

MECHANISMS AND EFFECTS OF HIGH-LEVEL SCIENTIFIC AND TECHNOLOGICAL INNOVATION PLATFORMS IN DRIVING HIGH-QUALITY URBAN ECONOMIC DEVELOPMENT: EMPIRICAL EVIDENCE FROM PREFECTURE-LEVEL CITIES IN CHINA

ZhanLei Xing, SiRui Zhang*

School of Economics and Management, Shaanxi University of Science and Technology, Xi'an 710021, Shaanxi, China.

**Corresponding Author: SiRui Zhang*

Abstract: Against the backdrop of innovation-driven development and the cultivation of new quality productive forces, high-level science and technology innovation platforms have emerged as core hubs and strategic pivots within regional innovation systems. Treating the establishment of these platforms as a quasi-natural experiment, this study constructs a multi-period difference-in-differences (DID) model based on panel data from 282 prefecture-level cities in China between 2012 and 2024 to systematically examine their impact on urban high-quality economic development and the underlying mechanisms. The findings are as follows: (1) High-level science and technology innovation platforms significantly promote local high-quality economic growth, a conclusion that remains robust after a series of checks, including the parallel trends test; (2) Mechanism analysis indicates that these platforms primarily drive high-quality economic growth by enhancing technological innovation, facilitating industrial structure upgrading, promoting the agglomeration of high-end factors, and strengthening regional collaborative innovation; (3) Heterogeneity analysis reveals that the impact of platform construction is more pronounced in non-resource-based cities, inland cities, and cities that are not old industrial bases. This paper elucidates the intrinsic mechanisms through which high-level science and technology innovation platforms foster high-quality economic development at the city level, providing empirical evidence for optimizing the layout of national strategic scientific and technological forces and enhancing the efficacy of regional innovation systems.

Keywords: High-level science and technology innovation platforms; High-quality economic development; Multi-period difference-in-differences (DID); Transmission mechanisms

1 INTRODUCTION

China's economy has transitioned from a phase of high-speed growth to one of high-quality development. As the traditional factor-driven model becomes unsustainable, scientific and technological innovation has emerged as the core driver for facilitating economic transformation, cultivating new quality productive forces, and upgrading industrial structure [1]. The Report to the 20th National Congress of the Communist Party of China calls for accelerating the development of a science and technology powerhouse and optimizing the layout of national strategic scientific and technological capabilities, thereby providing strategic support for the comprehensive enhancement of the quality, efficiency, and drivers of economic development. Against this backdrop, high-level scientific and technological innovation platforms—exemplified by national laboratories, comprehensive national science centers, national technology innovation centers, national manufacturing industry innovation centers, and major national scientific and technological infrastructure—have been rapidly deployed, gradually becoming pivotal pillars of China's innovation system. These platforms aggregate high-end scientific talent, integrate innovation resources, and undertake critical technological breakthroughs, while fostering the coordinated development of industry, academia, research, and application [2]. Consequently, they hold significant potential for enhancing regional innovation capacity and promoting high-quality economic growth. High-level science and technology innovation platforms (HLSTIPs) not only possess capabilities in knowledge creation and R&D but also influence local economic growth through the commercialization of technological achievements, industrial chain linkages, and regional collaborative innovation. However, in practice, certain platforms still grapple with challenges such as a misalignment between platform construction and industrial demand, low efficiency in converting scientific and technological achievements, and uneven resource allocation. On one hand, some platforms exhibit a tendency to prioritize research over industrial application or construction over operation. On the other hand, significant heterogeneity in industrial foundations, resource endowments, and locational conditions across cities introduces uncertainty regarding the marginal effects of these platforms on empowering economic growth. Therefore, it is necessary to clarify the economic effects and underlying mechanisms of high-level scientific and technological innovation platforms at the prefecture-level city scale, so as to provide a scientific basis for policy formulation and regional innovation layout. Existing literature primarily examines the relationship between innovation platforms and regional economies from three perspectives. The first category focuses on the construction and operation of high-level platforms, investigating platform classification, governance structures, and development models. Di Yuebao et al. reviewed the types and spatial distribution of major scientific and technological innovation platforms in China [3]; Xie

Qijun et al. analyzed the operational mechanisms of national technology innovation centers [4]; and Cai Chengbin, drawing on practices in Fujian Province, pointed out that the effectiveness of platform construction depends on collaborative governance by local governments and enterprises [5]. These studies have laid the foundation for understanding the organizational logic and operational models of such platforms. The second category concerns platform functions. Scholars generally agree that platforms play a strategic supporting role through the agglomeration of innovation resources, tackling key technological challenges, transforming achievements, and building innovation ecosystems. Tian Hongyu et al. noted that platforms strengthen basic research and resource agglomeration to support the cultivation of new quality productive forces [6], while Gao Qian emphasized the role of platforms in institutional innovation and achievement transformation, thereby clarifying the functional pathways of their potential economic value [7]. The third category focuses on the economic effects of platforms. Existing studies indicate that platforms can enhance regional innovation capacity and economic development through knowledge spillovers, technology diffusion, and industrial linkages. Chen Shenglan and Liu Xiaoling found that platforms promote corporate R&D performance and industrial upgrade [8]; Feng Luanye et al. empirically verified the positive impact of platforms on industry clusters using data from national manufacturing innovation centers [9]; Wang Zhixin et al. elucidated the internal mechanisms by which scientific and technological innovation platforms drive high-quality economic growth from the perspectives of innovation-driven development and industrial synergy [10]; and Yang Lisheng and Gong Jia further revealed the role of platforms in promoting high-quality economic growth under digital inclusive finance and innovation-driven development [11]. However, they also pointed out that existing research is predominantly concentrated at the provincial level or within high-tech zones, lacking systematic empirical evidence and mechanism analysis at the prefecture-level city scale. Despite the substantial progress in existing literature, three critical gaps remain. First, research subjects are predominantly provincial-level platforms or those located in high-tech zones, resulting in a scarcity of empirical evidence regarding the economic effects of high-level platforms in prefecture-level cities. Second, causal identification methods are limited; most studies rely on fixed-effects models or correlation analyses, lacking quasi-natural experiments to verify the causal effects of policy shocks. Third, mechanism analysis is unsystematic, failing to integrate technological innovation, industrial upgrade, factor agglomeration, and regional coordination into a unified framework, while also overlooking the analysis of heterogeneous effects across cities.

