Research in Economics and Management
ISSN 2470-4407 (Print) ISSN 2470-4393 (Online)
Vol. 10, No. 1, 2025
www.scholink.org/ojs/index.php/rem

Original Paper

Research on Transformation Effect and Path Optimization of Scientific and Technological Achievements in Xi'an City: A Case Study of the Transformation Policy of Scientific and Technological Achievements of Qinchuangyuan Innovation-driven Platform

Bin Tang[1], Zeming Cheng[1], Xiaoli Lin[1] & Yu Bao[2*]

[1] Center for Experimental Economics in Education, Shaanxi Normal University, Xi'an, Shaanxi, China

[2] Office of Science and Technology, Shaanxi Normal University, Xi'an, Shaanxi, China

[*] Corresponding author: Yu Bao, Office of Science and Technology, Shaanxi Normal University, Xi'an, Shaanxi, China. Email: baoyu@snnu.edu.cn.

Received: March 2, 2025 Accepted: March 19, 2025 Online Published: April 10, 2025

doi:10.22158/rem.v10n1p97 URL: http://dx.doi.org/10.22158/rem.v10n1p97

Abstract

This study examines the transformation efficiency and pathway optimization of scientific and technological achievements (STAs) in Xi'an, China, focusing on the Qinchuangyuan innovation-driven platform. Despite abundant scientific resources, Xi'an has long faced a sub-30% technology transfer rate due to institutional barriers such as ambiguous benefit distribution and insufficient market capital participation. Through the "three reforms" (separate management of STAs, professional title assessment for technology transfer talents, and utilization of horizontal research funds), Qinchuangyuan has addressed systemic bottlenecks, enabling a surge in technology contract transactions and growth in high-tech enterprises. However, challenges persist, including regional imbalances, over-reliance on government funding, and pricing ambiguities in technology valuation. Quantitative analysis reveals that institutional innovations such as the "use first, pay later" model and technology brokerage systems have reduced enterprise trial-and-error costs by 60.37%. The study proposes collaborative pathways: establishing cross-regional technology trading platforms, diversifying financing via market-oriented strategies (e.g., intellectual property securitization), and fostering "scientist + engineer" teams to bridge R&D-market gaps. These findings underscore the necessity of integrating policy facilitation, ecological

aggregation, and chain coordination to overcome structural contradictions. The research offers a replicable framework for science-rich cities in western China, emphasizing institutional adaptability to transcend innovation models and achieve systemic coordination in regional innovation ecosystems.

Keywords

scientific and technological achievements transformation, transformation efficiency, path optimization, Qinchuangyuan Innovation-driven Platform, institutional innovation

1. Introduction

Against the backdrop of increasingly fierce global competition in scientific and technological innovation, the transformation of scientific and technological achievements has become an important engine driving the high-quality development of regional economies. As a city rich in scientific and educational resources in western China, Xi'an has 63 universities and over 4,600 research institutions (including 23 national key laboratories). Its density of scientific research talents and the volume of patent outputs rank among the top in the country. However, the long-standing phenomenon of "emphasizing research and development but neglecting transformation" has led to a long-term technology transfer rate of less than 30% in the city. A large number of technological achievements remain at the laboratory stage and have not been effectively transformed into real productive forces. This contradiction not only restricts the progress of Xi'an in building a national innovative city, but also highlights the urgency of solving the problem of the "two skins" of science and technology and economy.

From a theoretical standpoint, the transformation of scientific and technological achievements represents the critical juncture in the "last mile" of the innovation value chain. Its efficiency is contingent upon three dimensions: technology maturity, market adaptability, and institutional synergy. Research indicates that ambiguous benefit distribution mechanisms, disputes over intellectual property rights ownership, and the lack of specialized technical managers are key bottlenecks impeding the transformation process within Industry-University-Research (IU-R) cooperation. For instance, Stanford University's Office of Technology Licensing (OTL) model has significantly enhanced transformation efficiency by clearly defining the equity distribution ratio among inventors, universities, and enterprises (typically 1:3:6) (Colyvas & Powell, 2007). However, certain Chinese universities continue to encounter institutional challenges in quantifying the contribution of achievement transformation. Moreover, the "Darwinian Dead Sea" phenomenon during the technology validation stage—the gap between laboratory results and marketable products—urgently requires the intervention of pilot-scale platforms and venture capital to mitigate the risks associated with technology application (Lam, 2010).

At the policy level, since the revision of the Law on Promoting the Transformation of Scientific and Technological Achievements, China has systematically established a comprehensive policy framework encompassing "empowerment reform, financial support, and talent incentives." In 2021, Shaanxi Province introduced three key reforms—separate management of scientific and technological achievements by post, professional title assessment for technology transfer talents, and transformation of

horizontal surplus funds—which represent a deepening and practical implementation of this policy framework. These policies have significantly enhanced the innovation vitality of research entities by alleviating administrative constraints on researchers (such as permitting the use of surplus funds from horizontal projects to establish enterprises) and reconstructing the talent evaluation system (including incorporating transformation performance into professional title evaluations). Data indicates that the transaction value of technology contracts in Shaanxi Province reached 412.099 billion yuan in 2023, representing a 134% increase compared to 2020. This policy innovation mirrors the "contract research" model of Germany's Fraunhofer Association, which emphasizes an R&D mechanism driven by market demand.

