Academic Journal of Business & Management
ISSN 2616-5902 Vol. 8, Issue 7: 19-26, DOI: 10.25236/AJBM.2026.080704

Evaluation on the Integration-synergy Degree of Regional Dual-innovations and the Construction of Its Evolution Mechanism under the Goal of New-quality Productive Forces

Junjun Han[1], Shuai Mao[1]*

[1]Hubei University of Automotive Technology, Shiyan, Hubei, 442002, China
**Corresponding Author*

Abstract: *Cultivating new-quality productive forces requires deep integration of technological and industrial innovation. Based on the panel data of 30 Chinese provinces from 2015 to 2024, this paper establishes a two-system evaluation framework according to core characteristics of new-quality productive forces. The entropy-weight method and coupling-coordination model are adopted to quantify the integration-synergy level of regional dual innovations and analyze its spatiotemporal-evolution patterns and internal mechanism. The results reveal that the national coupling-coordination degree keeps increasing through three evolutionary phases yet remains in the maladjustment range. The synergy level presents a spatial gradient pattern with high values in eastern China, low values in western China and a rising trend in central China. A closed-loop mechanism of "goal-driven effect-bilateral coordination-iterative feedback" exists between the two innovations. Differentiated regional strategies are accordingly proposed to support policy-making for fostering new-quality productive forces.*

Keywords: *New-quality Productive Forces; Technological Innovation; Industrial Innovation; Coupling Coordination Degree*

1. Introduction

At present, the transformation of industrial technology has been completed, the integration of science and technology and industrial innovation should be promoted, which is the focus of China's strategic development, and the continuous upgrading of productivity and the improvement of development quality are required.Scientific and technological innovation is the fundamental basis for industrial upgrading, industrial innovation provides effective scenes for the development of technology, the two promote each other, and it is necessary to analyze their evolutionary path, internal mechanism and regional differences in depth, which is conducive to the rapid formation of new productive forces.

At present, the academic circles are focusing on the integration of dual innovation, and have carried out in-depth research.Theory scholars believe that the integration of the two is a dynamic process, which requires the upgrading of industrial chains and innovation chains to be coordinated, and requires breakthroughs in technology, improvement of factor allocation efficiency and so on [1-3].From a quantitative point of view, the coupling coordination degree model should be constructed, and the entropy weight method should be introduced to form a dual system evaluation framework.

Reviewing the current literature, we can see that there are some deficiencies, which are specifically reflected in two aspects: First, the connotation of "double innovation integration" is relatively narrow, and there is a lack of systematic research in this regard, and the role of new quality productive forces in guiding the development of "double innovation integration" has not been brought into play.Second, the existing indicator system can not reflect the characteristics of the new quality productive forces, and the description of the dimensions such as commercialization and original innovation is not enough, and the model is not standardized, which can not capture the contradictions in the process of innovation integration.

In order to make up for the above shortcomings, this paper contributes to the following three aspects: First, it combs the connotation of "iterative feedback" and analyzes the evolution mechanism of "target guidance" in the process of integrating dual innovation, which is guided by the goal of improving the quality of productive forces.Secondly, the paper sorts out the connotation of new quality productive

ISSN 2616-5902 Vol. 8, Issue 7: 19-26, DOI: 10.25236/AJBM.2026.080704

forces, and constructs a dual-system evaluation index system from the three dimensions of environment, input and output.Thirdly, this paper uses the panel data of 30 provinces and cities in China from 2015 to 2024 to measure whether the integration of dual innovation is standard, and describes the development of regional integration from the aspects of space and time, so as to provide reference for the development of new quality productive forces in all regions.[5]

2. Research Design

2.1. Construction of Indicator System

In accordance with the connotation and characteristics of coupling and coordination between scientific and technological innovation and industrial innovation, combined with the principles of scientificity, operability and data availability, and drawing on relevant existing studies, this paper constructs a corresponding evaluation indicator system consisting of two target layers: the scientific and technological innovation system and the industrial innovation system[4][6-7]. The detailed indicator system is shown in Table 1.

Table 1: Technological Innovation System.

