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Practical Pathways of Universities for Industrial Innovation under Double-Chain Integration: A Case Study of Wujin district

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Abstract

The deep integration of the industrial chain and the innovation chain is key to achieving high-quality regional development. However, as sources of innovation, universities have not fully fulfilled their role in supporting the innovative development of industries in the Wujin district, Changzhou City. There are predicaments such as the mismatch between technology supply and enterprise demand, low efficiency in the transformation of scientific and technological achievements, and insufficient innovation capabilities of small and medium-sized enterprises. Based on the dual-chain integration theory, this study, through a systematic investigation of the current situation of industrial and innovation resource allocation in Wujin District and a comparative analysis of advanced regions such as Beijing, Shanghai, the Guangdong-Hong Kong-Macao Greater Bay Area, and Hefei, reveals the deep-rooted reasons for the insufficient supporting role of universities. The research finds that the main constraints are fragmented governance, lagging enterprise innovation concepts, low efficiency in cross-regional collaboration, and the absence of a technology transfer service system. Based on this, this paper proposes a multi-party collaborative strategy system, including establishing quantitative policy support standards, embedding technological innovation as the core of the enterprise's development strategy, building a digital collaborative innovation platform, improving the guarantee and incentive mechanism for scientific researchers' achievements, and strengthening the supporting guarantee for institutional innovation and ecological governance. The research provides a theoretical basis and practical reference for Wujin District and similar manufacturing hubs to promote the integration of the dual chains and achieve industrial modernization transformation.

Keywords

Dual-chain integration; University support; Industrial innovation; Industry-university-research collaboration.

1. Introduction

China's economic development model has shifted from pursuing rapid growth to a new phase focused on high-quality growth, with its economic development approach, structure, and growth drivers undergoing structural transformations (Wu et al., 2026). Innovation, as the core driving force for development, has become the key engine in the new phase of economic growth (Zhao, 2024). The important statement of General Secretary Xi Jinping that 'the innovation chain should be deployed around the industrial chain, gather the demands of industrial development, integrate various innovation resources, and promote the organic connection between the innovation chain, the industrial chain, and market demands' reveals the close interdependence between the industrial chain and the innovation chain. This statement further clarifies the key position of the integration of the dual chains in enhancing the efficiency of the

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national innovation system and building a modern economic system. The industrial chain provides practical application scenarios for technological innovation, and the innovation chain provides technical support for industrial transformation and upgrading (Zhao et al., 2024). Together, they have injected inexhaustible impetus into the high-quality development of China's economy.

Promoting the deep integration of the industrial chain and the innovation chain has become an important approach for various regions in China to enhance their regional competitive advantages (Hu & Zhang, 2023). The 'Proposal of the Central Committee of the Communist Party of China on Formulating the 15th Five-Year Plan for National Economic and Social Development' clearly states, 'Support enterprises in taking the lead in forming innovation consortia, undertaking more national scientific and technological research tasks, encourage enterprises to increase investment in basic research, and promote the in-depth integration of the innovation chain, industrial chain, capital chain and talent chain.' Therefore, the integration of dual chains will be a key development direction for China during the '15th Five-Year Plan' period. In the practice of the integration of the dual chains, innovation highlands represented by Beijing, Shanghai, the Guangdong-Hong Kong-Macao Greater Bay Area, and Hefei are rapidly promoting the integration of the dual chains by leveraging their innovation resources and industrial foundations. In the new era, the realization of regional technological competitiveness no longer relies on the large-scale aggregation of traditional production factors, but rather on the efficient integration and optimal allocation of regional innovation elements. This approach enables systematic alignment and sustained evolution between local industrial development needs and innovation capabilities (Liu et al., 2026), thereby fully leveraging the innovative support role of universities and research institutions within industrial chains.

In the context of increasingly fierce regional competition, the Wujin district of Changzhou City, as a major manufacturing hub in the Yangtze River Delta urban agglomeration, urgently needs a new development model to achieve industrial transformation and upgrading, as well as the conversion of development momentum. As a major innovation hub in Wujin District, Changzhou Science and Education City has gathered research and development institutions and industrial incubation platforms, including many well-known domestic universities such as Nanjing University, Southeast University, and Dalian University of Technology. It has partially achieved the preset goals of technology transfer from universities and enterprise entrepreneurship incubation. However, the collaboration between the overall innovation activities of the Science and Education City and the leading industries within the area is insufficient, and it has failed to fully play its driving role in the innovative development of the local industrial chain. In addition, the limited local university resources in the Wujin district make it difficult for local enterprises to obtain necessary scientific research support, forcing them to spend more resources to introduce R&D forces from other places. This decoupling between the innovation chain and the industrial chain leaves Wujin District lacking the essential foundational innovation capacity required for integrating both chains, making it difficult to meet the technological innovation demands of its regional industrial system's transformation and upgrading. Consequently, this hinders the realization of Wujin District's strategic goal of advancing its industrial system to higher-value segments of the global value chain.