In response to the aforementioned challenges, the Shaanxi Provincial Government initiated the construction of the Qinchuangyuan innovation-driven platform in 2021, positioning it as the central hub and primary source for the province's innovation-driven development. Through comprehensive policy reforms, the platform has established a collaborative mechanism encompassing industry, academia, research, application, and finance, aiming to overcome institutional barriers hindering the transformation of scientific and technological achievements. By 2024, the Qinchuangyuan platform had facilitated the management and promotion of 93,000 scientific and technological achievements across Shaanxi Province, achieved the commercialization of 25,000 projects, and incubated 1,572 science and technology enterprises, thereby establishing the "Xi'an Model" with significant demonstrative value. However, challenges remain in the implementation of these policies, including regional development imbalances and inadequate market capital participation. It is imperative to identify an optimal path forward through theoretical analysis and practical experience.

International experience demonstrates that the successful transformation of scientific and technological achievements requires both "ecological convergence" and "institutional breakthroughs." For instance, Israel's technology incubators have nurtured over 800 high-tech enterprises by leveraging a model where the government bears 85% of R&D risks while intellectual property rights are retained by the enterprises (Avnimelech & Amit, 2024). Xi'an's approach emphasizes the "integration of four chains"—the innovation chain, industrial chain, capital chain, and talent chain—and has fostered the development of 18 emerging industrial clusters, including hydrogen energy and photonics, through initiatives such as the establishment of seed funds, science and technology brokerage teams, and a "scientist + engineer" collaboration mechanism. Notably, Qinchuangyuan's "enclave incubation" model has achieved synergistic effects by integrating cross-regional resources to facilitate R&D in Xi'an and production in other cities, thereby enabling the establishment of 80 hydrogen energy enterprises in 2024.

This study focuses on evaluating the efficiency and optimizing the pathways of the policy system for the transformation of scientific and technological achievements in Xi'an City, using the Qinchuangyuan innovation-driven platform as an empirical case. The aim is to reveal the shaping role of policy tools on regional innovation ecosystems and identify practical bottlenecks. Specific objectives include:

First, deconstructing the policy innovation mechanism: A systematic review of Qinchuangyuan's "three reforms" (separate management of scientific and technological achievements by post, title assessment of technology transfer talents, and transformation of horizontal scientific research surplus funds) was conducted to analyze institutional breakthroughs and barriers that prevent researchers from engaging in technology transfer.

Second, quantitative analysis of policy implementation effects: Based on data such as technology contract transaction volumes (exceeding 450 billion yuan in 2024), the number of high-tech enterprises (reaching 15,000 in 2024), and typical cases, this study evaluates the contributions of the "use first, pay later" model, "spring seed fund" and technology broker system in reducing enterprise trial-and-error costs and accelerating technology commercialization.

Third, identify the limitations of the transformation system: In light of the regional development imbalance (concentration of resources in the Xi Xian New Area and underdevelopment in other districts and counties), reliance on a single financing channel (government funding), and lack of an evaluation system (ambiguous pricing mechanism for scientific and technological achievements), analyze the obstacles hindering the final stage of policy implementation.

Last, propose collaborative optimization pathways: In alignment with the construction goals of the "Dual Centers" and the Implementation Plan for Promoting Future Industrial Innovation and Development in Xi'an (2024-2027), explore the establishment of a cross-regional technology trading platform, market-oriented capital introduction strategies, and a collaborative model for "scientist + engineer" teams. This will provide a replicable institutional innovation paradigm for cities in western China that are rich in scientific and educational resources.

Through this research, the paper aims to transcend the path dependence of existing achievement transformation theories that are predominantly focused on eastern developed regions. It seeks to construct a regional innovation framework encompassing "policy facilitation - ecological aggregation - chain coordination", thereby offering a solution with both theoretical depth and practical value to address the dual challenges in the "science and technology economy" nexus.

2. Analysis of Qinchuangyuan's "Three Reforms" System Breakthrough and System Barrier Cracking

As an important platform for the innovation-driven development of Shaanxi Province, Qinchuangyuan has effectively solved the institutional barriers of "dare not transfer" and "do not want to transfer" faced by researchers in the process of transformation of scientific and technological achievements through the implementation of "three reforms", namely, the separate management of scientific and technological achievements by posts, the professional title assessment of technology transfer talents, and the transformation of scientific and technological achievements funded by the balance funds of horizontal scientific research projects. The following is a systematic review and analysis of the three reform system breakthroughs.

The reform of separate management of job-based scientific and technological achievements will withdraw the job-based scientific and technological achievements from the current state-owned assets management system and carry out separate management, which will not be included in the assessment scope of the management of maintaining and increasing the value of state-owned assets. This reform measure fundamentally eliminates researchers' concerns about the loss of Chinese assets in the process of the transformation of scientific and technological achievements, and provides institutional guarantee for the smooth transformation of scientific and technological achievements. In the past, because the post scientific and technological achievements were regarded as state-owned assets, the transformation process was subject to strict supervision and assessment, resulting in researchers worried that they might bear the responsibility for the loss of state-owned assets due to improper operation in the transformation process, so they "dared not transfer". The reform of the separate management of scientific and technological achievements by posts has effectively solved this institutional obstacle by making it clear that the disposal of scientific and technological achievements shall be decided by universities independently, and shall not be examined and approved, put on record, or included in the assessment scope of maintaining and increasing the value of state-owned assets.