Target Layer	Domain Layer	Indicator Layer		
		Name	Unit	Attribute
Technological Innovation System	Technological Innovation Input	Internal Expenditure on R&D	100 million yuan	+
		Full-time Equivalent of R&D Personnel	person-year	+
		R&D Expenditure Intensity	%	+
	Technological Innovation Output	Number of Domestic Scientific Papers Published	piece	+
		Transaction Volume of Technology Market	100 million yuan	+
		Granted Invention Patents	piece	+
	Technological Innovation Environment	Regional Gross Domestic Product	100 million yuan	+
		Number of Students in Regular Institutions of Higher Education per 10,000 People	person	+
		Number of Science and Technology Business Incubators	unit	+

Drawing on the research frameworks proposed by Sun Li[4], Zhao Fang[6], Yang Jinchao [8], Wang Sheng[9] and other scholars for the industrial innovation system, this paper selects nine indicators covering three domain layers: industrial innovation input, industrial innovation output and industrial innovation environment, as detailed in Table 2.

Table 2: Industrial Innovation System.

Target Layer	Domain Layer	Indicator Layer		
		Name	Unit	Attribute
Industrial Innovation	Industrial Innovation Input	Funds for New Product Development	100 million yuan	+
		Technology Introduction Expenses	100 million yuan	+
		R&D Personnel for Applied Research and Experimental Development	person-year	+
	Industrial Innovation Output	Sales Revenue of New Products of Industrial Enterprises above	100 million yuan	+

ISSN 2616-5902 Vol. 8, Issue 7: 19-26, DOI: 10.25236/AJBM.2026.080704

		Designated Size		
		Proportion of Strategic Emerging Industries Output Value in GDP	%	+
		Main Business Income of High-tech Industries	100 million yuan	+
	Industrial Innovation Environment	Number of High-tech Enterprises	enterprise	+
		Digitalization Level Index	-	+
		Marketization Index	-	+

2.2. Research Methods

2.2.1. Standardization of Data and Determination of Indicator Weights

To eliminate biases in evaluation results caused by different dimensions of various indicators, the range standardization method is first adopted to standardize and preprocess the original data. Afterwards, the entropy weight method, an objective weighting approach, is used to calculate indicator weights, so as to avoid interference from subjective factors and information overlap. The calculation formulas for standardized values (y_{ij}), indicator weights (w_{ij}) and entropy values (e_j) are presented as follows:

$$w_{ij}=\frac{y_{ij}}{\sum_{i=1}^{n} y_{ij}} \tag{1}$$

$$e_j=-\frac{1}{\ln n}\sum_{i=1}^{n} w_{ij}\ln w_{ij} \tag{2}$$

In Formulas (1) and (2):y_{ij} denotes the standardized value; n represents the sample size of indicators, which equals 300 in this study. When $w_{ij}=0$, we set $w_{ij}\times\ln w_{ij}=0$.

Based on the weights of each indicator, the comprehensive score$S_i$of the scientific and technological innovation subsystem and industrial innovation subsystem is calculated year by year.

$$S_i=\sum_{i=1}^{m}(w_j*y_{ij}) \tag{3}$$

2.2.2. Coupling Coordination Degree Model

To systematically quantify the interaction intensity and sound coordination level between scientific and technological innovation and industrial innovation, this paper constructs a coupling coordination degree model. The calculation steps are as follows:

(1) Calculate the system coupling degree C: it reflects the degree of interaction between the two systems.

$$C=2\sqrt{\frac{S_i*S_j}{(S_i+S_j)^2}} \tag{4}$$

Where C stands for the coupling degree between the sci-tech innovation subsystem and the industrial innovation subsystem, ranging from 0 to 1. A value closer to 1 indicates stronger coupling and a more ordered overall system[10] ; S_i refers to the comprehensive score of the sci-tech innovation subsystem, and $S_j$represents the comprehensive score of the industrial innovation subsystem.

(2) Calculate the system coordination degree T: it characterizes the overall development level of Dual Innovations Integration.

$$T=\alpha S_i+\beta S_j \tag{5}$$

Where T denotes the comprehensive coordination index; α and β represent the importance weights of the sci-tech innovation system and industrial innovation system, respectively. This study holds that the two systems are equally important. Referring to existing research [11], we set $\alpha=\beta=0.5$.

(3) Calculate the system coupling coordination degree D: it comprehensively evaluates the quality of

ISSN 2616-5902 Vol. 8, Issue 7: 19-26, DOI: 10.25236/AJBM.2026.080704

coordinated development of the systems.

$$D=\sqrt{C*T} \tag{6}$$

Where D refers to the coupling coordination degree derived from the coupling degree and comprehensive coordination index of the two systems, ranging from 0 to 1. A larger value of D signifies a higher level of coupling coordination between the two subsystems. Drawing on existing literature[12-13], this paper divides the coupling coordination degree into ten grades, as shown in Table 3.

