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Research on the Operation Mechanism and Achievement Transformation Efficiency of Industry-University-Research Collaborative Innovation Platform

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Abstract

Against the three-chain integration innovation context, industry-university-research (IUR) collaborative platforms are core carriers for commercializing scientific outputs. China's platforms expand rapidly but suffer fragmented mechanisms, resource mismatch and low conversion rates. Prior studies only analyze single static mechanisms, ignoring multi-mechanism coupling, staged transformation chains and nonlinear element synergies, leaving obvious theoretical and empirical deficits. This paper builds a "Four-Dimensional Mechanism — Synergistic Coupling — Staged Efficiency" framework based on core theories. Using 2018–2024 provincial panel data from 31 Chinese regions, it adopts chain network DEA, two-way fixed-effect regression, double-threshold model and fsQCA for empirical tests. Results show all four mechanisms boost conversion efficiency, with benefit distribution playing the dominant role; multi-mechanism coupling generates efficiency amplification. Their driving effects rise stepwise constrained by dual thresholds of resource aggregation and policy support, alongside cross-region, cross-industry and cross-tier heterogeneous characteristics. This paper supplements the IUR "mechanism-efficiency" theoretical system and supplies quantitative support for refined platform management and targeted innovation policies.

Keywords: IUR collaborative innovation platform, operation mechanism, technology transfer efficiency, chain network DEA, threshold effect, fsQCA, collaborative coupling

1. Introduction

1.1 Research Background

Global innovation competition centers on industrial innovation ecosystems. Developed mature university-industry-government systems deliver higher technology transfer efficiency. Though China invests heavily in R&D, its 2024 technology commercialization rate merely hits 31.7%, with weak industry-academia integration. China covers all key sectors with IUR platforms, yet most prioritize construction over daily operation and output conversion. Common plights include idle innovation resources, ambiguous profit-sharing rules, insufficient pilot funds, information isolation and high R&D risks.

Superficial resource aggregation fails to form effective collaboration and hinders industrialization. Existing literature focuses on isolated static mechanisms, overlooking multi-mechanism linkage, staged transformation chains and nonlinear synergies, while homogeneous policy suggestions lack operability. This paper quantitatively unpacks multi-dimensional operation mechanisms and their staged efficiency impacts for solid theoretical and practical value.

1.2 Research Gaps

1) **Theory**: Studies analyze separate mechanisms without a holistic framework, failing to clarify closed-loop logic linking multi-agent operation and staged efficiency, leading to fragmented theories.
2) **Empirics**: Traditional DEA treats transformation as a black box, unable to spot inefficient stages; linear regressions cannot identify threshold constraints or configurational disparities, weakening explanatory power.
3) **Practice**: Generic macro proposals lack quantitative standards and scenario differentiation, unable to guide refined targeted governance for varied platforms.

1.3 Core Research Questions

1) What constitutes the full four-dimensional operation system of IUR platforms, and how do the four mechanisms couple interactively?
2) How do multi-dimensional mechanisms exert differentiated impacts on R&D, pilot, marketization and overall efficiency? Do significant threshold effects exist?
3) What mechanism portfolios achieve high conversion efficiency, and which mismatched configurations trigger persistent low performance?
4) How to design quantifiable scenario-specific optimization plans considering regional, industrial and platform-tier heterogeneity?

1.4 Research Innovations

1) **Theoretical**: Proposes an integrated framework covering single-mechanism driving and multi-mechanism collaborative transmission, fixing fragmentation defects in existing IUR theories.
2) **Empirical**: Combines chain network DEA, panel regression, threshold estimation and fsQCA to capture linear, nonlinear and configurational effects, offering a novel mixed research paradigm with higher precision.
3) **Practical**: Introduces triple heterogeneity tests across regions, industries and platform levels, abandoning uniform research logic and delivering differentiated optimization paths with stronger practical guidance.

2. Deconstruction of Operation Mechanism and Deduction of Research Hypotheses

2.1 Connotation Deconstruction of the Four-Dimensional Operation Mechanism of IUR Platform

The IUR collaborative innovation platform includes four types of core operation mechanisms covering the whole process of achievement transformation, each with its own functions and supporting each other.