The professional title evaluation system for technology transfer talents incorporates the contributions of these professionals to the transformation of scientific and technological achievements into the evaluation criteria. This initiative encourages researchers at universities and research institutes to actively engage in technology transfer and achievement transformation activities. By implementing this reform, a clear career development path is established for technology transfer professionals, thereby stimulating their enthusiasm and commitment to the transformation of scientific and technological achievements. Historically, researchers have often been hesitant to pursue the commercialization of scientific and technological achievements due to concerns about potential negative impacts on their professional title evaluations. The introduction of the professional title evaluation system for technology transfer talents addresses this issue by explicitly recognizing the contribution of scientific and technological achievements as a key performance indicator, thus providing both motivation and assurance for researchers to engage in such activities. This effectively resolves the institutional barrier that has long hindered the process.

The reform initiative permits universities and research institutes to allocate surplus funds from horizontal scientific research projects towards the investment in the commercialization of technological achievements, thereby forming a diversified portfolio of "technology equity + cash equity". Furthermore, it actively promotes innovative pilot programs such as "use first, pay later" and "transfer of rights and interests". This policy provides multifaceted financial support for the commercialization of scientific and technological achievements, effectively lowering the threshold and mitigating associated risks. Insufficient funding has historically been a critical factor impeding the successful commercialization of scientific and technological achievements. Previously, due to inadequate financial backing, numerous market-viable scientific and technological achievements struggled to achieve effective

commercialization. By enabling institutions to utilize surplus funds for this purpose and exploring various innovative pilot models, the reform offers comprehensive financial support and effectively addresses institutional barriers faced by researchers due to insufficient capital.

The Fraunhofer-Gesellschaft is a preeminent organization in the field of applied research in Europe. Its "Contract Research" model establishes a three-dimensional innovation mechanism characterized by demand orientation, benefit sharing, and risk sharing. The core features of this model are as follows: Firstly, market-oriented R&D mechanism: through a hybrid funding system of "basic funds + contract revenue" (with government basic funds accounting for 30% and enterprise contract revenue accounting for 70%), a deep integration between R&D and market demands is achieved. According to 2023 data, the association's 76 research institutes have completed 12,000 projects commissioned by enterprises, achieving a technology conversion rate of 83%. This mechanism effectively addresses the issue of misalignment between scientific research topics and industrial needs. Secondly, dynamic allocation of intellectual property rights: the implementation of the "inventor priority" system allows researchers to retain 70% of the profits from intellectual property rights, while the STEP Fund supports technical team entrepreneurship. This institutional arrangement enables the association to incubate 120 technology enterprises annually, with a survival rate exceeding 75%. Thirdly, talent flow incentive mechanism: the establishment of a "revolving door" system mandates that researchers rotate between academia and industry every five years to ensure the symmetry of technology supply and demand information. Statistics show that 15% of the association's researchers hold dual professional identities, and this mobility improves the efficiency of technology diffusion by 28%.

On the basis of absorbing international best practices and aligning with China's institutional context, the Qinchuangyuan innovation-driven platform has undergone transformative reforms, establishing a distinctive model for the transformation of scientific and technological achievements in western China. Firstly, the restructuring of the property rights system: by implementing separate management of scientific and technological achievements, the traditional state-owned assets management model has been reformed. Specifically: (1) An independent asset ledger for scientific and technological achievements has been established outside of fixed asset management, thereby decoupling 85,000 achievements from administrative oversight; (2) The "tiered decision-making + negative list" system has been introduced, enabling universities to independently review and approve achievement transformation projects valued under RMB 5 million. Secondly, the innovation in the evaluation system: a two-dimensional evaluation framework encompassing both economic value and social benefits has been constructed, leading to the establishment of a specialized title sequence for scientific and technological achievements transformation. Thirdly, the innovation in capital circulation mechanisms: horizontal balances are now permitted to be converted into a "risk-sharing fund".

Based on the Institutional Distance Theory (Alexiou & Vogiazas, 2021), the transformation of scientific and technological achievements in western China necessitates the localization adjustment of international experience at multiple levels. Firstly, a dual-drive mechanism integrating policy and market should be

established: drawing inspiration from Fraunhofer's "demand identification - directed research and development" model, Qinchuangyuan has implemented a technology demand list opening system under the "chain length system". In 2024, 19 key industrial chain enterprises have released their technology demand lists, promoting the establishment of 76 school-enterprise joint research entities. A differentiated capital allocation system will be established, reducing the proportion of government guidance funds from 78% to 50%, and encouraging private capital participation in early-stage investments through tax incentives (such as increasing the additional deduction for R&D expenses to 200%). Secondly, an integrated "whole chain" service system should be improved: referencing Germany's VDI-certified technology broker system, provincial standards for technology brokers' capabilities (including technology assessment, business planning, and other six modules) will be established. Physical carriers for "proof-of-concept - pilot maturation" will also be constructed. Thirdly, an innovative risk prevention and control mechanism should be developed: an insurance system for the transformation of scientific and technological achievements will be established, with specialized products such as "technology failure insurance" and "market risk insurance". The "decision exemption" system will be implemented, exempting university managers from the responsibility of maintaining and increasing the value of state-owned assets for projects evaluated by professional institutions.

3 Quantitative Evaluation and Policy Mechanism Analysis of the Development Outcomes of Science and Technology Enterprises in Xi'an City

3.1 Synergistic Growth Mechanism of Technology Contract Turnover and R&D Investment

Based on the open innovation theory (Chesbrough, 2003) and the innovation value chain theory (Hansen & Birkinshaw, 2007), Xi'an City has achieved significant progress in the marketization of technological factors through the establishment of a collaborative innovation system encompassing government, industry, universities, research institutions, and application sectors. Under the policy framework of the "three reforms" (separate management of job-related scientific and technological achievements, reform of technology transfer talent evaluation, and transformation of surplus horizontal funds), the transaction volume of technology contracts in Xi'an reached 288.13 billion yuan in 2022, ranking first among sub-provincial cities. It is projected to exceed 450 billion yuan by 2024, with a compound annual growth rate of 25.3%, significantly higher than the national average of 15.6%. This remarkable achievement can be attributed to the deepening of the incentive mechanism for property rights: by delegating the rights of use, disposal, and profit from scientific and technological achievements, the stock of patent resources at universities and research institutes has been effectively activated.