Table 3:Classification of Coupling Coordination Degree.

Grade	Value of D	Type of Coupling Coordination
1	0-0.1	Extreme imbalance
2	0.1-0.2	Severe imbalance
3	0.2-0.3	Moderate imbalance
4	0.3-0.4	Mild imbalance
5	0.4-0.5	On the verge of imbalance
6	0.5-0.6	Bare coordination
7	0.6-0.7	Primary coordination
8	0.7-0.8	Intermediate coordination
9	0.8-0.9	Good coordination
10	0.9-1.0	High-quality coordination

3. Evolution Mechanism of the Integration and Coordination of Dual Innovations under the Goal of New Quality Productive Forces

3.1. Temporal Dimension: Three-Stage Progressive Evolution Mechanism

In light of data fluctuations and policy timelines, detailed results are presented in Figure 1. The integration of Dual Innovations across China exhibits distinct developmental characteristics over time, which can be divided into the following three phases:

Phase 1 (2015-2018): In this stage, the coupling degree of the country is between 0.22 and 0.26, and the imbalance interval is relatively large, with the score of most provinces below 0.3. Looking at the innovation echelons, only two provinces have entered the coordination area, while Guangdong has achieved primary coordination by 2018.Compared with this, the innovation centers of Shanghai, Beijing and other places have not entered the imbalance interval by 2018. It can be seen that the coordinated development of the two innovations is in the initial stage of exploration, and there are obvious institutional barriers to cross-chain factor flow, and there is no strategic traction to slow down the evolution process.

Phase 2 (2019-2021): under the impetus of policy, the development of this period is relatively rapid.With the rapid implementation of the strategy of innovation-driven development, the coupling coordination degree of the country has gradually increased from 0.27 to 0.31, and the imbalance has changed from serious to slight. At the regional level, Hunan, Hubei and other provinces have broken through the 0.3 threshold and are no longer seriously unbalanced. Shandong is close to balance, and the imbalance is relatively small. Guangdong, Jiangsu and other provinces have achieved coordination in 2021.In the process of upgrading the industry, the demand for general technology has increased, and the supply at the R&D end has been effectively guaranteed, and the efficiency and frequency of interaction between the two innovation systems have increased significantly.

Phase 3 (2022-2024): In-depth adaptation period, guided by strategic objectives. In this stage, we should grasp the strategic objectives, implement the concept of new productive forces, achieve qualitative leap in dual innovation, and achieve a new breakthrough in coupling degree, which is 0.35, a new record.During this period, the development of many provinces in Southwest China and Central China has reached a new level, and the coordination degree has been significantly improved. Hunan, Hubei and Anhui provinces have entered the imbalance zone, and the integration of the two innovations has formed a transition belt.The most prominent feature of this stage is the upgrading of first-tier innovative clusters: Zhejiang Province has achieved primary coordination, and Beijing, Shanghai and Shandong Province have broken through 0.5 and achieved coordinated development. The breakthrough of many economic engine areas is particularly prominent, and the coordinated development of the two innovations has achieved breakthroughs in the whole chain.