This study aims to answer the following core questions: (1) What are the current characteristics and main obstacles to support for industrial innovation and development by universities in Wujin District? (2) What reference significance can the successful models of advanced regions in China hold for the Wujin district? (3) How to build a multi-party collaborative strategy system suitable for the Wujin district? Therefore, by systematically analyzing the institutional mechanisms of universities in the Wujin district that support the innovative development of industries, and exploring the realization path of the deep integration of the industrial chain and

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the innovation chain, it has become the inevitable way to drive the Wujin district to build a modern industrial system and a regional innovation highland. Thus, this research has significant theoretical and practical significance.

2. Problems Existing in the Support of Industrial Innovation and Development by Universities in the Wujin District

First, the support mechanism suffers from structural contradictions. Universities in the Wujin district are confronted with institutional obstacles when supporting industrial innovation, which seriously restricts the exertion of their supporting effectiveness. First, there is an imbalance in the allocation of university resources. The overall distribution of university resources in the Wujin district shows a distinct Matthew effect, with a small number of leading enterprises occupying the vast majority of cooperation resources among universities. This resource allocation model among universities prevents most small and medium-sized enterprises from achieving technological upgrades through these institutions (Johnston & Prokop, 2021), meaning that universities are unable to support the comprehensive transformation and upgrading of the Wujin district's industrial chain. Second, the depth of cooperation between universities and enterprises is insufficient. The innovation cooperation between universities and enterprises in the Wujin district shows a superficial feature. A large number of industry-university-research collaboration projects are concentrated in the shallow cooperation stages, such as technical consultation and entrusted development, while the number of projects involving in-depth cooperation links, such as pilot-scale maturation and engineering verification, is relatively small. Finally, there is insufficient stability in cooperation. Currently, collaborations between universities and enterprises in the Wujin district exhibit a short-term orientation, with the majority of projects being brief partnerships lasting one year or less. This short-term industry-university-research collaboration model makes both sides lack the confidence to continuously promote the breakthrough of core technologies (Hu et al., 2025).

Second, a severe mismatch in innovative supply. There is a mismatch between the innovative supply of universities in the Wujin district and the technological demands of enterprises for transformation and upgrading, and this mismatch runs through the entire chain from the generation of demands to the transformation of achievements. On the technical demand side of enterprises, due to the lack of necessary technical demand expression capabilities of small and medium-sized enterprises, universities are unable to grasp the ultimate technical goals of industry-university-research collaboration projects, thereby restricting the quality of cooperation. On the technology supply side, universities have a serious disconnection between their scientific research activities and the actual technological demands of industrial development, which makes it difficult for innovative achievements to be implemented. Since most research projects conducted by institutions and universities within Changzhou Science and Education City focus on cutting-edge international academic challenges, they lack an understanding of the technological needs of local enterprises. This results in research outcomes that fail to meet the practical requirements of industrial development, exacerbating the low rate of technology commercialization (Li et al., 2025). The gaps in the pilot-scale testing phase during technology commercialization have further widened the supply-demand gap. At present, the number of public platforms for technology pilot production in the Wujin district is relatively small, making it difficult to meet the technological application demands of enterprises. The extensive industry-university-research collaboration lacks the necessary pilot-scale mitigation, resulting in poor industrial application effects and serious waste of innovation resources in universities.