From the perspective of R&D investment structure, the proportion of enterprises' R&D expenditure is projected to rise to 45.69% in 2024. This supports the conclusion that enterprises are becoming the primary entities responsible for innovation resource allocation, as posited by the resource-based theory (Barney, 1991). The structural shift stems from Xi'an City's targeted measures aimed at reinforcing the dominant role of enterprise innovation. Specifically, the additional deduction rate for R&D expenses will

be increased to 100%, and full coverage of R&D institutions within manufacturing enterprises will be ensured. These initiatives have propelled the R&D intensity of enterprises (R&D/GDP) from 2.1% in 2021 to an anticipated 3.4% in 2024. A notable example is Longji Green Energy, which, leveraging the Qinchuang Yuan platform, has achieved an R&D intensity of 8.2%, set a new record for photovoltaic conversion efficiency 14 times, and established the world's largest single-crystal silicon production base, thereby creating a demonstrative "laboratory-to-market" closed-loop effect.

3.2 Analysis of the Gradient Policy Effect on High-Tech Enterprise Cultivation

The number of high-tech enterprises in Xi'an has surged from fewer than 800 in 2021 to 15,000 in 2024, demonstrating an exponential growth trend with a compound annual growth rate (CAGR) of 65.4%. This significant increase validates the effectiveness of the "combined policy intervention" as proposed in the theory of policy instruments (Schneider & Ingram, 1990). The specific mechanisms contributing to this success include:

(1) Fiscal Leverage Effect: The "Spring Seed Fund" successfully leveraged RMB 3.27 billion in social capital through an initial fiscal investment of RMB 239 million, achieving a leverage ratio of 13.7 times. A notable case is Hydrogen Easy Energy, which experienced a valuation increase of 120 times, reaching over RMB 5 billion by 2024. This outcome underscores the signal transmission function of government guidance funds.

(2) Service Network Construction: The establishment of a technology brokerage system has created a collaborative network comprising scientists, engineers, and entrepreneurs. With 172 brokers facilitating key projects, the average achievement transformation period has been reduced from 18 months to 7.2 months, resulting in a 60.37% increase in efficiency.

(3) Industrial Chain Penetration: Technological advancements have permeated 24 key industrial chains, including semiconductors and biomedicine. By 2024, the total output value of these industrial chains is projected to exceed RMB 1.2 trillion. For instance, the Xi'an Institute of Optics and Mechanics has incubated 385 enterprises using a model of "research institute + incubator + fund", forming a photonics industry cluster with an annual output value exceeding RMB 60 billion.

3.3 Reconstruction of Achievement Transformation Mechanism Driven by Institutional Innovation

Based on the theoretical framework of transaction costs (Williamson, 1981; Fagerstrøm & Hantula, 2013), the "use first, pay later" model has achieved an institutional breakthrough through a risk-sharing mechanism. Its innovative value is primarily reflected in three dimensions:

(1) At the level of technical factor allocation, the forward-risk sharing mechanism effectively addresses the issue of information asymmetry in patent pricing. By incorporating technology verification into the value confirmation stage, this approach significantly reduces measurement and bargaining costs associated with technology transactions. Empirical data indicate that patent pricing costs are reduced by 37%, thereby facilitating the transformation of technological elements from a "right confirmation impasse" to an "application-oriented" paradigm. This fosters a positive cycle of technological upgrading.

(2) At the level of financial collaborative innovation, the establishment of a risk mitigation pool creates a multi-agent incentive compatibility mechanism. The involvement of guarantee and insurance institutions not only achieves cross-period smoothing of technology transformation risks but also enhances the market's ability to evaluate early-stage technologies through signaling effects. This institutional arrangement transforms deposited financial resources into technology verification capital via risk structuring, forming a collaborative development paradigm between science and technology insurance and patent transformation.

(3) At the level of institutional breakthrough, the innovation in scientific research fund management has restructured the allocation rules of innovation factors. Specifically, the establishment of a horizontal balance fund investment mechanism overcomes the "North Paradox" associated with state-owned asset management in public institutions. By creating a "policy safe harbor", this approach internalizes institutional transaction costs. This adaptive efficiency-oriented institutional change (North, 1990; Lam et al., 2023) maintains the core objective of preserving and increasing the value of state-owned assets while introducing institutional flexibility that facilitates the transformation of scientific and technological achievements. Consequently, it effectively activates latent innovation resources.

Policy evaluation indicates that this institutional innovation system has significantly optimized factor allocation. Among the 93,000 job-related scientific and technological achievements managed separately, 27% have been commercialized through market mechanisms, reducing the transformation period by 78%. These results confirm the effectiveness of the institutional innovation pathway in reducing transaction costs. Notably, the proportion of researchers engaging in entrepreneurship has increased by 42%, demonstrating a successful shift from an "administrative dominance" to a "market discovery" mechanism for allocating innovation factors. This provides a practical model for deepening the reform of the property rights system of scientific and technological achievements.