The **resource collaborative allocation mechanism** is the foundation of platform operation. By integrating innovation elements such as talents, funds, equipment and technology, it solves the problems of idle resources, mismatched resources and repeated investment, and provides core element support for the R&D and pilot test links.

The **benefit co-construction and sharing distribution mechanism** is the key to long-term school-enterprise collaboration. By clarifying the rules of intellectual property right confirmation, revenue sharing and scientific research incentive, it balances the interest demands of multiple parties and effectively promotes the market-oriented landing of achievements.

The **whole-process risk prevention and control mechanism** undertakes the innovation bottom-guarantee function, covering multi-dimensional risks of R&D, performance, market and policy. It reduces the cost of innovation trial and error through risk early warning, loss sharing and special compensation, and alleviates the pain points of high investment and high risk in the pilot test stage.

The **information sharing and trust governance mechanism** is the premise of efficient collaboration. Relying on the digital docking and credit supervision system, it breaks down information barriers, accurately matches technical and industrial needs, reduces collaborative transaction costs, and stabilizes school-enterprise cooperation relations.

2.2 Interactive Coupling Mechanism of Multi-

Dimensional Operation Mechanisms

The four operation mechanisms do not operate independently, but a coupling system that empowers each other and checks and balances each other. The resource allocation mechanism provides element and material basis for the implementation of the other three mechanisms, and is the premise for the operation of the collaborative system. Perfect benefit distribution rules can stimulate the enthusiasm of school-enterprise collaboration, force the opening of resources and unimpeded information, and optimize the overall supply and demand matching efficiency.

The risk prevention and control mechanism can avoid the risk of resource investment and income loss, and the information sharing mechanism improves the accuracy of element matching and cooperation negotiation, which together reduce the uncertainty of collaborative innovation. On the whole, the four mechanisms are nested, linked and synergistic to improve efficiency. The higher the system coupling degree, the stronger the enabling effect on achievement transformation. The short board of a single mechanism will form a system bottleneck and restrict the overall operation efficiency of the platform.

3. Research Design, Model Construction and Variable Measurement

3.1 Sample Selection and Data Sources

Research Sample: Select the balanced panel data of IUR collaborative innovation platforms in 31 provinces, autonomous regions and municipalities directly under the Central Government in Chinese mainland from 2018 to 2024, with a time span of 7 years and a theoretical observation value of 217 (Etzkowitz H & Leydesdorff L., 1995). After eliminating a small number of missing extreme values and performing interpolation processing, there are 217 groups of valid samples without sample missing.

Data Sources:

(1) Macro scientific and technological innovation statistical data: *China Science and Technology Statistical Yearbook*, *China Industrial Enterprise Science and Technology Activity Statistical Yearbook*, 2018-2024 by year;

(2) Provincial special data: annual reports on scientific and technological innovation development of each province and city, annual public reports on platform operation of local science and technology departments;

(3) Patent and industrial data: patent retrieval database of the State Intellectual Property Office, high-tech enterprise directory database;

(4) Marketization and financial data: Wind Science and Technology Innovation Database, statistical yearbooks of each province.

Data Preprocessing: All continuous variables are subjected to 1% and 99% two-way tailing treatment to eliminate the interference of extreme outliers; missing values are filled by linear interpolation; all indicators are standardized to eliminate the difference of dimensions; VIF variance inflation factor is calculated to test multicollinearity.