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Third, the cross-regional collaborative efficiency is insufficient. The limitations of its higher education institutions in the Wujin district have led it to vigorously expand a cross-regional collaborative innovation network, hoping to break through the constraints of limited local innovation resources with the help of external innovation institutions. However, cross-regional collaborative innovation has complex cooperation conditions. Spatial distance and institutional differences constitute invisible cooperation thresholds (Tian & Lu, 2023), thereby affecting the efficiency of the cross-regional collaborative innovation network in the Wujin district. In the process of the transformation and application of scientific and technological achievements, there are significant localization obstacles in cross-regional collaboration, and the technological development direction of collaborative innovation achievements cannot meet the industrial development needs of the Wujin district. Although the Wujin district successfully integrated into the Yangtze River Delta Science and Technology Resource Sharing Platform, leveraging its geographical and industrial advantages, practical implementation has been constrained by both policy barriers and transaction costs, resulting in the platform's effectiveness in the region falling far short of expectations. The difficulties faced by cross-regional collaborative innovation in the Wujin district, such as differences in institutional environment, information asymmetry, and the lack of collaborative mechanisms, make it difficult for collaborative innovation to become a strategic means to promote the support of industrial innovation by universities.

Fourth, the innovation ecosystem is inadequately shaped. The innovation ecosystem built by the Wujin district through universities, intermediary service systems, enterprises, and the government is subject to institutional constraints, which seriously restrict the exertion of its innovation support effectiveness. First, the system lacks sufficient collaboration capabilities. Innovation platforms primarily established by universities suffer from severe cutthroat competition. These platforms repeatedly collect common technological demands from enterprises, resulting in substantial resource waste on redundant university-enterprise demand matching processes that significantly undermine platform innovation efficiency (Wu et al., 2024). Second, there is insufficient coordination among government policies. In the Wujin district, the management authority for dual-chain integration is excessively fragmented, leading to significant disparities in evaluation criteria when enterprises and universities apply for industrialization projects. This management system, characterized by fragmented policies and inconsistent standards, significantly undermines the innovative incentive effect that WuJin district's support policies should deliver. Finally, the professional service system is absent. Wujin district lacks professional intermediary agencies for industry-university-research collaboration. The current number of practitioners and their professional levels are difficult to adapt to the complex cooperative behaviors of universities in supporting industrial innovation. The absence of intermediary service further restricts the innovative vitality of the innovation ecosystem in the Wujin district.

Fifth, the innovation support system for small and medium-sized enterprises is lacking. As an important subject for the transformation and upgrading of the industrial structure in Wujin district, the technological upgrading effect of small and medium-sized enterprises directly affects the development of the overall innovation capacity of the industrial clusters. Unlike leading enterprises, small and medium-sized enterprises are constrained by their resource endowments, lacking professional R&D institutions and unable to afford the employment costs of high-level technical R&D personnel (Teirlinck, 2022). This predicament constitutes an invisible threshold for small and medium-sized enterprises to connect with the innovative resources of universities. Meanwhile, the Wujin district lacks a common service platform for small and medium-sized enterprises, which leads to their inability to effectively seize the policy dividends provided by the government. In addition, the scale limitations and asset allocation conditions of small and medium-sized enterprises themselves determine that they are facing

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more severe constraints on innovation financing. Moreover, the insufficiency of collateral and the lack of market confidence further exacerbate the capital bottleneck for technological upgrading of small and medium-sized enterprises.

3. Analysis of Models for University Support of Industrial Innovation in Advanced Domestic Regions

3.1. Beijing model: the research hub-driven systematic innovation framework

Beijing is a leading region in the practice of universities supporting industrial innovation and development. It not only has abundant university resources but also has established a highly mature innovation chain organization mechanism and a systematic innovation ecosystem, thus laying a solid foundation for giving full play to the supporting role of universities. As a national center for scientific and technological innovation and a concentration of universities, Beijing has established a technological innovation support system that is market-driven, enterprise-centered, and deeply integrated with industry, university, and research through measures such as institutional innovation and mechanism reform. The core rationale behind Beijing's role in supporting university innovation lies in fully leveraging the concentration advantages of its research resources. Through a robust technology transfer system and market-oriented industry-university-research collaboration mechanisms, it fosters a synergistic relationship between technological innovation and industrial development. Taking the Beijing Zhongguancun National Innovation Demonstration Zone as an example, in order to better leverage its innovation resource advantages, the demonstration zone has established a full technological chain from original innovation to industrial application and completed a systematic transformation of the innovation organization mode. In this way, Beijing has not only provided technical support for exploring the cutting-edge fields of industries such as artificial intelligence, integrated circuits, and biomedicine, but also laid a technical foundation for the transformation and upgrading of traditional industries.