ISSN 2616-5902 Vol. 8, Issue 7: 19-26, DOI: 10.25236/AJBM.2026.080704

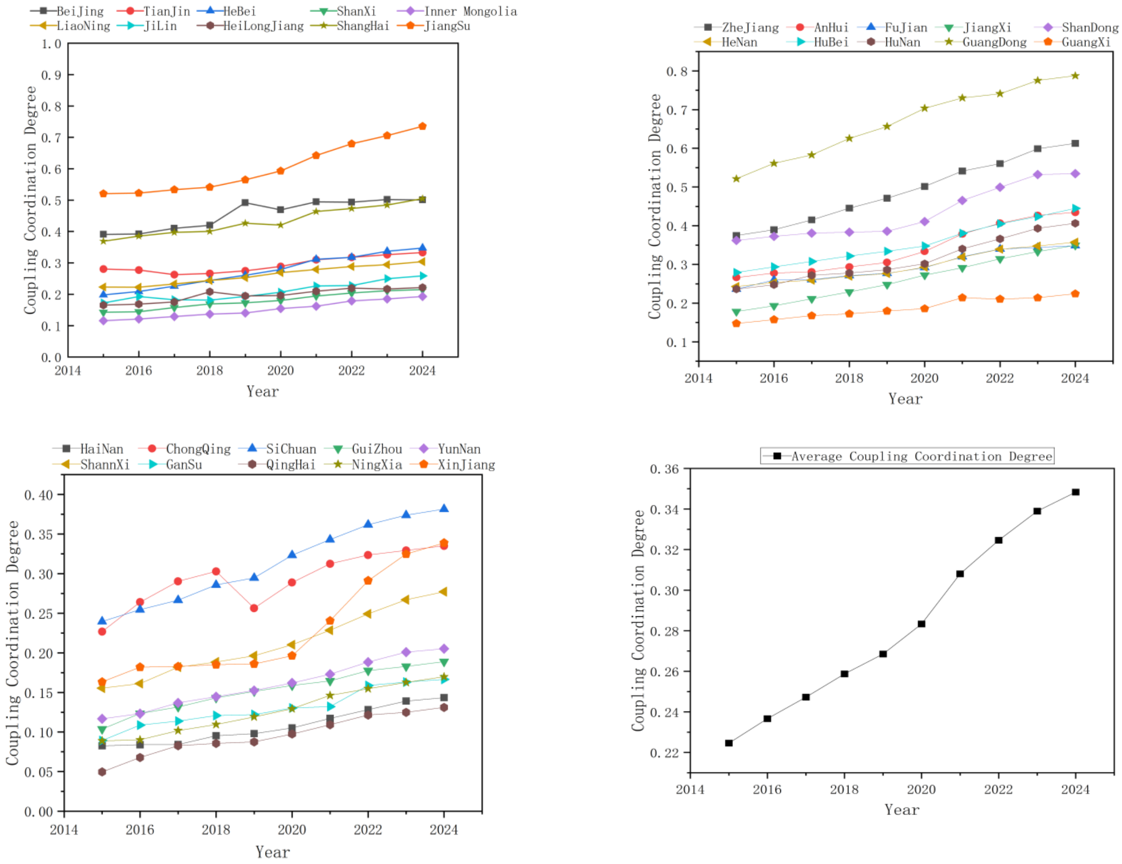

Figure 1 Coupling Coordination Degree Data

3.2. Spatial Dimension: Gradient Differentiation and Differentiated Evolution Mechanism

In the process of promoting the integration of "double innovation", the industrial structure, resource endowment and economic foundation of each region are different, so the integration of "double innovation" is obviously different among regions. The development level of the eastern region is relatively high, while the development level of the western region is relatively low, and the central region is rising. The provinces have formed three completely different development paths:

First tier: The eastern coastal region is relatively advanced.By 2024, the coupling coordination degree of each province in this echelon exceeded 0.5, and the gap between the provinces in this region was relatively large. These provinces have a solid foundation in industrial-university-research integration and manufacturing clusters, and Jiangsu and Guangdong have achieved coordination and stability. Zhejiang has a strong private sector and a sound digital economy, and has achieved primary coordination. Shanghai, Beijing and other provinces and cities have achieved coordination.This region has become a strategic engine for the upgrading of production capacity, relying on the development of science and technology, innovation and upgrading of industry, and strengthening of research.

Second echelon: some areas in central and western China are in the process of rapid development.This echelon has the most provinces and cities, and most of them are in the critical period of achieving coordinated development. Shanxi Province is different from other provinces in this regard, because the transformation of resource-based industries is not smooth enough, and there is an imbalance.Hubei, Anhui and other provinces have made remarkable achievements in the development of emerging industries, but they are still in the imbalance zone.Sichuan, Chongqing and other provinces have achieved mild imbalance. The rise of central China has made this echelon a key growth pole in the process of national innovation and integration.

Third echelon: Western and northern regions are relatively backward.In 2024, the coupling degree of most provinces in this region was less than 0.3, and the imbalance was serious.Shaanxi and Jilin are in a state of moderate imbalance, while Qinghai, Hainan, Gansu, Ningxia, Guizhou and other provinces are in a state of serious imbalance. There are obvious structural contradictions between the provinces, which

ISSN 2616-5902 Vol. 8, Issue 7: 19-26, DOI: 10.25236/AJBM.2026.080704

are related to brain drain and unbalanced development of heavy industry.Xinjiang has achieved the goal of mild imbalance because of its unique geographical location and abundant resources, and has played a model role for other provinces.