In light of these limitations, this study treats the establishment of high-level scientific and technological innovation platforms as a quasi-natural experiment. Leveraging panel data from 282 prefecture-level cities in China between 2012 and 2024, we employ a multi-period difference-in-differences (DID) model to identify the causal effect of platform establishment on local high-quality economic growth. Furthermore, we systematically examine four mediating pathways: technological innovation, industrial upgrade, factor agglomeration, and regional coordination. Meanwhile, a heterogeneity analysis is conducted across three dimensions—resource endowments, locational conditions, and industrial foundations—to explore the differential effects of these platforms across various city types. The marginal contributions of this study are threefold: First, the use of a multi-period difference-in-differences (DID) design based on prefecture-level city panel data enhances the reliability of causal identification. Second, by constructing and examining four complete mediating pathways, this paper reveals the underlying logic through which high-level scientific and technological innovation platforms empower high-quality economic growth. Third, by focusing on urban heterogeneity, it provides theoretical and empirical insights for optimizing the layout of high-level platforms and designing policies tailored to different types of cities.

2 THEORETICAL MECHANISMS AND RESEARCH HYPOTHESES

2.1 The Direct Impact of High-Level Science and Technology Innovation Platforms on High-Quality Economic Development

High-level science and technology innovation platforms constitute a crucial component of national strategic scientific and technological strength, serving as vital carriers for aggregating innovation resources, organizing major scientific and technological breakthroughs, and facilitating the commercialization of scientific and technological achievements. Compared with general innovation platforms, high-level science and technology innovation platforms possess superior capabilities in allocating innovation resources, higher-level organizational capacities for innovation, and more extensive radiating and driving effects, thereby playing a strategic supporting role within regional innovation systems.

From the perspective of innovation-driven development, the core of high-quality economic development lies in transforming the drivers of growth from factor-driven to innovation-driven. High-level science and technology innovation platforms continuously enhance regional innovation capacity and the efficiency of resource allocation by aggregating innovation resources, strengthening technology supply, and facilitating the conversion of scientific and technological achievements. Meanwhile, by promoting the deep integration of the innovation chain, industrial chain, and talent chain, these platforms improve the quality and efficiency of regional economic development. As the innovative functions of these platforms are increasingly unleashed, their innovation advantages will gradually be transformed into developmental advantages, thereby driving local economies to undergo transformations in quality, efficiency, and growth drivers. Based on this, we propose the following hypothesis:

H1: The establishment of high-level science and technology innovation platforms significantly enhances the level of high-quality economic growth in local regions.

2.2 Transmission Mechanisms of High-Level Sci-Tech Innovation Platforms in Empowering High-Quality Economic Development

The impact of high-level sci-tech innovation platforms on high-quality economic development is not direct; rather, it is transmitted gradually through pathways such as technological innovation, industrial upgrading, factor agglomeration, and regional coordination. These four mechanisms are interconnected and operate synergistically, collectively constituting the internal logic by which high-level sci-tech innovation platforms empower local economic development, see Figure 1.

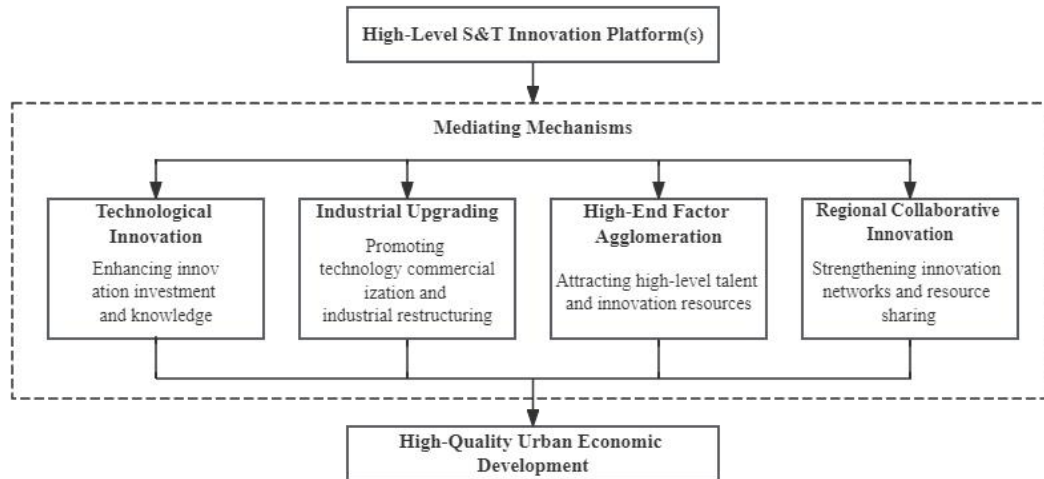


Figure 1 Mechanism of High-Level Sci-Tech Innovation Platforms Empowering the Local Economy

This schematic diagram clearly elucidates the “four core pathways” through which high-level sci-tech innovation platforms drive high-quality local economic development. These pathways are not isolated but form an organic, intertwined whole that mutually reinforces their effects.

2.2.1 Enhancement of technological innovation

High-level scientific and technological innovation platforms serve as the epicenter for original innovation and breakthroughs in key core technologies. Driven by their strategic mandates, these platforms secure substantial R&D resource inputs and orchestrate two distinct types of research activities: “directed” and “exploratory”, thereby facilitating knowledge creation and technological invention. Directed research focuses on concentrated efforts to address major national needs and resolve critical technological bottlenecks, leading to breakthroughs in key core technologies. In contrast, exploratory research is dedicated to original innovation in frontier fields, yielding high-quality scientific papers and invention patents. By undertaking major national science and technology projects, constructing large-scale scientific facilities, and attracting top-tier scientific talent, these platforms significantly enhance regional capabilities in knowledge creation and technological invention. These new knowledge assets and technologies spill over to entities outside the platform through knowledge spillovers and technological diffusion. The channels for such spillovers include the mobility and collaboration of researchers, academic exchanges and publications, as well as technology licensing and transfer. By absorbing and applying these new technologies, external firms improve their production processes and management efficiency, thereby directly enhancing regional total factor productivity (TFP) and injecting fundamental technological momentum into high-quality economic development. Accordingly, we propose:

H2a: High-level scientific and technological innovation platforms promote local high-quality economic development by enhancing technological innovation capabilities.