3.2. Shanghai model: the functional platform integrated with engineering-driven technology transfer

Shanghai has elevated the engineering capacity of scientific and technological achievements to the strategic level of the city and established a scientific and technological achievement transformation system supported by functional platforms and guided by market demand, thus taking the lead in the country in the application and transformation of scientific and technological achievements. Shanghai has orderly connected all links of the innovation chain and the industrial chain by focusing on key links such as proof-of-concept and pilot-scale verification. At present, Shanghai has established various functional platforms covering key industrial fields such as biomedicine, artificial intelligence, and integrated circuits. Meanwhile, relying on the digital overseas expansion service policy, it has newly built 32 service platform pilot projects. These platforms and pilot programs effectively help enterprises reduce innovation and entrepreneurship costs while improving the efficiency of technology commercialization by providing specialized technical services and shared research facilities. Furthermore, Shanghai's emphasis on market mechanisms has driven significant improvements to its technology transfer service system and the establishment of specialized technology transfer institutions, thereby fostering a professional team of technology economists. Through this systematic model of technology transfer, Shanghai has significantly enhanced the supporting role of innovation in industrial development while maintaining the scientific research and innovation capabilities of universities, providing a strong guarantee for the region to build a modern industrial system.

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3.3. Guangdong-Hong Kong-Macao Greater Bay Area model: open innovation and cross-regional collaboration as complementary enablers

The Guangdong-Hong Kong-Macao Greater Bay Area has formed a unique collaborative innovation model by virtue of its highly open market environment, relatively complete industrial system, and active innovation ecosystem. For the Wujin district, which has a solid industrial foundation but relatively insufficient scientific research and innovation resources, the innovation model of the Guangdong-Hong Kong-Macao Greater Bay Area has strong reference significance. The innovation model of the Greater Bay Area has broken through the institutional and mechanism limitations brought about by traditional administrative regions, achieved the reform of the collaborative innovation mechanism, and ensured the free flow and optimal allocation of regional innovation elements. The Guangdong-Hong Kong-Macao Greater Bay Area hosts a large number of high-tech enterprises, with over 20 companies achieving annual output values exceeding 100 billion RMB. The innovation entities composed of these enterprises have established a favorable pattern of integrated innovation among large, medium, and small enterprises in the Greater Bay Area. In particular, the customs clearance, taxation, and talent policies implemented in the Shenzhen-Hong Kong Science and Technology Innovation Cooperation Zone have attracted numerous world-leading research institutions and high-caliber professionals to the Guangdong-Hong Kong-Macao Greater Bay Area. Furthermore, the Greater Bay Area has established a comprehensive technology and financial services system, providing robust funding support for innovation and entrepreneurship activities. Through this open and networked innovation ecosystem, the Greater Bay Area has been able to evolve a complete collaborative innovation community while maintaining its regional urban development characteristics.

3.4. Hefei model: government-led leapfrog development

While universities in Hefei have lagged in supporting local industrial innovation and development, they have pioneered a government-led, capital-driven approach to innovation, enabling their strategic emerging industries to achieve leapfrog growth within a relatively short period. The core of Hefei's innovative model lies in fully leveraging the government's guiding role alongside the market's decisive role in resource allocation, thereby achieving deep integration of technology, industry, and capital to jointly empower industrial development. After nearly a decade of dedicated efforts, the output value of strategic emerging industries in Hefei has grown rapidly, with their total output accounting for over half of the city's overall industrial output. This development speed is inseparable from the multiple roles of the government. First, strategic leaders. After conducting thorough research on technological trends and industrial transformation directions, the Hefei Municipal Government has identified the key development sectors for the region. Second, innovative organizers. Backed by its administrative attributes, the Hefei Municipal Government has taken the lead in integrating various innovative resources and has established a complete collaborative innovation system. Finally, the risk-taker. The Hefei Municipal Government has established an industrial investment fund to support major projects with forward-looking and leading characteristics, and to provide risk guarantees for the development of these projects. To mitigate the risk of administrative orders disrupting market operations, Hefei has established a project review committee composed of industry experts, technical specialists, and investment professionals to conduct professional evaluations of major projects, thereby significantly enhancing the scientific rigor and feasibility of government project decisions. Thanks to the development model that organically combines the government and the market, Hefei has formed a significant cluster advantage in strategic emerging industries such as new display and integrated circuits, providing experience for the innovation-driven development of similar regions.