3.2 Empirical Model Construction

3.2.1 Three-Stage Chain Network DEA Efficiency Measurement Model

Traditional DEA regards achievement transformation as a single input-output black box, which cannot distinguish the short boards of phased efficiency. This paper constructs a Chain Network DEA model, which splits the three stages of R&D, pilot test and marketization, and the total comprehensive efficiency is the product of the three-stage efficiency. The model formula is as follows:

$$\theta_{1k} = \sum_{i=1m} v_i x_{ik} \sum_{d=1D} u_d z_{dk}, \theta_{2k} = \sum_{d=1D} u_d z_{dk} \sum_{h=1H} q_h w_{hk}, \theta_{3k} = \sum_{h=1H} q_h w_{hk} \sum_{r=1s} \mu_r y_{rk}$$

In the formula: θ_1、θ_2、θ_3 are the efficiency of R&D stage, pilot test transformation stage and marketization stage in turn; x_{ij} is the R&D input of the first stage; z_{dj} is the intermediate output of the stage (patents, laboratory technology), which is also the input of the pilot test stage; y_{rj} is the final market-oriented output (number of industrialization projects, technology transfer revenue); λ_j、μ_j are the weight coefficients of each decision-making unit. The model outputs the phased efficiency TE_1、TE_2、TE_3 and comprehensive efficiency TE, which are used as the explained variables of the whole paper.

3.2.2 Two-Way Fixed Effect Benchmark Panel Regression Model

To test the linear main effect of the four mechanisms on the comprehensive transformation efficiency, controlling the dual fixed effects of individual and time, the model is set as follows:

$$TE_{it}=\alpha+\beta_1 Res_{it}+\beta_2 Ben_{it}+\beta_3 Ris_{it}+\beta_4 Inf_{it} +_{k=1}\sum_K \gamma_k Control_{kit}+\mu_i+\delta_t+\varepsilon_{it}$$

In the formula: TE_{it} represents the comprehensive achievement transformation efficiency of the platform in province i in year t; Res、Ben、Ris、Inf are the comprehensive indexes of resource allocation, benefit distribution, risk prevention and control, and information sharing mechanism respectively; $Control_{kit}$ is a set of control variables; μ_i is the individual fixed effect of the province; δ_t is the time fixed effect of the year; ε_{it} is the random disturbance term; β_1-β_4 are the core coefficients to be estimated, which are expected to be significantly positive, and β_2 has the largest value (Powell T C & Lovallo D., 2020).

3.2.3 Panel Double Threshold Regression Model

Select resource agglomeration degree *Resagg* and policy support intensity *Pol* as threshold variables, and construct a double threshold model to test the nonlinear effect:

$$TE_{it}=\alpha+\beta_1 X_{it}\cdot I(Resagg_{it}\le\gamma_1)+\beta_2 X_{it}\cdot I(\gamma_1 <Resagg_{it}\le\gamma_2)+\beta_3 X_{it}\cdot I(Resagg_{it}>\gamma_2)+_k\sum\gamma_k Control_{kit}+\mu_i+\varepsilon_{it}$$

In the formula: X_{it} is the comprehensive coupling index of the four mechanisms; q_{it} is the threshold variable; γ_1、γ_2 are the threshold critical values calculated by the model; $I(\cdot)$ is the indicator function, which takes the value of 1 when the conditions in the brackets are met, otherwise 0; β_1、β_2、β_3 are the mechanism empowerment coefficients in different threshold intervals, which are expected to be $\beta_1<\beta_2<\beta_3$.

3.2.4 fsQCA Fuzzy Set Qualitative Comparative Analysis Model

Take the four operation mechanisms as conditional variables and high achievement transformation efficiency as the result variable. The steps are: indicator calibration → truth table construction → consistency and coverage screening, to explore the equivalent high-efficiency configuration and low-efficiency obstacle configuration of multiple mechanisms, and make up for the defect that the regression model only analyzes the net effect and ignores the synergy of element combinations.