2.2.2 Industrial structure upgrading

The innovative outcomes and technological supply generated by high-level scientific and technological innovation platforms can accelerate the integrated development of the innovation chain and the industrial chain. By establishing entities such as technology transfer offices, pilot-scale testing bases, and industrial incubators, the platform proactively facilitates the penetration and commercialization of technological innovations into the industrial sector. Specific mechanisms include technology licensing, startup incubation, and the formation of industrial innovation alliances. On one hand, this directly fosters the emergence of emerging industries, such as artificial intelligence and biomedicine, creating new drivers of economic growth. On the other hand, new technologies empower traditional industries by enabling their intelligent and green transformation, facilitating their ascent to the top end of the value chains through process reengineering and product upgrading. Consequently, the regional industrial structure achieves advancement and modernization, manifested by an increased share of high-tech industries and enhanced overall industrial competitiveness and resilience. Accordingly, we propose:

H2b: High-level scientific and technological innovation platforms promote high-quality local economic development by facilitating industrial structure upgrading.

2.2.3 Agglomeration of high-end factors

Functioning as a powerful magnetic field, high-level scientific and technological innovation platforms exert a strong siphon effect on premium factors such as high-end talent, venture capital, and innovative enterprises, leveraging their

strategic status and resource inputs. World-class research environments and career platforms attract top global scientists and young talents; forward-looking technological directions and incubation projects draw in venture capital and industrial capital; and potential opportunities for innovative collaboration encourage upstream and downstream enterprises within the industrial chain to establish nearby operations. This agglomeration transforms the regional factor endowment structure, shifting reliance from ordinary labor and land resources to high-end human capital and financial capital. The simultaneous enhancement in both the quality and quantity of factor endowments means that the agglomeration of high-end factors not only contributes directly to economic growth but, more importantly, generates synergistic effects through their interaction and combination. These dynamics spark new innovations, providing a continuous supply of “fuel” for high-quality economic development. Accordingly, we propose:

H2c: High-level scientific and technological innovation platforms promote high-quality local economic development by facilitating the agglomeration of high-end factors.

2.2.4 Regional collaborative innovation

Characterized by openness, sharing, and networked collaboration, high-level scientific and technological innovation platforms facilitate the cross-regional flow and sharing of innovation resources. This effectively breaks down institutional and cultural barriers among diverse innovation actors, including universities, research institutes, enterprises, government agencies, and financial institutions. Han Fengqin et al. found that innovation platforms facilitate the construction of regional innovation ecosystems and the integrated development of science, technology, and the economy through multi-agent collaboration and resource integration mechanisms [12]. These platforms enable precise alignment between the fundamental innovations generated by universities and research institutes and the market demands of enterprises, guide the deep integration of financial capital into the entire process of technological innovation, and promote cross-departmental and cross-regional R&D cooperation and resource sharing. Such synergistic effects optimize the regional innovation ecosystem, significantly reduce information asymmetry and collaborative barriers, and thereby lower the transaction costs of overall innovation activities. This leads to a Pareto-improved allocation of innovation resources within the region, enhances the overall efficiency of the regional innovation system, and generates greater innovation output from the same inputs, thus more effectively driving high-quality economic growth. Accordingly, the following hypothesis is proposed:

H2d: High-level scientific and technological innovation platforms promote high-quality local economic growth by strengthening regional collaborative innovation.

These four pathways collectively constitute a positive feedback loop. Specifically, factor agglomeration provides resources for technological innovation; the resulting innovations drive industrial upgrade; and the benefits and demands generated by such upgrades further attract factor agglomeration. Meanwhile, regional synergistic effects act as both a lubricant and an accelerator, permeating and reinforcing the other three pathways. These mechanisms mutually reinforce one another, jointly driving local economies toward a high-quality development paradigm characterized by greater innovation, coordination, greenness, openness, and inclusiveness. Furthermore, this process is moderated by regional heterogeneity and platform-type heterogeneity, resulting in a complex and diverse landscape of final impacts. Accordingly, the following hypothesis is proposed:

H2: Technological innovation, industrial upgrade, factor agglomeration, and regional synergy play significant mediating roles in the process by which high-level scientific and technological innovation platforms empower high-quality economic growth.

2.3 Urban Heterogeneity in the Impact of High-Level Scientific and Technological Innovation Platforms

Due to variations in resource endowments, locational conditions, and industrial foundations across cities, their capacities to absorb and transform innovative resources and technology spillover effects from high-level scientific and technological innovation platforms differ. In terms of resource endowments, non-resource-based cities, characterized by diversified industrial structures and vibrant innovation entities, are well-positioned to effectively assimilate platform-driven innovative outcomes and convert them into drivers of economic growth. In contrast, resource-based cities, which have long relied on resource extraction industries, suffer from monolithic industrial structures and underdeveloped innovation ecosystems. Consequently, they exhibit weaker capabilities in absorbing and transforming technological innovations, thereby failing to fully leverage the technology spillover effects of these platforms. In terms of locational conditions, inland cities suffer from a relative scarcity of innovation resources. The establishment of high-level scientific and technological innovation platforms can effectively address these deficiencies by agglomerating high-end factors, promoting technology transfer, and facilitating industrial upgrade, thereby yielding more pronounced marginal contributions. In contrast, coastal cities have already developed relatively robust innovation systems and industrial ecosystems with ample supplies of innovation resources, which partially dilutes the incremental empowering effect of such platforms.

Regarding industrial foundations, non-old industrial base cities exhibit weaker path dependence and more flexible institutional mechanisms, enabling them to rapidly integrate platform-based innovation resources and achieve optimization and upgrading of their industrial structures. Conversely, old industrial bases, constrained by path dependence in traditional industries and institutional barriers, face significant challenges in integrating new technological achievements into existing industrial systems, thus hindering the full realization of the platforms' industrial driving effects. Based on this, we propose:

Hypothesis H3: The impact of high-level science and technology innovation platforms on local high-quality economic growth exhibits significant urban heterogeneity.

3 RESEARCH DESIGN

3.1 Sample Selection and Data Sources

In this study, “high-level scientific and technological innovation platforms” refer to national-level platforms officially approved by central ministries and commissions—including the Ministry of Science and Technology, the National Development and Reform Commission, and the Ministry of Industry and Information Technology. Integrated into the national strategic scientific and technological strength, these platforms undertake major national scientific and technological tasks and allocate innovation resources on a nationwide scale. Specifically, they encompass nine categories: national laboratories, comprehensive national science centers, national technology innovation centers (approved by the Ministry of Science and Technology), national manufacturing innovation centers (approved by the Ministry of Industry and Information Technology), and national major scientific and technological infrastructure (approved by the National Development and Reform Commission), as well as large-scale scientific facilities, generic technology R&D platforms, new-type R&D institutions, and pilot-scale test platforms, all of which have played a pivotal role in the national innovation system in recent years. Given that the construction of high-level scientific and technological innovation platforms in China has been concentrated primarily since the 18th National Congress of the Communist Party of China, with a notable acceleration in the development of national strategic scientific and technological strength particularly after 2016, this study selects panel data from 282 prefecture-level cities in China for the period 2012–2024 as the research sample. This selection ensures a sufficient pre-policy observation window and satisfies the identification requirements of the multi-period difference-in-differences model. The treatment group consists of cities that established such platforms during the sample period, while the control group comprises those that did not. To ensure sample comparability, cities with severe data missingness or frequent administrative division adjustments are excluded, and missing data for certain variables are supplemented using interpolation methods.