3.3. System Core: Dynamic Circular Mechanism of Two-Way Mutual Promotion

In the process of promoting the integration of the two innovations, the guidance of the goal of new productive forces can not be ignored, which requires the establishment of a circular and closed-loop logic, and the promotion of the development of the regional innovation system.

First, it is necessary to analyze the goal guidance mechanism of new productive forces.New productive forces can be described as high-quality, high-efficiency and high-technology, which can provide guidance for the integration of the two innovations, and can play a role in the process of breaking institutional barriers, which is conducive to the separation of economic system and education system.In the panel data, it can be seen that the national average coordination degree has risen rapidly since 2022, and the growth rate has slowed down since 2015, reaching 0.35 by 2024, which shows that the setting of strategic goals can change the logic of factor allocation, and universities and scientific research institutions can cooperate with industrial sectors.This conclusion is convincing.

Secondly, the coordinated development mechanism between industrial innovation and scientific and technological innovation.The rapid development of science and technology is conducive to the transformation of industrial model, and can produce a large number of disruptive achievements, which will provide strong support for industrial upgrading.Industrial innovation can provide a good environment for the development of science and technology, and can also produce a large number of application scenarios, which can solve technological bottlenecks, and inject a large amount of commercial capital into science and technology development.For example, Jiangsu and Guangdong provinces are in the first echelon, which have achieved rapid development in advanced manufacturing and are willing to provide a good environment for the implementation of original innovation, which can bring higher value-added returns to the market, and also promote the upgrading and iteration of technology, so as to form a closed loop.

Third, the iterative feedback circular upgrading mechanism.The coordinated development between the two innovations can play an important role in promoting the development of productivity, and can give full play to the role of total factor productivity.This is enough to show that the quality of productive forces has been significantly improved, which is enough to produce a series of higher requirements for industrial chain upgrading and original innovation.This is a spiral mechanism, which can promote the upgrading of the whole industrial system, make the production of scientific and technological achievements more in line with the development of industrial technology, and enable the modern industrial system to get rid of the traditional path dependence and move towards the high-end value chain.

4. Research Conclusions and Policy Recommendations

4.1. Research Conclusions

This paper constructs a dual-system evaluation index system covering scientific and technological innovation and industrial innovation. Based on panel data of 30 provincial-level regions in China from 2015 to 2024, this study adopts the entropy method and the classical coupling coordination degree model to systematically measure and investigate the evolutionary characteristics and internal mechanisms of the coordinated level of regional Dual Innovations Integration under the goal of new quality productive forces. The main conclusions are drawn as follows:

(1) Distinct Temporal Evolution with a Steady Upward Trend. From 2015 to 2024, the national average coupling coordination degree (CCD) rose from 0.22 to 0.35, transitioning from "moderate dysfunction" to "mild dysfunction". The trajectory comprises three distinct stages: the "preliminary exploration period" (2015–2018) with blocked factor flows; the policy-driven "rapid advancement period" (2019–2021); and the strategy-led "deep adaptation period" (2022–2024) featuring all-factor binding.

(2) Pronounced Spatial Differentiation with an "East-High, West-Low, and Central-Rising" Pattern. The first echelon (eastern coastal regions) has collectively entered the coordination zone with clear internal hierarchical tiers; the second echelon (central and southwestern catching-up zones) is tightly clustered between 0.33 and 0.45, transitioning step-by-step from dysfunction to coordination; the third

echelon (western and northeastern weak zones) mostly suffers from severe dysfunction, though Xinjiang demonstrates great latecomer catching-up potential.

(3) Closed-loop System Core Governed by "Goal Orientation – Two-way Coordination – Iterative Feedback." New quality productive forces serve as the strategic guide; scientific supply and industrial scenario feedback form a two-way dynamic linkage; the deepening of integration optimizes factor allocation and generates higher-level demands, driving the innovation system to upgrade spirally.

4.2. Policy Recommendations

Based on the above research conclusions, the following policy recommendations are put forward to further advance the in-depth integration of technological innovation and industrial innovation at the regional level and accelerate the fostering and development of new quality productive forces:

(1)Implementing Gradient-based Differentiated Strategies. The first echelon should focus on original and disruptive innovations to build global innovation hubs; the second echelon should actively undertake high-quality industrial transfers to push Hubei, Anhui, and Hunan into the coordination zone; the third echelon needs to exploit unique resource advantages to explore characteristic catching-up paths.