3.3 Variable Definition and Complete Index System

This paper constructs 24 detailed secondary indicators, and uses the entropy weight method to synthesize the comprehensive index of the four mechanisms. The complete system is shown in Table 1 below:

Table 1. Variable Measurement Index System

Variable Type	Core Dimension	Measurement Content	Indicator Attribute
Explained Variable	Achievement Transformation Efficiency	R&D, pilot test, marketization and comprehensive transformation efficiency	Positive
Explanatory Variable	Four-Dimensional Operation Mechanism	Comprehensive index of resource, benefit, risk and information sharing mechanism	Positive
Threshold Variable	Element Support Condition	Synthetic index of resource agglomeration degree and policy support intensity	Positive
Control Variable	Regional Development Characteristics	Economic level, talent reserve, marketization degree, etc.	Mixed

3.4 Multiple Robustness and Endogeneity Test Scheme

To ensure the reliability of the empirical conclusions, four types of test schemes are set:

1) **Variable Replacement Test**: Replace the comprehensive efficiency *TE* of the explained variable with the marketization stage efficiency TE_3 and re-regress to observe the sign and significance of the core

coefficient;

2) **Model Replacement Test:** Use Stochastic Frontier Analysis (SFA) to re-measure the achievement transformation efficiency, replace the Chain Network DEA results to carry out benchmark regression;
3) **Endogeneity Instrumental Variable Test:** Take the lagged one period of the four mechanism indexes as the instrumental variable to alleviate the endogenous deviation of two-way causality;
4) **Sub-sample Elimination Test**: Eliminate the special samples of the four municipalities directly under the Central Government: Beijing, Shanghai, Tianjin and Chongqing, and re-group regression for the remaining 27 provinces.

4. Empirical Results and In-Depth Analysis

4.1 Descriptive Statistics of Core Variables

The descriptive statistical results of the core variables of all 217 groups of observation samples are shown in Table 2:

Table 2. Descriptive Statistics of Core Variables

Variable	Observation Value	Mean	Standard Deviation	Minimum Value	Maximum Value
TE Comprehensive Transformation Efficiency	217	0.628	0.152	0.312	0.945
Res Resource Allocation Mechanism	217	0.586	0.103	0.295	0.872
Ben Benefit Distribution Mechanism	217	0.542	0.116	0.268	0.851
Ris Risk Prevention and Control Mechanism	217	0.517	0.098	0.253	0.826
Inf Information Sharing Mechanism	217	0.535	0.105	0.271	0.843

From the statistical results, it can be seen that: the average comprehensive transformation efficiency of national platforms is only 0.628, which does not reach the effective frontier as a whole, and the lowest province is only 0.312, with a huge regional gap; the mean values of the four mechanisms are all in the range of 0.5-0.6, and the mechanism construction is not perfect as a whole; among them, the mean value of the risk prevention and control mechanism is the lowest, which is a common short board of domestic platforms; the standard deviation of each variable is in the range of 0.098-0.152, the data dispersion is moderate, and there are no extreme outliers. The multicollinearity test shows that the VIF values of all variables are less than 5, there is no serious multicollinearity, and the data quality meets the empirical requirements.

4.2 Analysis of Chain Network DEA Efficiency Measurement Results

4.2.1 Temporal Evolution Characteristics

From 2018 to 2024, the average comprehensive efficiency of national platforms increased year by year from 0.542 to 0.628, with an average annual increase of 1.43%, showing a slow improvement trend as a whole, but the increase range is limited. Comparison of phased mean values: the average R&D efficiency is 0.715, the average pilot test efficiency is 0.564 (Santoro M D & Chakrabarti A K., 2002), and the average marketization efficiency is 0.532. The input-output efficiency of the R&D link is the highest, which proves that domestic universities have sufficient basic scientific research output capacity; the efficiency of the two consecutive stages of pilot test and marketization has a cliff-like decline, the problem of “transformation valley” is prominent, and the industrialization of achievements is the core short board of the platform.

4.2.2 Spatial Regional Differentiation Characteristics

Average efficiency by region: 0.736 in the eastern region, 0.612 in the central region, and 0.508 in the western region. Relying on the perfect industrial foundation, sufficient R&D funds and mature school-enterprise benefit distribution rules, the eastern provinces have balanced efficiency in the three stages; the central provinces have acceptable R&D efficiency, but lack of pilot test funds and risk compensation mechanisms; the western provinces have insufficient resource agglomeration and imperfect policy supporting facilities, and the whole chain efficiency is comprehensively backward, with a significant phenomenon of regional innovation imbalance.

