



Financial-data-based Classification and Evaluation Method for Enterprise Innovation Output

Jingce Xu*, Qiang Lu and Gaoqi Dai

State Grid Energy Research Institute, Changping, Beijing, 102209, China

*Corresponding author: Jinceshee@163.com

Abstract. Evaluation of innovation output is an important means for enterprises to measure their contributions to innovation and guide the improvement of their innovation capabilities. This paper aims at the problems existing in the current evaluation methods of enterprise innovation output, such as strong subjectivity of classification standards and few quantitative indicators. Based on the perspectives of supply and application, it identifies the characteristics of innovation activities from enterprise financial statements and designs the classification standards for enterprise innovation. Deeply analyze the connotations of quality, effectiveness and contribution, and construct a classification evaluation index system for enterprise innovation oriented towards quality, effectiveness and contribution. By conducting an empirical analysis using the financial data of a certain power enterprise in China, we found that data such as the proportion of R&D, procurement, wage can be used as the classification basis for the enterprise's innovation output, which plays an important guiding role in comprehensively reflecting the enterprise's innovation ability and value contribution.

Keywords: Innovation Output Evaluation, Enterprise Classification, Financial Data

1 Introduction

As the main body of innovation, how enterprises can better guide them to enhance their innovation capabilities is an important issue for the science and technology management departments of governments around the world to conduct policy research. In recent years, with the continuous increase in the intensity of research and development investment by governments around the world, the science and technology management departments of many countries have intensified efforts to optimize the assessment and evaluation system for innovation, constantly highlighting the emphasis on key areas such as output, achievements, and transformation. For instance, on November 8, 2024, China held a conference on innovation for central enterprises, proposing to accelerate the improvement of institutional arrangements such as assessment and evaluation, and R&D investment for central enterprises to promote original innovation, Higher requirements have been put forward for the evaluation of technological innovation in enter-

prises[1]. The classified promotion of innovation evaluation technologies oriented towards innovation output will be widely applied in scenarios such as the optimization of enterprise R&D investment structure, the assessment and allocation of innovation capabilities. Under the current background where more emphasis is placed on innovation output, there is an urgent need to carry out research on innovation evaluation technologies and their applications.

At present, regarding the classification and evaluation methods of enterprise technological innovation, a combination of qualitative and quantitative analysis is adopted. The commonly used methods mainly include the Delphi method, the power coefficient method, the Analytic hierarchy Process, the grey relational method and other models and methods. [2] pointed out that the performance evaluation of knowledge-based innovation talents should include six personal qualities and ten cognitive abilities. [3] took 109 research institutions of the Spanish National Research Council as the classification objects. Based on the differences in research outputs, they divided them into humanistic basic type, scientific research type, and technology development type, and proposed to consider the differences in scientific activities of different natures and establish more accurate evaluation indicators. [4] proposed a comprehensive evaluation framework based on multi-level indicator cleaning and aggregation, including three layers of algorithms: the data processing layer, the indicator aggregation layer, and the comprehensive evaluation layer.

Overall, at present, the academic community's scientific understanding of the classification and evaluation of enterprises' innovation output is still weak, especially in the research of basic theories and technical methods, there are still shortcomings. First, there are many qualitative indicators and few quantitative ones in the evaluation of innovation. There is a lack of evaluation methods that comprehensively demonstrate the innovation capabilities and contributions of enterprises, and it is impossible to accurately profile the innovation outputs of enterprises. Second, the orientation of technological innovation for enterprises is not clear enough. They adopt a broad and comprehensive approach or a single set of standards, lacking scientific and reasonable classification standards. There is an urgent need to optimize the classification evaluation to help various enterprises clarify their own positioning and development direction. Thirdly, considering the long-term development goals of enterprises, the current evaluation of innovation cannot adapt to the formation of a more integrated and systematic deployment.

In response to the above problems, this paper first explores the concept of enterprise technological output. Combined with the supply and demand relationship in enterprise operation, it proposes the classification criteria of enterprise technological output from the perspectives of supply and application. Then, introduce the evaluation orientation of quality, effectiveness and contribution, and put forward the evaluation indicators of innovation for each type of enterprise. Finally, by using the financial data of a certain power enterprise in China and its affiliated subsidiaries, an empirical analysis was carried out to further verify the feasibility of the classification criteria described in this paper and the scientific nature of the evaluation indicators.

2 Enterprise classification criteria oriented towards innovation output

2.1 Classification Framework

Innovation output refers to various forms of achievements generated through innovation activities[5]. From the perspective of enterprise innovation activities, there exists a supply and demand relationship of innovation output among different enterprises.