Data related to high-level scientific and technological innovation platforms were manually compiled based on approval documents, construction lists, and official website information publicly released by ministries such as the Ministry of Science and Technology, the National Development and Reform Commission, and the Ministry of Industry and Information Technology, thereby obtaining information on the establishment dates of these platforms and their host cities. For cities with multiple high-level scientific and technological innovation platforms established during the sample period, the approval date of the first such platform is designated as the timing of the policy shock. Data for other variables are primarily sourced from the China City Statistical Yearbook, China Statistical Yearbook, China Science and Technology Statistical Yearbook, China Education Statistical Yearbook, and the statistical communiqués of various prefecture-level cities.

3.2 Model Specification

3.2.1 Multi-period difference-in-differences model

Given that high-level scientific and technological innovation platforms are established in batches across different cities, exhibiting the typical characteristics of staggered policy implementation, this study treats their establishment as a quasi-natural experiment. A multi-period difference-in-differences (DID) model is employed to identify the causal effect of these platforms on high-quality urban economic development. The model is specified as follows:

$$HQD_{it} = \alpha + \beta DID_{it} + \gamma X_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (1)$$

Where HQD_{it} represents the level of high-quality urban economic development in city i in year t . DID_{it} is the key explanatory variable, capturing whether city i is exposed to the policy shock associated with the establishment of HLSTIPs. X_{it} denotes a vector of city-level control variables that may influence high-quality urban economic development, including fixed asset investment, human capital, fiscal expenditure, and infrastructure development. γ represents the coefficient vector of the control variables. μ_i and λ_t denote city fixed effects and year fixed effects, respectively, which control for time-invariant city-specific characteristics and common macroeconomic shocks. ϵ_{it} represents the random error term.

The coefficient β captures the net effect of HLSTIP establishment on high-quality urban economic development. A positive and statistically significant estimate of β indicates that the establishment of HLSTIPs effectively promotes high-quality urban economic development.

3.2.2 Mediation analysis

Building upon the theoretical framework developed in Section 2, this study posits that High-Level Science and Technology Innovation Platforms (HLSTIPs) may promote high-quality urban economic development through four primary channels: technological innovation, industrial upgrading, high-end factor agglomeration, and regional collaborative innovation. To identify the underlying mechanisms through which HLSTIPs exert their effects, this study follows the mechanism identification framework proposed by Jiang Ting (2022) and examines whether HLSTIPs significantly affect these potential mediating variables [13]. Combined with the theoretical analysis, this approach enables us to identify the transmission channels through which HLSTIPs facilitate high-quality urban economic development.

The mediation model is specified as follows:

$$M_{it} = \alpha + \beta DID_{it} + \gamma X_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (2)$$

where M_{it} denotes the mediating variable, including technological innovation (Tech), industrial upgrading (Ind), high-end factor agglomeration (Talent), and regional collaborative innovation (Coop). DID_{it} is the treatment variable indicating exposure to the policy shock associated with the establishment of HLSTIPs. X_{it} denotes the vector of control variables. μ_i and λ_t represent city fixed effects and year fixed effects, respectively, while ϵ_{it} is the random error term. A statistically significant coefficient on DID_{it} indicates that the establishment of HLSTIPs has a significant impact on the corresponding mediating variable, suggesting that this mechanism constitutes an important transmission channel through which HLSTIPs promote high-quality urban economic development.

3.3 Variable Definition

3.3.1 Dependent variable: high-quality urban economic development (HQD)

The dependent variable is high-quality urban economic development (HQD). Following the evaluation framework developed by Liu et al. (2021), this study constructs a comprehensive indicator system based on the five development dimensions proposed in China's new development philosophy, namely innovation, coordination, openness, green development, and sharing [14]. The indicator system consists of five first-level dimensions, twelve second-level indicators, and twenty-one third-level indicators. The composite index of high-quality urban economic development is calculated using the entropy weighting method, which objectively determines indicator weights based on the information contained in the data. The complete indicator system is presented in Table 1.

Table 1 Indicator System for Measuring High-Quality Urban Economic Development (HQD)

First-level Dimension	Weight	Second-level Indicator	Weight	Third-level Indicator	Attribute
Innovation	0.255415	Science and Education Investment	0.066179	Fiscal expenditure on science and technology / Total fiscal expenditure	Positive
				Fiscal expenditure on education / Total fiscal expenditure	Positive
		Patent Development	0.189236	Number of patent grants	Positive
Coordination	0.052253	Financial Development	0.039807	Deposits of financial institutions / Loans of financial institutions	Positive
				GDP per capita	Positive
				Non-real estate investment / Fixed asset investment	Positive
				Share of the tertiary industry	Positive
Openness	0.568117	Foreign Investment	0.161114	Actual utilized foreign direct investment (FDI)	Positive
				Gross output value of foreign-funded enterprises	Positive
				Number of foreign-funded enterprises	Positive
Green Development	0.033525	Three Industrial Pollutants	0.007245	Industrial wastewater discharge / Industrial output value	Negative
				Industrial sulfur dioxide (SO ₂) emissions / Industrial output value	Negative
				Industrial smoke and dust emissions / Industrial output value	Negative
		Pollution Treatment	0.02628	Comprehensive utilization rate of general industrial solid waste	Positive
				Centralized treatment rate of wastewater	Positive
Sharing	0.09069	Social Welfare	0.047056	Harmless treatment rate of domestic waste	Positive
				Number of practicing physicians per 10,000 residents	Positive
		Consumption Level	0.005923	Average wage of on-the-job employees	Positive
				Green coverage rate in built-up areas	Positive
		Government Burden	0.037711	Total retail sales of consumer goods / GDP	Positive
				Fiscal expenditure / Fiscal revenue	Positive

3.3.2 Key independent variable: HLSTIP policy shock (DID)

The key independent variable is the policy shock associated with the establishment of High-Level Science and Technology Innovation Platforms (HLSTIPs), which is constructed based on a staggered Difference-in-Differences (DID) design. Specifically, this study treats the establishment of HLSTIPs as a quasi-natural experiment and exploits the variation in the timing of policy implementation across cities to identify its causal effect.