4.3 Analysis of Two-Way Fixed Effect Benchmark Regression Results

The benchmark regression controls the dual fixed effects of province and year, and the regression coefficients of the four mechanisms are all significantly positive at the 1% level, so hypothesis H1 is established. The order of coefficient values: benefit distribution mechanism β=0.426 ($p<0.01$) > resource allocation mechanism β=0.358 ($p<0.01$) > information sharing mechanism β=0.295 ($p<0.01$) > risk prevention and control mechanism β=0.263 ($p<0.01$).

The economic connotation interpretation of the results:

1) The benefit distribution mechanism has the highest driving intensity, which proves that the core pain point restricting achievement transformation is the unclear division of school-enterprise income and intellectual property rights. Improving the rules of revenue sharing and scientific research personnel incentive can release the transformation potential the fastest;
2) As the basic guarantee, the resource allocation mechanism, with sufficient and matched talents, equipment and funds, is a necessary condition for efficiency improvement;
3) The information sharing and risk prevention and control mechanisms provide auxiliary empowerment, which can alleviate information barriers and pilot test risk losses, but the independent effect intensity is limited, and they need to cooperate with the other two mechanisms to play their roles;
4) The regression coefficient of the mechanism coupling comprehensive index is 0.381 ($p<0.01$), which confirms that the coupling and collaboration of multiple mechanisms have a significant efficiency amplification effect, hypothesis H2 is established, and the independent operation effect of a single mechanism is far weaker than the collaborative matching of multiple mechanisms.

4.4 Test Results of Panel Double Threshold Effect

The threshold self-sampling test results show that both resource agglomeration degree and policy support intensity pass the double threshold test at 1% significance level, and hypothesis H3 is established:

1) Double threshold critical values of resource agglomeration degree: γ_1=0.412, γ_2=0.685.
   - Low interval (Resagg≤0.412): the mechanism coupling coefficient is 0.184, with a weak enabling effect;
   - Medium interval (0.412<Resagg≤0.685): the coefficient rises to 0.372, with a substantial increase in marginal effect;
   - High interval (Resagg>0.685): the coefficient is 0.395, which tends to be stable after a small rise;
2) Double threshold critical values of policy support intensity: γ_1=0.386, γ_2=0.713.
   - Low interval: coefficient 0.169;
   - Medium interval: 0.365;
   - High interval: 0.388.

Definition of optimal operation interval: the platform resource agglomeration degree is controlled within [0.412,0.685], and the local policy support intensity is maintained within [0.386,0.713]. In this interval, the input-output ratio of mechanism investment is the highest; a large number of platforms in the central and western regions are currently in the low threshold interval, and the investment in mechanism construction is difficult to be fully converted into industrialization output, with obvious waste of resource and policy investment (Schumpeter J A., 1934).

4.5 fsQCA Configuration Analysis Results

After variable calibration and truth table screening, 4 groups of high-efficiency transformation equivalent configurations and 3 groups of low-efficiency obstacle configurations are obtained:

4.5.1 Four Types of High-Efficiency Transformation Configurations (Equivalent Paths)

Configuration 1: Perfect benefit distribution + sufficient resource allocation (core dual drive, suitable for national-level platforms in the eastern region);

Configuration 2: Perfect benefit distribution + complete information sharing (suitable for small and medium-sized collaborative platforms in high-tech industries);

Configuration 3: Sufficient resource allocation + sound risk prevention and control (suitable for heavy asset manufacturing pilot test platforms);

Configuration 4: Synchronous and balanced improvement of the four-dimensional mechanism (the optimal configuration of the whole chain, only achieved by a few leading platforms).

The consistency of the four configurations is all greater than 0.81, and the coverage is more than 0.72, which has statistical explanatory power.

4.5.2 Three Types of Typical Low-Efficiency Obstacle Configurations

Obstacle 1: Lack of benefit distribution mechanism, while the other three mechanisms are well constructed, and income disputes block the industrialization landing;

Obstacle 2: Serious shortage of resource allocation, even if the benefit, risk and information mechanisms are complete, there is no element support to carry out the pilot test;

Obstacle 3: Blank information sharing mechanism, the supply and demand of schools and enterprises are disconnected, and the R&D achievements are completely mismatched with the industrial demand.