3.4 Comprehensive Effectiveness Evaluation of the Innovation Ecosystem

Based on the theory of the innovation ecosystem (Adner & Kapoor, 2010), the structural evolution of Xi'an's innovation system exhibits characteristics of a three-level transition:

(1) In terms of knowledge flow, the proportion of technology contract turnover relative to GDP has surpassed the critical threshold of 26.5%, indicating that the regional innovation system has transcended the stage of "knowledge accumulation" and entered an accelerated phase of "achievement transformation". Compared with Shenzhen's industry-driven model and Wuhan's institution-led approach, Xi'an has achieved a multiplicative effect of knowledge elements through institutional innovation. Its marginal contribution growth rate of 22.3% underscores the positive feedback mechanism between basic research and application development. At the policy level, new policy instruments such as pilot project subsidies and proof-of-concept funds have effectively mitigated the risks associated with the "valley of death" in technology commercialization.

(2) The 45.69% surge in R&D intensity among enterprises undergoing structural upgrades of core capabilities signifies the formation of a market-oriented innovation resource allocation mechanism. This

progress can be attributed to the policy package encompassing "additional deduction of R&D expenses, government procurement of innovative products, and first-set insurance compensation". Notably, the 82.3% coverage rate of R&D institutions within regulated industrial enterprises demonstrates the government's role in guiding enterprises to develop complementary assets via the "innovation carrier construction special project". Unlike traditional subsidy models, this four-dimensional policy framework—encompassing institutions, talent, capital, and cooperation—fundamentally reconstructs the innovation production function of enterprises.

(3) Furthermore, the ecological reconstruction of the institutional environment is evident through the establishment of 372 interdisciplinary teams and the deployment of 28 pilot test carriers, validating the efficacy of the "government-industry-university-research-fund" collaborative governance mechanism. Through institutional innovations such as the creation of innovation enclaves and the establishment of an intellectual property securitization platform, Xi'an has overcome the institutional constraints of the traditional linear transformation model. Particularly during the proof-of-concept phase, the government-led "technology maturity evaluation system" and "risk-sharing mechanism" have reduced the marketization cycle of early-stage technologies by over 40%, thereby fostering a value co-creation pathway from basic research to pilot testing and ultimately to industrial application.

The analysis of policy effects reveals that the success of the Xi'an model is attributed to the synergistic realization of three institutional dimensions: dynamic adaptation in supply-side policies (factor allocation reform), demand-side policies (application scenario opening), and environment-side policies (innovation governance transformation). This ecosystem governance paradigm offers valuable theoretical insights for late-developing regions aiming to overcome the "catch-up trap" in innovation. Specifically, it emphasizes the importance of reconstructing knowledge production functions through institutional innovation rather than relying solely on linear growth in factor inputs.

3.5 Policy Optimization Path and Theoretical Innovation from the Perspective of Institutional Economics

Based on the institutional analysis framework of Coase's social cost theory (Coase, 1960), the current innovation ecosystem faces institutional dilemmas such as asymmetric transaction costs and fuzzy definition of property rights. Policy optimization needs to focus on building institutional arrangements adapted to the new production relations, focusing on breaking through the following dimensions:

(1) Reconstruction of the Regional Innovation Collaboration Mechanism: Xi Xian New Area contributes to 63% of the city's technology trading volume, while other districts and counties account for less than 10%. To address this imbalance, it is imperative to draw lessons from Fujian's "Joint Center for Inter-Provincial Technology Transfer" model. Considering the institutional barriers that hinder the cross-domain flow of technical factors, it is crucial to refine the design of the compensation mechanism based on transaction cost theory (Williamson, 1985). We propose establishing a "center-periphery" technology transfer ecosystem and an institutionalized cooperation framework encompassing patent right confirmation, revenue sharing, and risk distribution. It is also necessary to transcend traditional

administrative divisions' path dependence, establish an innovation community system that includes tax-sharing and GDP accounting, and foster a regional innovation network with positive externalities.

(2) Innovation and Iteration of Fiscal and Financial Instruments: In cases where initial project risk compensation is inadequate, the fiscal instrument of "investment first, equity later" can be introduced to establish a risk compensation fund pool. Drawing on the theory of market failure (Stiglitz, 1989), a collaborative mechanism between government-guided funds and venture capital should be established. This paper proposes a composite financial instrument combining "risk compensation and equity incentives," achieving Pareto improvement in the leverage effect of financial resources through the establishment of a risk reserve fund pool and a dynamic compensation coefficient model. Specifically, it is essential to design a phased capital injection mechanism for seed-stage projects and develop a multi-dimensional evaluation system that includes technology maturity and market validation.

(3) Gradient Innovation Network Reengineering: Based on the theory of innovation ecosystems (Adner & Kapoor, 2010), a three-tiered innovation governance framework comprising "strategic layer, network layer, and application layer" should be established. Drawing upon the principles of this three-tiered innovation network, national laboratories, provincial platforms (e.g., Qinchuanyuan), and municipal carriers (e.g., high-tech zones) should be integrated to achieve differentiated roles and responsibilities. Specifically, national strategic scientific and technological entities should enhance their focus on fundamental research, regional innovation consortia should prioritize the development of generic technologies, and market-oriented platforms should concentrate on the commercialization of research outcomes. By instituting a gradient flow mechanism for innovation elements, a virtuous cycle of knowledge spillover and value creation can be fostered.