Cities that obtained national approval for establishing HLSTIPs during the sample period are classified as the treatment group, whereas cities without such approval constitute the control group. Based on the official approval documents

released by relevant central government agencies, the year in which each city first received approval for establishing an HLSTIP is identified and used to determine the timing of policy intervention.

The treatment variable is constructed as follows:

$$DID_{it} = Treat_i \times Post_{it} \quad (3)$$

where $Treat_i$ is a binary indicator equal to 1 if city i was approved to establish an HLSTIP during the sample period and 0 otherwise. $Post_{it}$ is a time indicator that equals 1 for all years beginning with the year in which city i first received approval for establishing an HLSTIP, and 0 otherwise. The interaction term, DID_{it} , serves as the key independent variable and captures the policy effect associated with the establishment of HLSTIPs.

Because HLSTIPs were approved in different cities at different points in time, this study employs a staggered Difference-in-Differences (DID) model for estimation. By controlling for both city fixed effects and year fixed effects, the model accounts for time-invariant city-specific characteristics and common temporal shocks, thereby identifying the net effect of HLSTIP establishment on high-quality urban economic development.

3.3.3 Mediating variables

Drawing upon the theoretical framework, this study examines four mediating variables through which High-Level Science and Technology Innovation Platforms (HLSTIPs) may influence high-quality urban economic development.

Technological Innovation (Tech). Technological innovation is measured using two proxy indicators: the number of patent applications ($tech_effect1$) and the number of patent grants ($tech_effect2$). To facilitate comparison across cities, both indicators are normalized by dividing the total number of patent applications and patent grants by 10,000. These measures capture regional innovation output and reflect the extent to which HLSTIPs stimulate knowledge creation and technological innovation.

Industrial Upgrading (Ind). Industrial upgrading is measured using the industrial structure advancement index and the share of value added by the tertiary sector in GDP. Specifically, the industrial structure advancement index is calculated as the ratio of value added in the tertiary industry to that in the secondary industry. A higher value indicates a more advanced industrial structure characterized by a transition toward technology-intensive and high value-added industries.

High-End Factor Agglomeration (Talent). High-end factor agglomeration is proxied by the number of R&D personnel at the prefecture-level city. A larger R&D workforce reflects a stronger capacity to attract and concentrate innovative talent, indicating that HLSTIPs facilitate the agglomeration of high-end innovation factors.

Regional Collaborative Innovation (Coop). Regional collaborative innovation is measured by the transaction value of technology contracts at the prefecture-level city. This indicator reflects the level of interregional innovation collaboration and captures the role of HLSTIPs in promoting cross-regional cooperation, resource sharing, joint innovation, and innovation network integration.

3.3.4 Control variables

To mitigate potential omitted-variable bias, this study controls for six city-level characteristics that may influence high-quality urban economic development.

① **Openness (Open):** measured by the ratio of total imports and exports to regional GDP. ② **Population Size (Population):** measured as the natural logarithm of the registered population. ③ **Fiscal Capacity (Fiscal):** measured as the natural logarithm of fiscal expenditure. ④ **Urbanization (Urban):** measured by the ratio of the urban population to the total population. ⑤ **Education Expenditure (Education):** measured by the ratio of education expenditure to total general public budget expenditure. ⑥ **Mobile Communication Penetration (Mobile):** measured by the ratio of mobile phone subscribers at year-end to the registered population.

3.4 Descriptive Statistics

Table 2 reports the descriptive statistics for the main variables used in this study. Overall, considerable variation exists across the sample, suggesting substantial heterogeneity among Chinese prefecture-level cities in terms of economic development, innovation capacity, and resource endowment. Such variation provides a solid empirical basis for identifying the effects of High-Level Science and Technology Innovation Platforms (HLSTIPs).

The mean value of the high-quality urban economic development (HQD) index is 0.081, with a standard deviation of 0.039, indicating substantial disparities in the level of high-quality development across cities. The mean value of the HLSTIP policy shock (DID) variable is 0.030, implying that only a relatively small proportion of city-year observations were exposed to the policy intervention during the sample period. This finding is consistent with the strategic and selective nature of HLSTIP deployment in China. The control variables also exhibit substantial cross-city variation, indicating that the sample is sufficiently heterogeneous and provides an appropriate basis for subsequent econometric analyses.

Table 2 Descriptive Statistics of the Main Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
High-quality Urban Economic Development (HQD)	3634	0.0810	0.0390	0.0370	0.741
DID	3634	0.0300	0.171	0	1
Population	3634	5.762	0.916	-3.219	7.380
Open	3634	0.00200	0.00300	0	0.0290
Urban	3634	0.396	0.216	0.0150	1
Fiscal Inv	3634	6.217	4.530	0.0100	41.68

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Education ~Exp	3634	0.176	0.0400	0.0150	0.383
Mobile	3634	40.24	682.6	0.234	142.25

4 EMPIRICAL RESULTS

4.1 Baseline Regression Results

Table 3 reports the baseline regression results. After controlling for city and year fixed effects, as well as a set of city-level characteristics, the coefficient on the HLSTIP policy shock (DID) is positive and statistically significant at the 1% level, indicating that the establishment of HLSTIPs significantly promotes high-quality urban economic development. This finding provides strong support for Hypothesis 1 (H1).

HLSTIPs serve not only as strategic platforms for concentrating innovation resources but also facilitate the transformation of innovation advantages into development advantages. By optimizing the allocation of innovation resources, facilitating knowledge spillovers, and accelerating the commercialization of scientific and technological achievements, HLSTIPs provide sustained momentum for high-quality urban economic development.

From a theoretical perspective, HLSTIPs enhance regional innovation capacity by attracting high-caliber researchers, innovation capital, and research institutions. They also promote deeper integration between the innovation chain and the industrial chain, thereby facilitating the commercialization of scientific and technological achievements and improving resource allocation efficiency. Together, these mechanisms contribute to high-quality urban economic development and provide further support for Hypothesis 1 (H1).

