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The Impact and Mechanism of Free Trade Zone Construction on the Innovative Development of Beijing's High-End Service Industry

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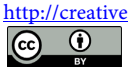

Abstract

As the core vehicle for institutional opening-up, the construction of free trade pilot zones plays a crucial role in driving the innovative development of Beijing's high-end service industry. This paper uses panel data from Beijing to construct a difference-in-differences model and a spatial econometric model, systematically arguing that free trade pilot zones influence the innovative development of the high-end service industry through four transmission mechanisms: demand expansion, knowledge spillover enhancement, information efficiency improvement, and institutional environment optimization. Empirical results show: First, free trade zone policies significantly promote the specialized clustering and enhanced industrial diversity of high-end services; Second, policy effects exhibit significant spatial spillover, with notable overall effects, and foreign-invested areas showing a significantly higher increase in total factor productivity compared to traditional service areas; Third, the construction of digital infrastructure and the reduction of institutional transaction costs constitute the core enabling pathways. Based on this, three policy frameworks are proposed: deepening institutional openness, strengthening digital-institutional synergy, and optimizing spatial layout, to provide theoretical support and practical models for building an open innovation ecosystem for high-end services.

Keywords

Free Trade Pilot Zone, High-End Services, Institutional Openness, Specialized Clustering, Digital Infrastructure

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1. Introduction

Against the backdrop of the profound restructuring of global value chains and the digital technology revolution, high-end services—with their high intellectual intensity, high value-added nature, and strong industrial driving force (Li, 2024)—have become a strategic pillar for nations to reshape their competitive advantages. As the core implementation zone of China's "Four Centers" strategy, Beijing leverages the synergistic advantages of the "National Comprehensive Demonstration Zone for Expanding Services Opening-up" and the "China (Beijing) Pilot Free Trade Zone" (collectively referred to as the "Two Zones") to establish a hub for institutional innovation. In recent years, it has accumulated multiple pioneering institutional achievements at the national level (such as the cross-border data flow white list and equity trust property registration), successfully attracting international institutions like Standard Chartered Securities and Mubadala to cluster in the region. This has driven the rapid growth of core digital economy industries, with the contribution rate of the information services sector to the regional GDP significantly increasing, marking the entry of the regional service economy into a new phase driven by innovation.

However, the development of Beijing's high-end service industry still faces three major challenges: first, an imbalance in the supply of composite talent, with a significant shortage of talent in the intersection of technology, management, and law; second, structural shortcomings in digital infrastructure, with mismatches between computing resource allocation and scenario demands, and relatively lagging application of cutting-edge technologies such as edge computing; third, generational gaps in international competitiveness, with deficiencies compared to global cities like New York and London in terms of international standard-setting authority and the cultivation of multinational enterprises. Against this backdrop, precisely analyzing the role of free trade pilot zone policies in driving innovation in the high-end service sector is of urgent importance for breaking through development bottlenecks and building an open innovation ecosystem. This study integrates innovation economics and spatial economics theory to construct a three-dimensional analytical framework of "institutional-digital-spatial," aiming to provide theoretical support and policy tools for the high-quality development of Beijing's high-end service sector, while contributing a "Beijing solution" to the institutional opening-up of China's service sector.

2. Literature Review

The academic understanding of high-end services has evolved from defining its elemental characteristics to deepening its functional positioning. Early studies primarily focused on its "high-intelligence, high-efficiency, and high-value-added" elemental attributes. Subsequent scholars expanded this to include its industrial driving function, pointing out that it drives the upgrading of manufacturing through knowledge integration and technology diffusion (Chen et al., 2011). The international academic community uses knowledge-intensive business services

(KIBS) as a benchmark concept, emphasizing their core hub functions in knowledge transfer, cross-entity collaboration, and value re-creation (Muller, 2021). This understanding provides a theoretical anchor for grasping the innovative logic of emerging hybrid sectors such as fintech and legal tech.

Regarding the innovative driving forces of high-end services, existing research has revealed a triple-drive logic involving policy, market, and technology. At the policy level, incentive tools such as tax incentives and industrial funds reduce innovation risks, optimize resource allocation, and strengthen industrial agglomeration effects (Adner, 2006; Zhang, 2023); At the market level, an open competitive environment drives continuous upgrades in service capabilities, while the growth of cross-border service demand further promotes technological iteration and model innovation (Zhang et al., 2025); At the technological level, digital technologies such as artificial intelligence and blockchain are deeply restructuring service processes, giving rise to new business models like intelligent investment advisory and digital twins, thereby injecting new momentum into innovation (Zhang & Xia, 2025).