(2) Dismantling Institutional Barriers to Deepen Joint Synergy. Relying on the reverse-forcing mechanism of strategic goals, governments should secure enterprises' dominant position in innovation and deepen industry-university-research cooperation. Refinement of patent commercialization and benefit-sharing mechanisms is required to boost technology market turnover and bridge the gap between technology supply and industrial application.

(3) Optimizing Regional Environment to Drive Full-chain Upgrades. Regions should refine the construction of business incubators and elevate digital infrastructure powered by 5G. By expanding high-tech enterprises and the share of strategic emerging industries, a modern industrial system can be forged where industrial demands reverse-pull the precise iteration of scientific innovation.

References

[1] Wang, X. Y. Exploration and Enlightenments of the Integrated Development of Scientific and Technological Innovation and Industrial Innovation in Fujian[J]. Journal of Fujian Agriculture and Forestry University (Philosophy and Social Sciences Edition), 2025, 28(05): 39-47.

[2] Huang, M., & Wan, X. L. Deep Integration of Scientific and Technological Innovation and Industrial Innovation Empowering New Quality Productive Forces: Logical Framework, Practical Barriers and Implementation Paths[J]. Scientific Management Research, 2025, 43(02): 82-91.

[3] Zhou, J., & Wu, H. Integrated Development of Scientific and Technological Innovation and Industrial Innovation: Theoretical Logic and Realization Paths[J]. Qiushi Journal, 2025, 52(03): 12-22.

[4] Sun, L., Jiang, N., & Zhong, H. Statistical Measurement and Optimization Path of Integrated Development of Scientific and Technological Innovation and Industrial Innovation[J]. Statistics & Decision, 2026, 42(07): 99-107. DOI:10.13546/j.cnki.tjyjc.2026.07.016.

[5] Song, D. L., Kong, P. P., & Liu, X. T. Spatiotemporal Evolution of Coupling Coordination Between Digital Economy and Carbon Emissions of Urban Agglomerations in the Yellow River Basin[J/OL]. Journal of North China University of Water Resources and Electric Power (Social Science Edition): 1-16. [2026-06-14].

[6] Zhao, F., Zhang, M., Jiang, G. L., & Xu, Y. Spatiotemporal Evolution Characteristics and Mechanism of Deep Integration Between Scientific and Technological Innovation and Industrial Innovation: Evidence from High-tech Industries[J]. Science & Technology Progress and Policy, 2025, 42(13): 71-84.

[7] Wang, H., Liu, J., & Xu, Y. A System Coupling Analysis on the Integration of Scientific and Technological Innovation with Industrial Innovation for Sustainable Regional Development in China[J]. Sustainability, 2025, 17(4): 1627.

[8] Yang, J. C., Xu, J., & Wu, H. Measurement and Promotion Path of Coupling Coordinated Development Between Scientific and Technological Innovation and Industrial Innovation: Empirical Analysis Based on 13 Prefecture-level Cities in Jiangsu Province[J]. Statistical Science and Practice, 2025, (09): 32-35.

[9] Wang, S. Research on Coupling Coordination Degree Between University Scientific and Technological Innovation and High-tech Industrial Innovation[J]. Science and Technology & Innovation, 2025, (08): 164-167. DOI:10.15913/j.cnki.kjycx.2025.08.043.

[10] Shi, Y. S., Zhou, Z. J., Su, R. B., et al. Evaluation on Coupling Coordinated Development of Scientific

ISSN 2616-5902 Vol. 8, Issue 7: 19-26, DOI: 10.25236/AJBM.2026.080704

and Technological Innovation and Industrial Innovation: A Case Study of National High-tech Zones in Guangdong Province[J]. Science and Technology Management Research, 2024, 44(24): 84-91.

[11] Zhang, L. F. Evaluation and Influencing Factors of Coupling Coordination Between New Quality Productive Forces and Carbon Emission Efficiency[J]. Journal of Environmental Engineering Technology, 2026, 16(02): 541-554.

[12] Ren, B. P., & Du, Y. X. Coupling Synergy Among Economic Growth, Industrial Development and Ecological Environment in the Yellow River Basin[J]. China Population, Resources and Environment, 2021, 31(2): 119-129.

[13] Ma, Y. X., & Ma, C. Y. Coupling Coordination Degree and Path of University Scientific and Technological Innovation and Urban Innovation: Evidence from 13 Cities in the Beijing-Tianjin-Hebei Region[J]. Journal of Tianjin University (Social Sciences), 2024, 26(3): 250-258.