Table 3 Baseline Regression Results

Variables	(1) High-Quality Urban Economic Development	(2) High-Quality Urban Economic Development
DID	0.0236*** (5.450)	0.0136*** (3.089)
Population Size		0.0218** (2.137)
Openness		1.541*** (2.640)
Urbanization		0.000170 (0.0261)
Fiscal_Inv		0.000384*** (3.598)
Education Exp		0.0142 (1.269)
Mobile Communication Penetration		0.00216 (0.912)
City Fixed Effects	YES	YES
Year Fixed Effects	YES	YES
Constant	0.0802*** (592.9)	-0.0606 (-1.006)
Observations	3,634	3,634
R-squared	0.958	0.969

Note: Cluster-robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The estimated coefficients of the control variables indicate that population size, openness, fiscal capacity, and urbanization all exert significantly positive effects on high-quality urban economic development, suggesting that these factors provide important support for sustainable urban development. Although the estimated coefficient of DID decreases slightly after the inclusion of the control variables, it remains positive and statistically significant. This result indicates that the promoting effect of HLSTIPs is robust and that part of the policy effect may operate through channels such as population agglomeration, greater openness, and fiscal support.

Overall, the baseline regression results confirm the positive effect of HLSTIPs on high-quality urban economic development and provide a solid foundation for the subsequent mechanism and heterogeneity analyses.

4.2 Mechanism Analysis

To further explore the channels through which HLSTIPs promote high-quality urban economic development, this study builds on the theoretical framework developed in Section 2 and adopts the mechanism identification approach proposed by Jiang Ting (2022). Specifically, four potential transmission channels are examined: technological innovation, industrial upgrading, high-end factor agglomeration, and regional collaborative innovation. The estimation results are reported in Table 4.

Table 4 Effects of HLSTIPs on Local Economic Development: Mechanism Analysis

	(1)	(2)	(3)	(4)	(5)	(6)
	Technological Innovation		Technological Innovation		Industrial Upgrading	Industrial Upgrading
Variables	tech_effect1	tech_effect2	Ind_Upg1	Ind_Upg2	Talent_Agg	Reg_Coop
DID	1.380*** (4.600)	1.368*** (5.006)	0.131** (2.325)	1.881** (2.030)	10,517* (1.840)	79.29*** (3.764)
Population Size	2.026*** (2.746)	1.819*** (2.926)	-0.662** (-2.345)	-4.801 (-0.995)	-3,316 (-0.522)	61.64** (2.582)
Openness	-18.26* (-1.830)	-18.11* (-1.955)	-9.087 (-1.291)	4.585 (0.0523)	-53,114 (-0.159)	1,023 (1.075)
Urbanization	1.161*** (2.821)	1.100*** (2.674)	-0.220 (-1.265)	-0.970 (-0.346)	-9,555 (-1.357)	22.04 (1.285)
Fiscal Inv	0.00565 (0.969)	0.00595 (1.061)	0.000472 (0.118)	0.108* (1.723)	-156.4 (-1.109)	-0.0451 (-0.114)
Education Exp	0.646 (0.997)	0.414 (0.736)	0.747 (1.598)	26.85*** (4.174)	-2,426 (-0.259)	68.51** (2.476)
Mobile Communication Penetration	-0.297 (-1.331)	-0.158 (-0.968)	0.157*** (2.606)	3.201*** (3.401)	-89.96 (-0.0522)	-3.701 (-0.278)
City Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Constant	-11.39*** (-2.628)	-10.45*** (-2.860)	4.765*** (2.820)	63.03** (2.199)	38,318 (0.977)	-273.8** (-2.016)
Observations	3,634	3,634	3,634	3,634	3,634	3,634
R-squared	0.954	0.939	0.841	0.838	0.938	0.992

Note: Cluster-robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

First, technological innovation serves as the primary channel through which HLSTIPs generate economic benefits. As reported in Columns (1) and (2) of Table 4, the establishment of HLSTIPs significantly increases both patent applications and patent grants, indicating that these platforms effectively enhance regional innovation output. Unlike conventional innovation infrastructures, HLSTIPs undertake national strategic research missions and key core technology breakthroughs. Consequently, their most immediate effect is not on industrial restructuring or factor mobility, but on strengthening regional knowledge production capacity. Through the concentration of advanced research facilities, national-level research teams, and sustained R&D investment, HLSTIPs continuously expand the supply of original innovation, enabling cities to become producers rather than merely users of new knowledge and technologies. As innovation accumulates, new knowledge diffuses to firms through talent mobility, technology collaboration, and the commercialization of research outcomes, thereby improving technological progress, productivity, and ultimately total factor productivity. From the perspective of high-quality economic development, this process represents a fundamental transition from factor-driven growth to innovation-driven development. Patent growth is merely an observable manifestation of this transformation, whereas the enhancement of innovation capability constitutes its underlying driving force. Therefore, technological innovation is not only the most direct outcome of HLSTIPs but also the fundamental source of their contribution to high-quality urban economic development, providing strong support for Hypothesis H2a.

Second, industrial upgrading represents the key process through which HLSTIPs transform innovation advantages into development advantages. Whereas technological innovation emphasizes knowledge creation, industrial upgrading reflects the realization of knowledge value. A persistent obstacle to regional innovation has been the disconnect between the innovation chain and the industrial chain, leaving many research outcomes confined to laboratories. HLSTIPs address this bottleneck by improving technology transfer, pilot testing, and industrial incubation, thereby shortening the path from scientific discovery to market application and strengthening the integration of innovation and industrial chains. On the one hand, HLSTIPs foster the development of strategic emerging industries, such as artificial intelligence, biomedicine, and new energy, creating new sources of economic growth. On the other hand, the technologies generated by these platforms facilitate the digitalization, intelligent transformation, and green upgrading of traditional industries, promoting the movement of industrial activities toward higher value-added segments of the value chain. As shown in Table 4, HLSTIPs significantly promote industrial upgrading, suggesting that they not only generate new technologies but also facilitate their integration into industrial production and economic activities. Hence, the industrial upgrading mechanism primarily reflects the commercialization and application of innovation rather than technological progress alone.

Under an innovation-driven development paradigm, competition among cities increasingly depends on the ability to attract high-end innovation resources. Traditional location theory suggests that capital and labor tend to concentrate in regions with larger markets or lower production costs. In contrast, under innovation-driven development, highly skilled talent and innovation capital are more strongly attracted by favorable innovation environments and development opportunities. Supported by national-level resource allocation and superior research conditions, HLSTIPs substantially enhance urban attractiveness for innovation and strengthen cities' competitive advantages. The empirical results show

that HLSTIPs significantly promote the agglomeration of R&D personnel, indicating that these platforms reshape the spatial distribution of innovation resources. More importantly, this process represents not merely an increase in population but a structural reallocation of regional innovation resources. As researchers, research institutions, and technology-oriented firms continue to cluster, urban development gradually shifts away from dependence on traditional production factors, such as land and labor, toward a knowledge-, technology-, and talent-driven development model. Therefore, the agglomeration mechanism fundamentally reflects the capacity of HLSTIPs to reconfigure the allocation of urban innovation resources.