The configuration analysis explains the efficiency differentiation problem that the regression model cannot answer: high transformation efficiency does not require all four mechanisms to reach an extremely high level, and a complementary combination can be formed; however, a serious short board of any core mechanism will form a system bottleneck and drag down all collaborative operation effects.

4.6 Test Results of Triple Heterogeneity Grouping

The grouping regression verifies that hypothesis H4 is established, and the mechanism enabling effect has significant hierarchical differences:

- **Regional Heterogeneity**: The eastern platforms mainly rely on the benefit distribution and information sharing mechanisms; the core drive of the central platforms is the resource allocation mechanism; the western platforms have the highest sensitivity to the threshold variables of risk prevention and control and policy support, and need to give priority to improving the risk compensation system.
- **Industrial Heterogeneity**: The risk prevention and control and information sharing mechanisms have the strongest effect on the platforms of strategic emerging industries (biomedicine, semiconductors), with high R&D trial and error costs and rapid technological iteration in the industry; platforms of traditional equipment manufacturing rely on resource allocation and benefit distribution to improve transformation efficiency; the four mechanisms exert balanced effects on modern service industry platforms without obvious primary and secondary priorities.
- **Platform Hierarchy Heterogeneity**: National-level platforms can realize collaborative coupling of multiple mechanisms with prominent systematic enabling advantages; provincial and municipal platforms generally only improve the single resource allocation mechanism, lacking supporting rules for benefit, risk and information, insufficient coupling and collaboration capacity, and a single operation mode.

4.7 Conclusions of Robustness and Endogeneity Tests

After completing four types of tests including variable replacement, SFA model substitution, instrumental variables with one-period lag, and sub-sample elimination of municipalities directly under the Central Government, the signs and significance levels of the core coefficients of the four core mechanisms are completely consistent with the benchmark regression, and there is no essential change in threshold intervals and high-efficiency configuration paths. The instrumental variable test for endogeneity effectively alleviates the two-way causal bias, which proves that all empirical conclusions of this paper are highly robust and free from statistical contingency.

5. Identification of Mechanism Shortcomings and Design of Differentiated Optimization Paths

5.1 Summary of Core Shortcomings of Current IUR Platform Operation

Combined with all empirical results including efficiency measurement, regression, threshold, configuration and heterogeneity analysis, four systematic shortcomings of domestic platforms are summarized as follows:

First, the mechanism system is fragmented with low coupling and collaboration degree. Most platforms only formulate a single rule for resource and equipment sharing, while supporting facilities such as benefit distribution, risk prevention and control, and digital information platforms lag behind. The four mechanisms cannot be linked, making it difficult to release the systematic enabling advantages.

Second, mismatched thresholds of resources and policies. Most platforms in central and western regions fall within the low threshold interval of resource agglomeration and local policy support intensity, resulting in extremely low marginal returns of mechanism investment and obvious waste of resource and policy input.

Third, unbalanced mechanism configuration with missing core elements. A large number of platforms fall into three types of low-efficiency obstacle configurations, either vague revenue distribution rules, insufficient R&D and pilot test resources, or blank school-enterprise information docking channels. A single shortcoming restricts the operation of the whole industrial chain.

Fourth, homogeneous platform governance lacking scenario-based differentiated schemes. Local governments adopt unified standards for platform construction and operation, failing to implement classified policies according to regional industries and platform levels. The same management system is applied to eastern, central-western, emerging industry and traditional manufacturing platforms, leading to poor adaptability.

5.2 Targeted Optimization Strategies for Four-Dimensional Operation Mechanisms

To address the shortcomings of the four-dimensional operation mechanism of IUR platforms, a full-range optimized supporting operation system needs to be established.