Policy innovation should prioritize the reduction of institutional transaction costs. It is recommended to establish a "LIFT system" encompassing four dimensions of institutional innovation within the framework of the "Xi'an Implementation Plan for Promoting Future Industrial Innovation and Development": Legislation System, Incentive Mechanism, Flow Framework, and Technical Standards System. Specifically, in emerging industries such as quantum information, it is advisable to explore the "directed R&D contract system" and develop a new R&D organizational model based on innovation consortia. This form of institutional innovation represents an extension of North's theory of institutional change (North, 1990), deepening its practical application. By constructing a collaborative governance model characterized by "government guidance, market leadership, and social participation," this approach creates a path for institutional innovation with increasing returns to scale. The theoretical significance lies in expanding the theory of innovation ecosystems from the organizational level to the institutional level, offering a novel institutional economics framework that facilitates innovation catch-up for lagging regions.

4. Analysis of Structural Contradictions and Policy Obstructions in the Transformation System of Scientific and Technological Achievements of Science and Technology Enterprises in Xi'an

4.1 Unbalanced Regional Development: The Institutional Dilemma of "Center-periphery" Differentiation of Innovation Factors

The spatial layout of the transformation of scientific and technological achievements in Xi'an exhibits a pronounced "central polarization" characteristic. Leveraging the innovation-driven platform of Qinchuangyuan, the Xi'an New Area, as a national-level new district, has aggregated over 65% of the city's new R&D institutions, 80% of its science and technology innovation funds, and 90% of its pilot base resources, thereby forming an integrated ecosystem encompassing "R&D, incubation, and industry." Conversely, peripheral districts such as Weiyang and Baqiao are constrained by inadequate infrastructure and insufficient policy support, resulting in a local conversion rate of scientific and technological achievements below 15%. This developmental imbalance fundamentally stems from the failure of the market-oriented allocation mechanism for innovation factors: firstly, the administration-led resource allocation exacerbates the Matthew effect, widening the innovation potential gap among districts; secondly, the absence of a cross-regional collaborative governance system leads to a "geographical proximity trap" between areas rich in science and education resources and industrial zones, exemplified by Chang'an University Town. According to the theory of innovation ecosystems, regional imbalances not only diminish resource utilization efficiency but also contribute to the phenomenon of "southeast flight" of scientific and technological achievements.

4.2 Single Financing Channel: The Double-Edged Sword Effect of Government-Led Financial Support

Currently, the financing for the transformation of scientific and technological achievements in Xi'an exhibits the characteristics of "three highs and three lows": high government fund participation (accounting for 78% of early-stage project financing), high reliance on bank credit (comprising 62% of corporate financing), low proportion of intellectual property pledges (less than 5%), low venture capital activity (the size of angel funds is only one-seventh that of Shenzhen), and low utilization rate of capital markets (the pilot scale of technology asset securitization is merely 100 million yuan). This structural imbalance arises from institutional design path dependence: while government guidance funds leverage 132.4 billion yuan of social capital through an "investment and loan linkage" model, their risk-averse tendency results in excessive concentration of funds in mature projects, with seed project investment rates below 12%. In contrast to the diversified financing system established by the Bayh-Dole Act in the United States, Xi'an has yet to form a complete closed loop of "financial fund guidance - venture capital relay - capital market exit." According to financial exclusion theory, the lack of an effective credit rating system makes it challenging for small and medium-sized technology enterprises to overcome the "Macmillan gap," leading to a financing satisfaction rate of only 34% for such enterprises in Xi'an in 2024.

4.3 Lack of an Evaluation System: Multiple Institutional Barriers in the Pricing Mechanism for Scientific and Technological Achievements

The ambiguity in valuing scientific and technological achievements represents the central obstacle in the transformation process. Survey data indicate that 72% of technology transactions in Xi'an encounter pricing disputes, primarily due to three systemic deficiencies: First, there is a conflict between the state-owned asset management system and the incentive policies for achievement transformation. Service inventions face three major constraints: "difficult evaluation, slow approval, and strict accountability." Second, market-oriented evaluation institutions are underdeveloped. The city has only 287 certified technology managers, and the fragmentation of evaluation standards remains a significant issue. Third, the orientation of prioritizing academic publications over practical transformation in scientific research assessment has not been fundamentally changed. In 2024, the income from the transformation of university researchers' achievements remains below 30%. According to institutional economics theory, high transaction costs lead to the failure of Coase's Theorem. Notably, the "use before payment" and "rights transfer" mechanisms piloted in Xi Xian New Area have reduced patent licensing fees by 60%, but a unified pricing benchmark system has yet to be established across the entire region.

4.4 Obstruction in Policy Implementation: Governance Failure Resulting from the Superposition of "Fragmentation" and "Incentive Mismatch"

The "last mile" dilemma in policy implementation is exemplified by two major contradictions: first, the fragmentation of interdepartmental coordination, leading to institutional frictions in critical areas such as ownership of achievements and income distribution in science and technology, finance, and state-owned assets. For instance, due to conflicting audit rules, the actual implementation rate of the 2024 pilot project for "separate management of service inventions" is less than 40%. Second, innovation in policy tools lags behind; only 23% of the existing 142 science and technology policies have established quantitative assessment indicators, rendering new policies like "digital empowerment" and "scene opening" largely symbolic. Principal-agent theory analysis reveals that grassroots-level implementers face an asymmetric constraint where "accountability pressure exceeds innovation incentive," resulting in a 9 percentage point year-on-year decrease in the disclosure rate of scientific and technological achievements at municipal colleges and universities in 2025. Notably, the "free application, enjoy" payment model implemented by high-tech zones has reduced approval times by 83% through data-driven processes, offering a new paradigm for digital transformation to address policy obstruction.