If technological innovation represents the platform's capability of generating new knowledge "from 0 to 1," then regional collaborative innovation reflects its ability to diffuse innovation "from 1 to N." As reported in Column (6) of Table 4, HLSTIPs significantly increase technology contract turnover, indicating that they effectively facilitate the cross-regional flow and sharing of innovation resources. As technological innovation becomes increasingly complex, innovation has gradually evolved from competition among individual actors to competition among innovation networks. Owing to their open and collaborative nature, HLSTIPs function as important hubs linking universities, research institutes, enterprises, and government agencies. On the one hand, they foster stable collaborative relationships among innovation actors; on the other hand, they accelerate the cross-regional diffusion and reuse of technological achievements. As a result, regional innovation systems evolve from fragmented operations toward coordinated collaboration, substantially improving the efficiency of innovation resource allocation. Therefore, the regional collaborative innovation mechanism reflects not simply an increase in the quantity of innovation resources but, more importantly, an optimization of the way regional innovation systems operate.

4.3 Heterogeneity Analysis

To further examine whether the effects of High-Level Science and Technology Innovation Platforms (HLSTIPs) vary across different urban contexts, this study conducts heterogeneity analyses along three dimensions: resource endowments, geographical location, and industrial foundations. The estimation results are presented in Table 5.

Table 5 Estimation Results Considering Urban Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
	Resource-based Cities	Non-resource-based Cities	Coastal Cities	Inland Cities	Old Industrial Bases	Non-old Industrial Bases
DID	0.000186 (0.254)	0.0128*** (2.841)	0.00612** (2.038)	0.0321*** (2.666)	0.00251 (0.725)	0.0155*** (3.074)
Population	0.00848 (0.972)	0.0358*** (5.031)	0.0498*** (4.079)	0.0113 (1.212)	0.0166* (1.665)	0.0204 (1.550)
Open	0.901*** (4.136)	1.894** (2.369)	2.604*** (2.894)	0.454*** (2.765)	1.187*** (3.829)	1.877* (1.834)
Urban	0.00294 (0.371)	-0.00781 (-0.863)	-0.00511 (-0.536)	-0.00128 (-0.216)	0.00659 (0.932)	-0.00299 (-0.366)
Fiscal Inv	0.000403*** (3.964)	0.000424** (2.326)	0.000473*** (2.799)	0.000358*** (3.560)	0.000543*** (3.846)	0.000326** (2.277)
Education Exp	0.0322** (2.207)	0.00302 (0.182)	-0.0881*** (-3.859)	0.0532*** (5.199)	0.0421*** (3.196)	0.00306 (0.194)
Mobile	0.00651*** (2.669)	0.00196 (0.665)	-0.00309 (-1.189)	0.00603** (2.361)	0.00172 (0.466)	0.00288 (0.970)
City Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Constant	0.00218 (0.0431)	-0.135*** (-3.046)	-0.193** (-2.578)	-0.0136 (-0.250)	-0.0439 (-0.758)	-0.0467 (-0.592)
Observations	1,373	1,836	1,219	1,990	1,102	2,107
R-squared	0.903	0.975	0.980	0.941	0.941	0.971

Note: Cluster-robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The results reveal that the positive effects of HLSTIPs are significantly stronger in non-resource-based cities than in resource-based cities. This finding suggests that regional resource endowments play an important role in shaping the effectiveness of innovation policies. Resource-based cities have historically relied on the exploitation of natural resources as their primary growth engine, resulting in relatively concentrated industrial structures, stronger path dependence, and weaker incentives for innovation. Consequently, their capacity to absorb and commercialize new technologies remains limited. In contrast, non-resource-based cities generally possess more diversified industrial structures and more dynamic market environments, enabling innovation resources, knowledge spillovers, and technological diffusion generated by HLSTIPs to be integrated more effectively into existing production systems and translated into productivity gains. As a result, HLSTIPs are more likely to generate a virtuous cycle in which innovation investment promotes sustained economic

growth. This finding is consistent with previous studies showing that resource dependence constrains innovation-driven transformation and weakens the effectiveness of innovation policies.

Geographical location also significantly moderates the policy effect. Although coastal cities generally enjoy stronger economic fundamentals, richer innovation resources, and more mature innovation ecosystems, the estimated effects of HLSTIPs are substantially larger in inland cities. This finding suggests that HLSTIPs function not only as innovation platforms but also as mechanisms for reallocating innovation resources across regions. Inland cities have long faced shortages of high-level talent, research infrastructure, and scientific resources. The establishment of HLSTIPs effectively alleviates these constraints by strengthening local innovation capacity and improving the supply of innovation resources. By contrast, coastal cities already possess relatively well-developed innovation systems, implying that additional platforms generate comparatively smaller marginal gains. These results support the view that innovation policies tend to produce higher marginal returns in regions where innovation resources are relatively scarce.

The policy effects also differ according to cities' industrial foundations. Specifically, HLSTIPs generate significantly stronger economic effects in non-old industrial-base cities than in old industrial-base cities. This disparity does not reflect differences in innovation demand, but rather differences in the capacity to absorb and commercialize innovation. Old industrial-base cities are characterized by a high concentration of traditional industries, stronger industrial path dependence, and slower institutional transformation, all of which increase the costs of adopting new technologies and limit the commercialization of innovation. In contrast, cities outside the old industrial bases generally exhibit more flexible industrial structures and stronger market dynamism, enabling them to absorb innovation resources more efficiently and accelerate industrial upgrading. Consequently, identical innovation platforms produce heterogeneous economic outcomes under different industrial conditions, with stronger policy effects observed where the costs of structural transformation are relatively lower.

Overall, the results indicate that the economic effects of HLSTIPs are systematically heterogeneous rather than uniform across cities. The policy delivers greater benefits in non-resource-based cities, inland cities, and cities outside China's old industrial bases, where innovation constraints are more pronounced and the marginal returns to innovation investment are higher. These findings provide strong support for Hypothesis H3 and suggest that the future deployment of HLSTIPs should take regional heterogeneity into full consideration. Rather than adopting a uniform allocation strategy, policymakers should tailor platform deployment to local resource endowments, geographical conditions, and industrial foundations so as to maximize the contribution of national strategic science and technology resources to high-quality regional economic development.