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3.5. Common mechanisms for universities to support high-quality industrial innovation

First, establish a comprehensive innovation transmission chain spanning from university research innovation to enterprise technology application, fully leveraging the pivotal role of functional platforms and engineering service centers in bridging the innovation and industrial sectors. Second, give full play to the leading role of leading enterprises in the collaborative innovation network. Organize technological breakthroughs in the industrial chain by leveraging the technology roadmaps released by the chain leader enterprises, thereby forming a collaborative innovation network system with enterprise applications as the main body and university research and development as the support. Third, reshape the role of the government in the process of dual-chain integration, transforming it from a mere institutional designer to a composite role that takes into account project funders, platform builders, and resource integrators, thereby providing a more effective government support system for universities to support industrial innovation. Fourth, rooted in the technological development needs of enterprises, continuously promote the reform of research organization methods in universities, help university research activities shift from an academic logic to a market demand logic, and fully integrate enterprise needs into research activities. Fifth, comprehensively advance the establishment of a specialized and market-oriented technology transfer system, cultivate a high-caliber team of professional technology managers to facilitate the integration of dual chains, thereby optimizing the efficiency of technology commercialization. Sixth, build a cross-regional collaborative innovation system, break down the geographical barriers in the traditional process of industry-university-research collaboration, promote the free flow of innovation elements among regions and the sharing of resources among innovation platforms, and establish an efficient regional collaborative innovation community.

4. Conclusion

First, establish quantitative policy support standards to reduce the space for policy rent-seeking. Establish a classified evaluation system based on enterprise types (leading enterprises in the chain, key enterprises, innovative small and medium-sized enterprises), positions in the industrial chain, and innovation capabilities, and clearly define the scope of support, subsidy intensity, and qualification recognition standards. Establish an enterprise innovation capability index system covering dimensions such as R&D intensity, talent structure, and technology transfer, and accordingly form a differentiated policy support matrix. Meanwhile, strengthen the verification mechanism for policy implementation by engaging third parties to conduct mid-to-late stage evaluations of innovation investments and outcomes, refine default penalty clauses, and ensure that government resources are genuinely directed toward industrial upgrading.

Second, embed technological innovation as the core of the enterprise's development strategy. Some enterprises in the Wujin district still adhere to the strategy of prioritizing scale expansion, overly relying on factor input, and neglecting technological accumulation. Enterprises should shift their development strategy from ‘scale first’ to ‘innovation-driven’, increase investment in research and development, build internal R&D centers and innovation workstations, and promote the improvement of production processes and the construction of technology pilot platforms. Only when enterprises themselves have the capacity to absorb can the innovative achievements of universities be effectively implemented. Meanwhile, enterprises should establish and improve their internal intellectual property systems and innovation incentive mechanisms, refine the evaluation and selection processes for external technologies, and ensure that technology acquisition does not undermine their R&D capabilities. In addition,

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implementing equity incentives and profit-sharing rewards for key R&D personnel in technical cooperation can stimulate their intrinsic motivation for innovation.

Third, establish a digital collaborative innovation platform to optimize supply-demand matching. To address technological information asymmetry and supply-demand imbalance, the government should spearhead the establishment of regional digital collaborative innovation platforms that integrate functions such as enterprise technology demand publication, university research achievement display, and innovation resource matching. The platform should embed a full-process mechanism, including demand review, project classification, team challenge taking, and node assessment, guiding innovation resources to flow towards the most urgent and efficient fields and enhancing the efficiency of resource allocation. In addition, Wujin district should accelerate the promotion and application of industrial Internet of Things and intelligent manufacturing technologies, and help small and medium-sized enterprises build full-process digital production lines. Encourage the upstream and downstream of the industrial chain to jointly build a data service platform, achieve the linkage of technological demands and the sharing of innovation resources, and provide a solid industrial foundation for the transformation of university achievements.

Fourth, improve the guarantee and incentive mechanism for scientific researchers' achievements. The government will take the lead in establishing a committee for the protection of the rights and interests of scientific research talents, relying on third-party professional institutions to conduct evaluations of the value and technical contribution of achievements, and establish achievement contribution files for scientific researchers. Implement long-term incentive methods such as equity, dividends, and property rights empowerment, and incorporate the enterprise's scientific research performance into the performance evaluation system. Increase the weight of R&D positions in the organizational structure, optimize promotion channels, and enhance the sense of belonging and innovative vitality of scientific researchers. Meanwhile, universities should be guided to establish research projects aligned with industrial demands, and their engineering and industrialization capabilities should be incorporated into the professional title evaluation criteria. Establish an on-campus technology transfer office or technology commercialization center staffed with professional technical managers to enhance the success rate of translating research outcomes from laboratories to production lines.