The first category is the supply. Such enterprises mainly aim to provide original technologies, industry-specific technologies, and technical equipment to the country, industries, and other enterprises. They possess strong capabilities in innovation, and their innovation activities cover multiple links including basic research, applied basic research, applied technology development, engineering verification or pilot production, and commercialization of technological achievements.

The second category is the application. Such enterprises mainly focus on the commercial application of innovation achievements, applying new technologies, new processes and new products to production practice, expanding the application scenarios of innovation, improving the quality of products and services, enhancing the competitiveness of enterprises, and ensuring the safe and stable operation of the national economy.

The third category is the NO. 1 integration of supply and application. Such enterprises have strong technological innovation capabilities. The various original and common technologies they produce are only partially used in their own production and operation activities. The technological achievements are mainly supplied externally, with an overall bias towards supply.

The fourth category is the NO. 2 integration of supply and application. Such enterprises have a strong demand for innovation achievements and possess certain capabilities in innovation. The various original and common technologies they produce are mainly used in their own production and operation activities. However, the common technologies and technical equipment needed for production and operation are mainly provided by other enterprises, and the overall orientation is towards application.

2.2 Classification Criteria

Based on the reports of 14 subordinate subsidiaries of a certain power enterprise in China, the characteristics of unit expenditure of different types of enterprises were observed from aspects such as the intensity of R&D expenditure input, procurement expenditure, and the proportion of employee wage expenditure, and the relevant basis for the classification of central enterprises was summarized and proposed. From the perspective of business operations, enterprises A-D belong to scientific research institutions, mainly exporting innovation achievements externally, and are classified as supply-oriented enterprises. Enterprise E-G belongs to the engineering construction unit and is an application-oriented enterprise. Enterprise H-J belongs to the manufacturing industry, exports technological products externally, and is classified as a type of enterprise integrating supply and application. Enterprise K-N belongs to the power supply service unit. Its main business is to invest in and operate the power grid, and it belongs

to the second category of supply and application integration enterprises. All the relevant data of the enterprise financial statements are shown in Table 1 (the real data has been declassified).

Table 1. Financial expenditure of some subsidiary enterprises of one grid enterprise

Name	Type	Proportion of R&D expense	Proportion of purchase expense	Proportion of wages expense	Proportion of fixed asset investment
Enterprise A	Supply	3.45%	38.24%	19.01%	7.63%
Enterprise B	Supply	4.11%	74.12%	16.85%	3.19%
Enterprise C	Supply	1.51%	1.68%	18.40%	3.06%
Enterprise D	Supply	1.22%	15.30%	47.46%	1.92%
Enterprise E	Application	0.17%	4.36%	2.03%	34.59%
Enterprise F	Application	0.03%	64.43%	1.80%	0.02%
Enterprise G	Application	0.20%	0.14%	0.31%	90.00%
Enterprise H	Integration NO.1	3.08%	65.80%	3.99%	3.88%
Enterprise I	Integration NO.1	8.42%	71.82%	2.30%	3.25%
Enterprise J	Integration NO.1	4.25%	53.39%	4.95%	3.25%
Enterprise K	Integration NO.2	0.32%	65.66%	3.70%	4.71%
Enterprise L	Integration NO.2	0.21%	89.83%	3.37%	4.20%
Enterprise M	Integration NO.2	0.26%	51.98%	3.10%	3.63%
Enterprise N	Integration NO.2	0.22%	79.41%	4.28%	3.89%
Enterprise B	Supply	4.11%	74.12%	16.85%	3.19%

Based on the above analysis, different types of enterprises exhibit distinct characteristics in terms of financial expenditure, which can be used as an enterprise classification method oriented towards innovation output, as shown in Table 2.

Table 2. Enterprise Classification Method Based on Financial Expenditure

Name	Proportion of R&D expense	Proportion of purchase expense	Proportion of wages expense
Supply	High	Normal	High
Application	Low	High	Low
Integration NO.1	High	Normal	Normal
Integration NO.2	Normal	High	Normal

3 A Classification Evaluation System for Innovation Oriented Towards Quality, Effectiveness and Contribution

3.1 The Internal Logic of "Quality, Effectiveness and Contribution"

Quality, effectiveness and contribution respectively reflect three different evaluation orientations: goal-oriented, demand-oriented and value-oriented, which are interrelated and have their own emphases. As shown in Fig. 1.