5 CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

Using panel data for 282 Chinese prefecture-level cities from 2012 to 2024, this study investigates the effects of High-Level Science and Technology Innovation Platforms (HLSTIPs) on high-quality urban economic development. Treating the establishment of HLSTIPs approved by national ministries and commissions as a quasi-natural experiment, we employ a multi-period difference-in-differences (DID) model to systematically examine their policy effects, underlying mechanisms, and heterogeneous impacts. The findings indicate that HLSTIPs are not only important institutional platforms underpinning China's national strategic science and technology capabilities but also effective policy instruments for promoting high-quality urban economic development.

The empirical results first demonstrate that HLSTIPs significantly improve the level of high-quality urban economic development. Benchmark estimations show that the establishment of HLSTIPs leads to a substantial increase in the quality of urban economic development, and this conclusion remains robust after parallel-trend tests and a series of robustness checks. These findings suggest that HLSTIPs not only facilitate the concentration of innovation resources but also transform innovation advantages into sustainable development advantages by optimizing the allocation of innovation resources and accelerating the commercialization of scientific and technological achievements, thereby providing continuous momentum for high-quality urban economic development.

Further mechanism analysis reveals that HLSTIPs promote high-quality urban economic development through four mutually reinforcing channels: technological innovation, industrial upgrading, high-end factor agglomeration, and regional collaborative innovation. Technological innovation provides the fundamental source of new knowledge, industrial upgrading translates innovation into economic value, high-end factor agglomeration supplies the critical resources required for sustained innovation, and regional collaborative innovation further expands the diffusion of innovation outcomes and their economic spillover effects. Together, these mechanisms constitute an integrated pathway through which HLSTIPs drive high-quality urban economic development.

The study also identifies significant heterogeneity in the economic effects of HLSTIPs across different types of cities. Compared with resource-based cities, non-resource-based cities are better positioned to absorb innovation resources and knowledge spillovers generated by HLSTIPs. Likewise, inland cities benefit from larger policy effects than coastal cities, while cities outside China's old industrial bases exhibit stronger improvements in technology commercialization and industrial upgrading than old industrial-base cities. These findings indicate that the effectiveness of HLSTIPs is jointly shaped by regional resource endowments, geographical conditions, and industrial foundations, highlighting the importance of regional heterogeneity in the implementation of innovation policies.

Overall, HLSTIPs enhance high-quality urban economic development not only by strengthening urban innovation capacity but also by improving the allocation of innovation resources, facilitating industrial transformation and upgrading, and reinforcing regional innovation systems. This study enriches the literature on the economic effects of HLSTIPs and provides new empirical evidence for improving China's national innovation system and optimizing the spatial allocation of innovation resources.

5.2 Policy Implications

The above findings suggest that HLSTIPs have become an important policy instrument for promoting high-quality urban economic development. To further unlock their innovation potential and strengthen the contribution of national strategic science and technology resources to regional development, future policy efforts should focus on the following priorities. To begin with, greater emphasis should be placed on optimizing the spatial distribution of HLSTIPs in order to improve the regional allocation efficiency of national strategic science and technology resources. The central government should strengthen the overall planning of HLSTIPs in accordance with national strategic priorities and the objectives of coordinated regional development, while advancing the development of national laboratories, comprehensive national science centers, national technology innovation centers, and other high-level innovation platforms in a more coordinated manner. Building upon the existing advantages of innovation-leading regions, greater policy support should be directed toward areas with relatively weak innovation capacity but strong development potential, thereby enhancing the efficiency of innovation resource allocation and strengthening the regional spillover effects of HLSTIPs on innovation capacity and high-quality economic development.

Meanwhile, improving the operational performance of HLSTIPs should remain a policy priority. As their core mission is to achieve breakthroughs in key core technologies and strengthen original innovation capabilities, further efforts should be devoted to improving platform governance, increasing investment in basic research and frontier technologies, and concentrating scientific resources on major national strategic tasks and critical technological breakthroughs. At the same time, policies aimed at attracting and cultivating high-level talent, improving research evaluation systems, and strengthening innovation incentive mechanisms should be further enhanced to stimulate researchers' creativity and reinforce the long-term innovation capacity and scientific output of HLSTIPs, thereby providing a stable source of innovation-driven growth.

The findings also suggest that greater attention should be devoted to strengthening the commercialization of scientific and technological achievements and deepening the integration of innovation and industrial chains. Since industrial upgrading represents a key transmission mechanism through which HLSTIPs promote high-quality development, further improvements are needed in technology transfer systems, pilot-scale testing facilities, technology transfer institutions, and industrial incubation platforms to accelerate the transition of scientific discoveries from laboratories to markets. In addition, closer collaboration among HLSTIPs, leading enterprises, industrial parks, and innovative firms should be encouraged to promote the coordinated development of technological and industrial innovation, foster strategic emerging industries and industries of the future, and accelerate the digital, intelligent, and green transformation of traditional industries.

In addition, a more open and collaborative regional innovation ecosystem should be established to enhance the overall performance of regional innovation systems. Beyond serving as platforms for the concentration of innovation resources, HLSTIPs function as key hubs for regional collaborative innovation. Greater efforts should therefore be made to promote open resource sharing and strengthen collaboration among universities, research institutes, enterprises, financial institutions, and government agencies. Establishing cross-regional innovation networks and resource-sharing mechanisms would facilitate the mobility of innovation resources and the broader diffusion of technological achievements, thereby improving the efficiency of regional innovation systems.

Finally, future policies should adopt a more differentiated approach to the development of HLSTIPs by taking full account of regional heterogeneity. Given the substantial differences in resource endowments, geographical conditions, and industrial foundations across cities, a one-size-fits-all strategy is unlikely to maximize policy effectiveness. Resource-based cities and China's old industrial bases should place greater emphasis on integrating platform development with industrial transformation and improving their capacity to absorb and commercialize innovation. Inland regions and cities with relatively weak innovation capacity should receive stronger policy support and greater inflows of innovation resources to reinforce their innovation capabilities. By contrast, innovation-leading regions should focus more on strengthening original innovation capacity and enhancing their role in the global allocation of innovation resources, thereby further improving the contribution of HLSTIPs to China's national innovation strategy.

COMPETING INTERESTS

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