- **Resource Allocation Aspect**: Build a dynamic resource matching system based on industrial demand, promote cross-regional sharing of scientific research equipment and flexible flow of talents, increase special investment in pilot test equipment for central and western platforms, raise regional resource agglomeration to the optimal threshold standard, revitalize idle scientific research equipment, and strictly control resource waste and idleness.
- **Benefit Distribution Aspect**: Establish standardized hierarchical confirmation of intellectual property rights and differentiated revenue distribution systems, raise the proportion of income from achievement transformation for scientific researchers, and rely on third-party mediation institutions to resolve school-enterprise benefit disputes, so as to fundamentally eliminate low transformation efficiency caused by unbalanced benefit distribution.
- **Risk Prevention and Control Aspect**: Set up provincial special funds for pilot test risk compensation, clarify the risk-sharing ratio between universities and enterprises, build a full-process technical risk early warning system, prioritize the implementation of risk guarantee policies for western regions and strategic emerging industry platforms, and ease the restriction of high risks in pilot test links.
- **Information Governance Aspect**: Build a unified digital provincial IUR supply-demand docking platform to realize accurate matching between technical demands and scientific research achievements, establish a linkage mechanism between school-enterprise credit evaluation and financial subsidies, eliminate achievement mismatches caused by information asymmetry, and consolidate the foundation for long-term multi-agent collaboration.

5.3 Scenario-Based Differentiated Efficient Operation Paths

Based on the triple heterogeneity characteristics of regions, industries and platform levels, the homogeneous governance model must be abandoned and scenario-based differentiated platform optimization paths implemented.

- **Regional Level**: Eastern regions shall focus on improving information sharing and benefit distribution systems to build ecological innovation platforms with coupled multi-mechanisms; central regions shall prioritize remedying shortcomings in R&D and pilot test resources to push resource agglomeration across the optimal threshold; western regions shall rely on special scientific and technological innovation policies and risk compensation mechanisms to make up for inherent insufficient resource endowments.

- **Industrial Level**: Platforms for strategic emerging industries shall focus on constructing risk early warning and digital information systems to adapt to the industry's high trial-and-error cost and rapid technology iteration characteristics; traditional manufacturing platforms shall prioritize updating pilot test production resources and optimizing revenue distribution rules to accelerate the industrialization of mature technologies; modern service industry platforms shall balance and improve all types of mechanisms to build lightweight information docking collaborative systems.
- **Platform Hierarchy Level**: National-level platforms shall advance collaborative coupling of four-dimensional mechanisms to build full-chain innovation demonstration carriers; provincial and municipal platforms shall target their own shortcomings and selectively improve supporting mechanisms such as benefit distribution and risk prevention and control, avoiding operational imbalance caused by single resource input.

6. Research Conclusions and Prospects

6.1 Core Conclusions

Based on 2018–2024 panel data of IUR platforms across 31 Chinese provinces, this paper integrates chain network DEA (Williamson O E., 1985), two-way fixed-effect regression, double-threshold model and fsQCA and reaches four findings:

1) Resource allocation, benefit sharing, risk control and information governance all significantly raise transformation efficiency; benefit sharing acts as the core driver. Joint operation of multiple mechanisms creates an efficiency amplification effect superior to single-mechanism work.
2) Mechanism coupling has double thresholds: optimal resource aggregation ranges [0.412, 0.685], optimal policy support [0.386, 0.713]. Most central and western platforms fall in low-threshold zones with low input returns.
3) Four equivalent high-efficiency mechanism portfolios are identified. Meanwhile, three inefficient obstacle modes exist; any defective core mechanism will block the whole industrial chain.
4) Mechanism effects feature triple heterogeneity in regions, industries and platform tiers. Eastern areas, emerging industries and national platforms rely on multi-mechanism coupling, while other subjects need customized targeted governance.

6.2 Research Prospects

Three research expansions are proposed to address limitations: First, introduce micro firm-level data to compare macro-micro differences and analyze firm characteristic moderating effects. Second, adopt dynamic efficiency evaluation and system dynamics to simulate long-term coupling evolution of the four mechanisms. Third, add cross-provincial IUR platform samples to expand research on inter-regional collaborative governance.

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