The mechanism through which free trade pilot zones influence industrial development has been a hot research topic in recent years, with relevant literature primarily analyzing the issue from three perspectives. From an industrial agglomeration perspective, free trade zones promote the specialized agglomeration of the service industry by reducing institutional transaction costs and optimizing the efficiency of factor allocation (Yang et al., 2021), and generate regional synergy effects through knowledge spillovers and resource sharing (Teng & Shen, 2014); From the institutional innovation perspective, the "dynamic adjustment of the negative list" and the "streamlining administration and delegating power" reforms have significantly improved the business environment (Su, 2016), while flexible mechanisms such as regulatory sandboxes provide a trial-and-error space for the application of disruptive technologies, accelerating the implementation of innovative outcomes; From a digital synergy perspective, cross-border data flow pilot programs have improved supply chain response efficiency and factor matching precision (Li & Han, 2021), while the supportive role of new infrastructure such as computing power in technological innovation is increasingly evident.

Although existing research has achieved certain results, there are still three main limitations: first, the evaluation system is fragmented, with a focus on single-dimensional indicators, and lacks a comprehensive evaluation framework that integrates multiple objectives such as international competitiveness and green development; Second, mechanism analysis remains superficial, with insufficient systematic empirical testing of the synergistic pathways between policy tools, digital technology, and spatial layout, making it difficult to uncover the underlying logic of multidimensional interactions; third, regional adaptability is inadequate, as analysis schemes have not been sufficiently tailored to Beijing's "Two Zones" characteristic policies (such as the data outbound assessment mechanism), making it challenging to precisely capture the interactive relationship between institutional innovation and local industrial characteristics.

This paper addresses these limitations by constructing a four-dimensional transmission model of demand expansion—knowledge spillover—information efficiency—institutional optimization, systematically quantifying the multi-scale effects of free trade zone policies on innovation in Beijing's high-end service industry, and providing targeted evidence for the precise design of institutional opening-up policies.

3. The Mechanism of Free Trade Zones in Promoting the Innovative Development of High-End Services

As a key platform for institutional opening-up, free trade zones play a crucial role in driving the transformation and upgrading of Beijing's high-end services sector from an element-driven to an innovation-driven model. By fully leveraging the synergistic effects of the four transmission mechanisms, free trade zones have effectively driven the innovative development of high-end services. The following sections will delve into the operational pathways and underlying logic of each mechanism through rigorous theoretical models and systematic empirical analysis.

3.1. Expansion of Market Demand: Opening-Up Drives Service Capability Upgrades

By relaxing foreign investment access restrictions and expanding cross-border service trade pilot programs, the free trade zone has significantly increased the scale and structure of market demand for high-end services. This policy not only injects new vitality into the high-end service sector but also, through the technical standards and service requirements of foreign-invested enterprises, compels domestic enterprises to accelerate technological iteration and service model innovation, forming a virtuous cycle of "demand-driven capacity upgrading."

Specifically, relaxing foreign investment access restrictions has enabled more foreign-invested enterprises to enter Beijing's high-end service industry market. Zhang & Ma (2024) argue that these foreign-invested enterprises have brought advanced technology, management experience, and international service standards, creating strong competitive pressure on domestic enterprises. To maintain a competitive edge, domestic enterprises have had to increase R&D investment, enhance technological capabilities, and optimize service models. This competitive pressure has been transformed into an innovative driving force, promoting technological progress and service capability upgrades among domestic enterprises.

Meanwhile, the expansion of cross-border service trade pilot programs has opened up broader market opportunities for the high-end service sector. Huang & Chen (2009) emphasize that through these pilot programs, domestic enterprises can access more international clients and partners, expand their business scope, and increase their market share. This expansion of market demand not only brings more business opportunities but also drives enterprises to continuously improve service quality to meet the high standards of international markets.

In this process, the expansion and structural optimization of market demand

have become key drivers of innovation for domestic enterprises. The entry of foreign-invested enterprises has not only increased overall market demand but also, through their high-standard service requirements, prompted domestic enterprises to undertake technological upgrades and service model innovations. This "demand-driven" mechanism has compelled domestic enterprises to enhance their capabilities in response to higher market standards, thereby achieving "capability upgrading."