5. Collaborative Optimization Path: Establishing an Institutional Innovation Paradigm for Science and Education-Rich Cities in Western China

5.1 Development of a Cross-Regional Technology Trading Platform: Addressing the Institutional Dilemma of "Center-Periphery" Factor Differentiation

Xi'an, as a city abundant in science and education resources in western China, has long faced structural contradictions arising from the "center-periphery" differentiation of innovation factors. This is

characterized by the high concentration of resources in core areas such as the Xi Xian New Area, while surrounding regions and counties lack coordination between the innovation chain and industrial chain. In pursuit of the "dual-center" construction goal, establishing a cross-regional technology trading platform has become a critical measure to overcome administrative barriers. Drawing on the experience of the Shaanxi Science and Technology Resource Center and the Xi'an Science and Technology Market, we can integrate the scientific research resources of the five provinces and seven parties in northwest China through an "online + offline" model. This will establish a unified technology valuation system and credit database, enabling precise supply-demand matching. For instance, the Qinchuangyuan platform has created an integrated ecosystem of "R&D, incubation, and industry" by linking Xi'an High-tech Zone, Xi Xian New Area, and other carriers. In 2024, it added 132 new science and technology enterprises, accounting for 30% of the city's new additions. Its successful experience can be extended to the western region to promote the sharing of pilot test results in aerospace, new materials, and other fields. Further introduction of blockchain technology can facilitate rights confirmation and transaction traceability of scientific and technological achievements, addressing pricing ambiguities.

5.2 Market-Oriented Capital Introduction Strategy: Mitigating the "Double-Edged Sword" Effect of Government-Led Finance

In response to the issue of a single financing channel, Xi'an City's pioneering "investment-first, equity-later" model serves as an exemplary case for institutional innovation. This model advances financial support for the commercialization of scientific and technological achievements, stipulates conditions for equity conversion, and offers a 50% income transfer reward. It has facilitated the initial capital injection of RMB 22.4 million into 17 hard technology projects. For instance, the Spring Seed Fund has stimulated social capital participation through government guidance. By 2024, it had supported 303 seed projects; however, social capital still accounted for less than 20%, underscoring the need to deepen the construction of a capital ecosystem characterized by "risk sharing + incentive compatibility." To this end, it is recommended to promote the "investment-loan linkage" mechanism, integrating Xi'an Finance's venture capital fund ecosystem (including seed funds, angel funds, etc.) with "technology transaction credit loans," thereby forming comprehensive financing support that covers the entire enterprise lifecycle. Additionally, exploring the path of intellectual property securitization and establishing valuation models for scientific and technological achievements and risk pricing mechanisms can be achieved by referencing the ABS cases of technology properties in the Shenzhen Stock Exchange in 2024. The Several Measures to Strengthen the Dominant Position of Enterprise Innovation in Xi'an City proposed building a linked system of "equity, loans, debt, and insurance," laying a policy foundation for attracting long-term funds such as insurance capital and industrial capital.

5.3 "Scientist + Engineer" Team Collaboration Model: Overcoming Dual Barriers in Evaluation Systems and Policy Implementation

To address the failures in the pricing mechanism for scientific and technological achievements and the obstacles in policy implementation, it is imperative to reconstruct the collaborative innovation ecosystem

among industry, academia, research institutions, and application sectors. Xi'an City has successfully implemented a model where enterprises pose questions and research institutions provide solutions. Through the establishment of the Qinchuanyuan "Scientist + Engineer" team project, 22 key technologies along the industrial chain have been resolved. It is recommended to institutionalize these collaborative mechanisms as follows: (1) Establish a "dual employment system" to facilitate talent mobility, allowing researchers to retain their institutional positions while participating in enterprise R&D activities. (2) Implement a "chief technical officer responsibility system" and a research funding contract system to empower the team with decision-making authority over technical routes. (3) Develop market-oriented evaluation metrics, increasing the income distribution ratio from achievement commercialization to over 70%, and integrating this into the professional title evaluation system.

5.4 Policy Coordination and Governance Mechanism Innovation: Establishing an Incentive-Compatible Institutional Environment

In response to governance failures caused by "fragmentation," it is imperative to enhance top-level design through the following measures:

(1) Establish a municipal joint conference system for the transformation of scientific and technological achievements, thereby integrating resources from science and technology, education, industry, and other relevant sectors;

(2) Enhance the development of "first-of-a-kind" policies and application scenarios, guiding market demand via government procurement initiatives;

(3) Construct digital governance platforms, such as Xi'an's big data platform for the transformation of scientific and technological achievements, to facilitate policy alignment and implementation monitoring.

Additionally, drawing on the pilot experiences of the "three reforms," the scope of mixed ownership for service inventions should be broadened. Researchers should be permitted to acquire shares based on intellectual property rights, and institutional transaction costs associated with achievement transformation should be reduced through the establishment of three-tiered carriers: "proof-of-concept centers - pilot test bases - industrial parks."

The path design integrates institutional economics and innovation ecosystem theory: by reducing the transaction costs associated with factor flow (in line with Coase's Theorem) and establishing a multi-agent incentive-compatible mechanism (based on principal-agent theory), it achieves synergy among government, industry, universities, research institutions, funding, and consumption. At the policy level, the revision direction of the Law on the Transformation of Scientific and Technological Achievements is closely aligned with Xi'an's future industrial plans, such as the six overarching directions and 24 sub-fields outlined in the Implementation Plan for Promoting Future Industrial Innovation and Development. This approach aims to transform the advantages of hard science and technology into institutional innovation benefits. Through the integrated paradigm of "platform construction, capital activation, team empowerment, and governance iteration," Xi'an provides a replicable model of institutional innovation

for western cities, facilitating the transition of regional innovation ecosystems from "factor agglomeration" to "systemic coordination".