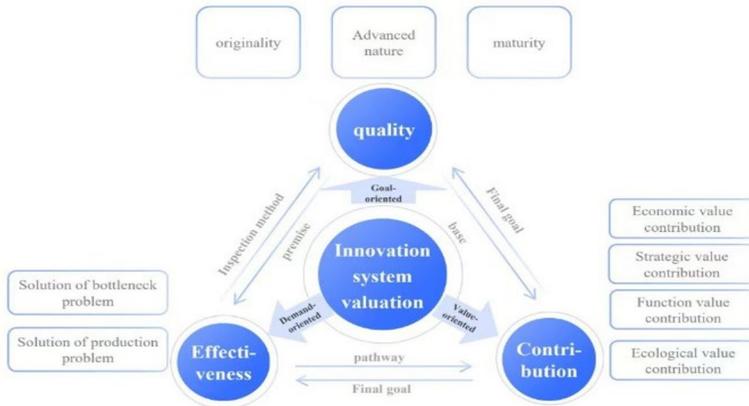


Fig. 1. The internal logic of "quality, effectiveness, and contribution"

Quality reflects the perspective of goal-oriented, and represents the continuous pursuit of technical performance, advancement and maturity in the process of innovation. It is the foundation and prerequisite for innovation to produce practical results and make contributions.

Effectiveness reflects the perspective of demand-oriented, addressing the practical needs of national strategies, industrial development, and enterprise growth. It aims to break through technological bottlenecks and solve urgent and forward-looking practical problems. This is not only the criterion for testing the quality of innovation but also a necessary way for it to make contributions.

Contribution reflects the perspective of value-oriented. Creating value and making contributions are the ultimate goals of innovation. Science and technology are the primary productive forces. The most essential feature of the transformation of innovation achievements into real productive forces is to generate economic value. Meanwhile, innovation achievements are a key component of the competitiveness of a country and enterprises, and also an important aspect of the contribution of innovation.

3.2 The Connotations of "Quality, Effectiveness and Contribution" In the Evaluation System for Innovation

3.2.1 The Connotation of "quality" in the Innovation Evaluation System.

The quality of the innovation evaluation system refers to the advancement, originality, technological maturity, as well as the reliability and effectiveness of the innovation achievements. It is an important indicator to measure whether innovation has reached the international advanced level and whether it has breakthrough and leading significance.

Originality. Focus on central enterprises proposing new theories, developing new technologies or products in their own business fields, and leading the development trends of the industry. **Advanced nature.** Focus on whether the innovation output achievements are in a leading position when compared with similar achievements worldwide. **Maturity.** Focus on the level at which innovation output achievements can be promoted and applied, such as prototypes, pilot applications, batch applications, and industrial applications, etc.

3.2.2 The Connotation of the "Effectiveness" in the innovation Evaluation System.

"Effectiveness" is an evaluation dimension from the perspective of demand orientation, with a focus on the effectiveness of innovation in solving practical problems and meeting the demands of the country, industries, and enterprises. Solve the "bottleneck" problems. From the perspective of technical security, efforts should be made to promote the domestic substitution of key core technologies and solve the problem of being "strangled" by key core technologies. Overcome the practical difficulties in production. Focus on the effectiveness of enterprises' technological innovation in solving specific and practical problems encountered in production practice.

3.2.3 The Connotation of "Contribution" in the Innovation Evaluation System.

"Contribution" is an evaluation dimension from the perspective of value orientation, fully reflecting the positive impact of the activities and achievements of central enterprises in the field of science and technology on the economy, society and environment. It mainly includes the following value dimensions. **Contribution to economic value.** The economic benefits generated through cost reduction and income expansion after the direct transformation and application of innovation achievements should be given priority consideration. **Strategic value contribution.** The focus should be on central enterprises as strategic innovation forces of the country, and the contribution of central enterprises in supporting the country to seize the commanding heights of science and technology through innovation breakthroughs should be evaluated. **Functional value contribution.** The key consideration should be the function of central enterprises as the "ballast stone" of the national economy and people's livelihood, and the contribution of central enterprises in supporting and maintaining the safe and stable operation of the national economy through innovation research and development should be evaluated. **Ecological value contribution.** Focus on the value and role of central enterprises as the

source of original technologies and the leaders of modern industrial chains. Build innovation platforms, form consortia and other forms to promote the formation of an innovation ecosystem in the upstream and downstream.

3.3 A Classification Evaluation System Oriented Towards Quality, Effectiveness and Contribution

3.3.1 Innovation Output Evaluation of Supply-Oriented Enterprises.

In terms of supply, enterprises mainly have three forms: original technology supply, equipment and product supply, and technical service supply. The quality, effectiveness and contribution evaluation indicators for different supply forms vary.