Additionally, the implementation of policies has facilitated technological diffusion and knowledge sharing within the region. The technical standards and management experience of foreign-invested enterprises have gradually spread to domestic enterprises through cooperation and competition, driving the overall improvement of the industry's technical standards. This technology spillover effect has further enhanced the innovation capabilities of domestic enterprises and promoted the overall development of the high-end service industry.

In summary, the free trade zone policy has significantly increased the scale and structure of market demand for the high-end service industry by relaxing restrictions on foreign investment and expanding cross-border service trade pilot programs. This expansion and structural optimization of market demand have compelled domestic enterprises to accelerate technological iteration and service model innovation, forming a virtuous cycle of "demand-driven capability upgrading." Through cooperation with international institutions, the technological innovation capabilities of domestic enterprises have been systematically enhanced, laying a solid foundation for the sustained innovative development of the high-end service industry. In the future, it is necessary to further deepen the free trade zone policy, optimize the institutional environment, and promote the high-end service industry to climb to higher value-added segments in the global value chain.

3.2. Strengthening Knowledge Spillover: Technology Collaboration Networks and Talent Mobility

As an important platform for institutional openness, the free trade zone has effectively promoted knowledge diffusion and enhanced technology spillover effects by attracting foreign-invested R&D centers, promoting international talent mobility, and building cross-border data sharing platforms.

Firstly, attracting foreign-invested R&D centers is a key measure for free trade zones to promote knowledge spillover. The entry of foreign-invested R&D centers not only brings cutting-edge international technologies and innovative concepts but also accelerates technological exchange and diffusion through collaboration with local enterprises. This collaborative model effectively enhances the technological capabilities and innovation capacity of local enterprises, driving the overall development of the high-end service industry.

Secondly, promoting international talent mobility is an important means for free trade zones to enhance their innovation capabilities. By optimizing talent recruitment policies, free trade zones have attracted more foreign R&D personnel

to participate in cross-border cooperation. These international talents have brought diverse innovative thinking and rich practical experience, not only improving the quality of cooperative projects but also directly driving the growth of total factor productivity in key technological fields.

Finally, building a cross-border data sharing platform is an important tool for the free trade zone to promote knowledge diffusion. By establishing a secure and efficient data sharing mechanism, the free trade zone has optimized the allocation and efficient utilization of data resources. The establishment of such a platform not only facilitates international information exchange and cooperation but also provides enterprises with richer data resources, thereby enhancing R&D efficiency and innovation capabilities.

In summary, the free trade zone has formed an efficient knowledge diffusion network by attracting foreign-invested R&D centers, promoting international talent mobility, and constructing cross-border data sharing platforms. This network has significantly enhanced the technological spillover effects of the high-end service industry, providing a solid institutional foundation and talent support for the industry's sustained innovative development.

3.3. Improving Information Efficiency: Digital Infrastructure and Cross-Border Data Flow

By strengthening digital infrastructure and piloting cross-border data flow, the free trade zone has effectively reduced information asymmetry and transaction costs, driving the innovative development of the high-end service industry. The improvement of digital infrastructure has provided stronger technical support for technology service enterprises, enabling them to respond more quickly to market demands. Specifically, digital infrastructure encompasses broadband networks, data centers, cloud computing platforms, and other aspects. The improvement of these facilities has significantly enhanced the speed and stability of data transmission, ensuring efficient operations for enterprises.

The pilot program for cross-border data circulation has further optimized supply chain collaboration efficiency. By establishing a secure and efficient data circulation mechanism, the free trade zone has achieved cross-border sharing and utilization of data resources. This data circulation mechanism not only promotes international information exchange but also provides enterprises with a broader market perspective and richer data resources, helping them make more precise decisions.

Improvements in information efficiency have also driven the transformation of innovative models in the high-end service industry. The industry has gradually shifted from the traditional "single-point breakthrough" model, where a single enterprise or research institution independently conducts technological innovation, to a "system-wide collaboration" model. Under this new model, multiple enterprises, research institutions, and government departments collaborate through information sharing and joint efforts to drive technological innovation and industrial upgrading. This collaborative effect significantly shortens the technology

transfer cycle and accelerates the process of bringing scientific and technological achievements from the laboratory to the market.

In addition, the improvement in information efficiency has also promoted the optimal allocation of resources. Through digital infrastructure and cross-border data circulation, companies can more accurately obtain market information and customer needs, thereby allocating resources more reasonably and improving resource utilization efficiency. This optimal allocation not only reduces operating costs for companies but also enhances the competitiveness of the entire industry.