6. Conclusion

Based on an in-depth analysis of the effectiveness and pathway optimization of the transformation of scientific and technological achievements in Xi'an City, this study examines the practical explorations, institutional breakthroughs, implementation outcomes, and challenges associated with such transformations in Xi'an City. On this basis, it proposes a collaborative optimization framework. The following are the key conclusions drawn from this study:

First of all, Xi'an, as a city rich in science and education resources in western China, has rich scientific research resources and talent reserve, but the long-standing phenomenon of "emphasizing research and development and light transformation" has seriously restricted the effective transformation of scientific and technological achievements. The establishment of Qinchuangyuan's innovation-driven platform has effectively solved the institutional barriers faced by researchers in the process of the transformation of scientific and technological achievements through the implementation of "three reforms" (the separate management of scientific and technological achievements by post, the professional title assessment of technology transfer talents, and the transformation of scientific and technological achievements funded by the balance funds of horizontal scientific research projects), and provided institutional guarantee for the smooth transformation of scientific and technological achievements. These reform measures not only eliminate researchers' concerns about the loss of state-owned assets, but also stimulate their enthusiasm to engage in the transformation of scientific and technological achievements, providing diversified financial support for the transformation of scientific and technological achievements.

Secondly, based on the data of technology contract turnover, the number of high-tech enterprises and typical cases, this study quantitatively evaluates the implementation effect of the transformation policy of scientific and technological achievements in Xi'an City. The results show that the transaction volume of technology contracts in Xi'an has achieved rapid growth, and the number of high-tech enterprises has also shown an exponential growth trend. These achievements benefit from the collaborative mechanism of "industry-university-research-application-fund" built by Qinchuangyuan platform and a series of institutional innovations, such as the mode of "use first, pay later", "spring seed fund" and technology broker system, which effectively reduce the trial-and-error cost of enterprises and accelerate the process of technology marketization.

However, Xi'an still faces many challenges in the process of transformation of scientific and technological achievements, such as unbalanced regional development, single financing channel, absence of evaluation system and obstruction of policy implementation. These challenges not only restrict the effective transformation of scientific and technological achievements, but also affect the healthy development of regional innovation ecology. To solve these problems, this study puts forward the optimization paths such as the construction of cross-regional technology trading platform, market-

oriented capital introduction strategy, "scientist + engineer" team collaboration mode, policy collaboration and governance mechanism innovation. These paths aim to break administrative barriers through institutional innovation and policy synergy, promote the free flow and efficient allocation of innovation factors, and provide strong support for the effective transformation of scientific and technological achievements.

Acknowledgements

The authors are supported by Xi'an Soft Science Research Program (24RKYJ0039), Natural Science Foundation of Shaanxi Province (2023-JC-QN-0784), Xianyang Soft Science Research Program (L2024CXNLRKX0007), and the 111 Project (B16031). The authors would also like to thank funds and support from Qinchuangyuan Innovation Promotion Center for their collaboration.

References

Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. *Strategic management journal*, *31*(3), 306-333. https://doi.org/10.1002/smj.821

Alexiou, C., & Vogiazas, S. (2021). European intellectual property institutions and Chinese foreign direct investment. *Journal of Economic Studies*, *48*(2), 296-312. https://doi.org/10.1108/JES-08-2019-0366

Avnimelech, G., & Amit, A. (2024). From startup nation to open innovation nation: The evolution of open innovation activities within the Israeli entrepreneurial ecosystem. *Research policy*, *53*(9), 105079. https://doi.org/10.1016/j.respol.2024.105079

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120. https://doi.org/10.1177/014920639101700108

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.

Colyvas, J. A., & Powell, W. W. (2007). From vulnerable to venerated: The institutionalization of academic entrepreneurship in the life sciences. In *The sociology of entrepreneurship* (pp. 219-259). Emerald Group Publishing Limited. https://doi.org/10.1016/S0733-558X(06)25007-9

Fagerstrøm, A., & Hantula, D. A. (2013). Buy it now and pay for it later: An experimental study of student credit card use. *The Psychological Record*, *63*, 323-332. https://doi.org/10.11133/j.tpr.2013.63.2.007

Hansen, M. T., & Birkinshaw, J. (2007). The innovation value chain. *Harvard business review*, *85*(6), 121-130.

Lam, A. (2010). From 'ivory tower traditionalists' to 'entrepreneurial scientists'? Academic scientists in fuzzy university—industry boundaries. *Social studies of science*, *40*(2), 307-340. https://doi.org/10.1177/0306312709349963

Lam, M. W. R., Lam, W., & Badia, M. M. M. (2023). *Fiscal policy and the government balance sheet in China*. International Monetary Fund. https://doi.org/10.5089/9798400248221.001

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge university press. https://doi.org/10.1017/CBO9780511808678

Schneider, A., & Ingram, H. (1990). Behavioral assumptions of policy tools. *The journal of politics*, *52*(2), 510-529. https://doi.org/10.2307/2131904

Williamson, O. E. (1981). The economics of organization: The transaction cost approach. *American journal of sociology*, *87*(3), 548-577. https://doi.org/10.1086/227496