The first is the supply of original technologies. It focuses on carrying out original innovation activities in the aspects of basic principles and technical application theories, forming technical solutions, and helping enterprises solve key technical problems.

The second is the supply of equipment products. The main goal is to accelerate the research and development of new equipment products with new technologies and new processes, improve the quality of products and services, enhance the competitiveness of enterprises, and provide high-quality equipment supply for the safe and stable operation of the national economy.

The third is the supply of technical services. By cultivating and reserving personnel with strong technical research experience, we provide external services such as technical consultation, technical supervision and technical research to help other enterprises enhance their technological level.

The evaluation indicators of innovation output on the supply side were designed in a way that combines common and characteristic indicators. The indicator system is shown in Table 3.

Table 3. Evaluation Indicators of Innovation Output in Supply

Form	Dimensionality	Index	
Quality	Originality	Number of authorized patents for independent inventions	
		Number of major innovations achieved	
		Cumulative Patent Ownership	
		Effectiveness of building a source of original technology	
		Outputs of the “three first” products	
	Advanced nature	Number of national science and technology awards	
		Number of core patent awards	
		Number of world-leading results achieved	
		Level of main technical specification parameters	
	Maturity	Number of high-level technical personnel	Number of major research results that have achieved mass application

Form	Dimensionality	Index
		Number of innovation achievements reaching maturity level 6 or above
		Average level of technological maturity of equipment products
		Level and number of technical certifications obtained
Effectiveness	Effectiveness of solving bottleneck problem	Completion rate of 'bottleneck' tasks
		Number of results in breaking the long-standing technology embargo
		Number of major technical equipment related to the security and stability of important industrial chains
	Effectiveness of solving production problem	Completion rate of major research tasks
		Number of engineering applications of independent intellectual property rights
		Number of engineering applications of technology and equipment
Contribution	Economic value contribution	Satisfaction with technical services in the production sector
		Number of patents converted to land
		Income from conversion of results
		Revenue from sales of new products
	Strategic value contribution	Contract value of technical service transactions
		Number of national R&D specialties undertaken
		Number of international standards
	Functional value contribution	Number of leading international technical organizations
		Number of major innovation achievements related to national economy and people's livelihood
	Ecological value contribution	Number of R&D and innovation platforms
Number of innovation consortia led		
Openness of key laboratories		

3.3.2 Innovation Output Evaluation of Application-Oriented Enterprises.

For the evaluation of innovation output of application-oriented enterprises, the focus should be on the ability and level of enterprises to fully play the role of demand-driven. Evaluation indicators can be constructed from the perspectives of quality, effectiveness and contribution for aspects such as the existing infrastructure, business conditions and procurement of technical products of enterprises. The indicator system is shown in Table 4.

Table 4. Evaluation Indicators of innovation output in application

Type of evaluation	Evaluation dimension	Evaluation indicators
Application Quality	originality	Number of projects demonstrating the application of new technologies
	Advanced nature	Number of major innovation projects completed
		Level of technical specifications for critical infrastructure
	maturity	New technology results application cycle
Number of patents transformed into applications on the ground		
Application effectiveness	Effectiveness in resolving 'bottleneck' issues	Substitution rate of localization of key core technologies
	Effectiveness in solving practical production problems	Chain resilience and security levels
		Safe and stable operation level of main business
Application Contributions	Economic value contribution	total profit
		Economic value added, EVA
		Main business brand value
	Strategic value contribution	Number of first equipment applications
		Number of applications of the Recommended Catalog of Innovation Achievements of Central Enterprises
	Functional value contribution	Investment in critical national infrastructure
	Ecological value contribution	Interconnection ratios of major manufacturing suppliers
Enhancement of joint supply chain reserve back-up and protection capacity		
Specialized inputs for the "chain length" of the industrial chain		

4 Conclusion

From the perspectives of supply and application, identify the characteristics of innovation activities from the financial statements of enterprises and design the classification standards for enterprise innovation. Deeply analyze the connotations of quality, effectiveness and contribution, and construct a classification evaluation index system for enterprise innovation oriented towards quality, effectiveness and contribution. By conducting an empirical analysis using the financial data of a certain power enterprise in China, we found that data such as the proportion of R&D expenses, the proportion of procurement expenses, and the proportion of employee wage expenses can be used as the classification basis for the enterprise's innovation output, which plays an important

guiding role in comprehensively reflecting the enterprise's innovation ability and value contribution.

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