Fifth, strengthen the supporting guarantees for institutional innovation and ecological governance. First, establish a special fund for innovation support in universities, adopting a mother-subsidiary fund model of "government-led and social capital participation", precisely covering high-risk and long-term links such as technology development, product verification, and the construction of pilot production platforms. Improving the exit and income distribution mechanism of funds can guide social capital to flow into key technological fields in an orderly manner and prevent the impact of short-term profit-seeking behavior on the innovation ecosystem. Second, optimize the project initiation and evaluation mechanism for innovation projects. Drawing on the experience of advanced regions, establish project selection criteria that are based on the local industrial foundation and benchmarked against the cutting-edge technologies both at home and abroad. Strengthen the regular tracking of the technological evolution trends of key industries, proactively carry out joint project initiation with external universities, and ensure that innovative projects can not only solve local practical problems but also lead the industry direction. Finally, improve the multi-party collaborative governance of the innovation platform. To address issues such as unclear responsibilities, lax management, and opaque resource allocation in existing innovation platforms, a platform management committee comprising the government, universities, industry chain enterprises, and technical experts will be established. Clarify the boundaries of platform responsibilities, optimize resource allocation rules, strengthen performance assessment, and ensure that the platform

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plays a stable, efficient, and standardized hub role in technology connection and achievement transformation.

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References

[1] Wu, J., Liew, C. Y., & Ji, D. Y. (2026). Digital finance and high-quality economic development: Evidence from Chinese municipal data. Journal of Asian Economics, 103, 102136. https://doi.org/10.1016/j.asieco.2026.102136

[2] Zhao, J. (2024). How do innovation factor allocation and institutional environment affect high-quality economic development? Evidence from China. Journal of Innovation & Knowledge, 9(2), 100475. https://doi.org/10.1016/j.jik.2024.100475

[3] Zhao, X., Wu, Z., & Qin, R. (2024). Construction strategy of industrial coordination system of secondary urban agglomerations in the context of low carbon economy. Polish Journal of Environmental Studies, 33(1), 965-979. https://doi.org/10.15244/pjoes/172839

[4] Hu, X., & Zhang, L. (2023). Research on the integration level measurement and optimization path of industrial chain, innovation chain and service chain. Journal of Innovation & Knowledge, 8(3), 100368. https://doi.org/10.1016/j.jik.2023.100368

[5] Liu, L., Dang, Y., & Ju, Z. (2026). Public data openness and private enterprise growth: The roles of local resource allocation and cross-regional collaborative innovation. Economic Modelling, 157, 107519. https://doi.org/10.1016/j.econmod.2026.107519

[6] Johnston, A., & Prokop, D. (2021). Peripherality and university collaboration: Evidence from rural SMEs in the UK. Journal of Rural Studies, 88, 298-306. https://doi.org/10.1016/j.jrurstud.2021.08.014

[7] Hu, F., Yang, H., Qiu, L., Wang, X., Ren, Z., Wei, S., ... Hu, H. (2025). Innovation networks in the advanced medical equipment industry: supporting regional digital health systems from a local–national perspective. Frontiers in public health, 13, 1635475. https://doi.org/10.3389/fpubh.2025.1635475

[8] Li, L., Chen, W., Song, B., & Cui, C. (2025). How to effectively promote the transformation of ecological and environmental scientific and technological achievements? A case study from China. Clean Technologies and Environmental Policy, 27(3), 1349-1371. https://doi.org/10.1007/s10098-024-02882-3

[9] Tian, X., & Lu, H. (2023). Digital infrastructure and cross-regional collaborative innovation in enterprises. Finance Research Letters, 58, 104635. https://doi.org/10.1016/j.frl.2023.104635

[10] Wu, Y., Wang, M., Li, Y., Zhou, J., & Cao, X. (2024). Can the construction of a research and development platform encourage innovation in green technology by private enterprises? Evidence from China. Business Strategy and the Environment, 33(2), 742-763. https://doi.org/10.1002/bse.3522

[11] Teirlinck, P. (2022). Enhancing R&D employment slack during environmental turbulence: triggers and firm performance consequences for R&D-active SMEs. Technovation, 118, 102622. https://doi.org/10.1016/j.technovation.2022.102622