data Innovation Talents

Has a large number of universities and scientific research institutions, and rich human resources. In the field of data innovation, private enterprises in have gathered a group of excellent data innovation talents through attracting, cultivating and retaining talents. These talents have solid professional knowledge and rich practical experience, and can provide strong support for the data innovation of enterprises. At the same time, also holds various data innovation competitions, forums and other activities to attract more talents to join the field of data innovation, forming a talent agglomeration effect.

4.4 Policy Support and Supervision to Ensure Data Security

The government attaches great importance to data security and privacy protection and has introduced a series of policies and regulations to regulate the use and management of data. In the process of enabling innovation by data

elements, private enterprises in can make full use of data resources to carry out innovation activities with the support of policies. At the same time, the government has also strengthened the supervision of data security to ensure the legal and compliant use of data, and protect the intellectual property rights of enterprises and customer privacy.

4.5 Build a Data Innovation Ecosystem and Promote Coordinated Development

The companies actively promote the construction of data innovation ecology, integrates the resources of government, enterprises, universities, scientific research institutions and other sources, and forms a synergy of collaborative innovation. In this ecosystem, private enterprises in can obtain comprehensive support such as policy, capital, technology and talent to promote the development of data innovation. In addition, focusing on cooperation and exchanges with other regions and enterprises at home and abroad, introducing advanced technology and management experience, and promoting international development in the field of data innovation.

5. Conclusions

This paper deeply discusses how data elements enable private enterprises to achieve breakthrough innovation, and reveals the core role of data elements in the innovation process of private enterprises through the combination of quantitative measurement and qualitative analysis. It is found that data elements not only optimize enterprise resource allocation and improve decision-making efficiency, but also promote product and service innovation by accurately matching market demand. At the same time, private enterprises need to build effective data governance mechanisms to ensure the safe and compliant use of data elements to provide a solid guarantee for breakthrough innovation. This paper provides theoretical support and practical guidance for private enterprises to use data elements to promote innovation, and helps private enterprises to achieve high-quality development in the digital era.

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References

[1] Byun, Oh, J.-M., & Xia, H. (2021). Incremental vs. Breakthrough Innovation: The Role of Technology Spillovers. Management Science, 67(3), 1779–1802.

[2] Kaplan, & Vakili, K. (2015). The double-edged sword of recombination in breakthrough innovation. Strategic Management Journal, 36(10), 1435–1457.

[3] Lv, Zhu, S., Liang, R., & Zhao, Y. (2024). Environmental regulation, breakthrough technological innovation and total factor productivity of firms-- evidence from emission charges of China. Applied Economics, 56(11), 1235–1249.

[4] Wolf, & Bernhart, M. J. (2022). Conceptualizing open distributed innovation: A framework for the collaboration of private companies with grassroots-driven open communities. Creativity and Innovation Management, 31(2), 340–357

[5] Bach, T. M., Dalazen, L. L., da Silva, W. V., Ferraresi, A. A., & da Veiga, C. P. (2019). Relationship between Innovation and Performance in Private Companies: Systematic Literature Review. SAGE Open, 9(2), 215824401985584.

[6] Cho, Sam Yul, and Sang Kyun Kim. “Horizon Problem and Firm Innovation: The Influence of CEO Career Horizon, Exploitation and Exploration on Breakthrough Innovations.” Research policy 46.10 (2017): 1801–1809.

[7] Zabbar, Daniel, and Jaclyn Margolis. “Beyond the Startup Stage: The Founding Team’s Human Capital, New Venture’s Stage of Life, Founder–CEO Duality, and Breakthrough Innovation.” Organization science (Providence, R.I.) 28.5 (2017): 857–872.

[8] Jin, Yi, Yun-fei Shao, and Yan-bo Wu. “Routine Replication and Breakthrough Innovation: The Moderating Role of Knowledge Power.” Technology analysis & strategic management 33.4 (2021): 426–438.

[9] Zhong, Changbiao et al. “Exploring the

Impacts of Knowledge Recombination on Firms' Breakthrough Innovation: The Moderating Effect of Environmental Dynamism." Journal of knowledge management 28.3 (2024): 698–723.

[10] Wang, Huan et al. "Unpacking Complementarity in Innovation Ecosystems: A Configurational Analysis of Knowledge Transfer for Achieving Breakthrough Innovation." Technological forecasting & social change 198.198 (2024): 122974.