In summary, by strengthening digital infrastructure construction and piloting cross-border data flow, the free trade zone has effectively improved information efficiency and reduced information asymmetry and transaction costs. This improvement has not only driven the transformation of high-end services from a "single-point breakthrough" to a "system-wide collaboration" innovation model but has also significantly shortened the technology conversion cycle, providing strong support for the industry's sustained innovative development.

3.4. Optimization of the Institutional Environment: Policy Iteration and Reduction of Friction Costs

Through dynamic adjustments to the negative list and the deepening of the "streamlining administration, delegating power, and improving services" reform, the free trade zone has significantly reduced institutional transaction costs, providing a more optimized institutional environment for the innovative development of high-end services. The dynamic adjustment mechanism of the negative list has made market access rules more transparent and flexible, reducing the uncertainty faced by enterprises in their investment and operations. This transparency and flexibility not only reduce compliance costs for enterprises but also enhance market vitality and attract more innovative resources.

The deepening of the "streamlining administration, delegating power, and improving services" reform has further simplified administrative approval processes, reducing the time and resource consumption for enterprises when handling various procedures. By optimizing government services, the free trade zone provides more efficient support for enterprise innovation activities (Su, 2016). For example, the digitization and automation of administrative approvals have significantly shortened approval cycles, enabling businesses to allocate resources more quickly to R&D and market expansion. This improved efficiency not only reduces operational costs but also enhances market competitiveness.

The introduction of regulatory sandbox mechanisms provides a testing ground for disruptive technologies. This mechanism allows businesses to test new technologies and business models in a controlled environment without immediately meeting all traditional regulatory requirements. This policy flexibility not only reduces the innovation risks for businesses but also provides policy support for the promotion and application of new technologies. Through this mechanism, businesses can more quickly convert innovative achievements into practical applica-

tions, accelerating the commercialization of technologies.

Additionally, the optimization of the institutional environment has promoted the efficient allocation of resources. By reducing institutional transaction costs, the free trade zone has attracted the aggregation of more innovative elements such as capital, technology, and talent. The aggregation of these elements not only enhances the innovation density within the region but also drives the innovative development of surrounding areas through knowledge spillover effects. This optimized allocation of resources further enhances the innovation attractiveness and competitiveness of the free trade zone.

In summary, through the dynamic adjustment of the negative list and the deepening of the "streamlining administration and delegating power" reform, the free trade zone has significantly reduced institutional transaction costs and provided a more optimized institutional environment for the innovative development of high-end services. The introduction of the regulatory sandbox mechanism has provided a testing ground for disruptive technologies, attracting more innovative resources to cluster. This optimized institutional environment not only improves corporate operational efficiency but also enhances the region's overall innovation capacity, providing a solid institutional foundation for the sustained innovative development of high-end services.

4. The Impact of Free Trade Zone Development on the Innovative Development of High-End Services

4.1. Model Specification and Data Description

To quantify the policy effects of free trade zones, the establishment of the Beijing Free Trade Zone in 2019 is treated as a quasi-natural experiment, and a difference-in-differences (DID) model is constructed:

$$Y_{it} = \alpha + \beta \cdot \left(\text{Treat}_i \times \text{Post}_t\right) + \gamma X_{it} + \mu_i + \lambda_t + \int_{it}$$

Data sources include the Beijing Statistical Yearbook, the China Science and Technology Statistical Yearbook, and the General Administration of Customs' Cross-Border Service Trade Database, covering the period from 2015 to 2024. Definitions of other variables are referenced in the preceding text, while the dependent variables—specialization agglomeration and diversification agglomeration—are defined as follows:

Specialization agglomeration: Measured using location entropy (LQ), reflecting regional industrial concentration, calculated as:

$$\text{LQ}_{ij} = \frac{E_{ij}/E_j}{E_i/E}$$

where E_{ij} is the number of employed persons in high-end service industry j in region i, and E_j is the national employment in industry j;

Diversification Agglomeration: Measured using the Herfindahl-Hirschman Index (HHI), calculated as:

$$\mathrm{HHI} = \sum_{j=1}^{N} s_j^2$$

where s_j is the share of value added in industry j, and a lower HHI indicates higher diversity.

Definitions and data sources for key variables:

Digital Infrastructure Index: A composite index measuring digital connectivity and computing capacity, constructed using principal component analysis (PCA) on indicators including 5G base station density, data center rack count, and industrial internet enterprise density. Data sources: Beijing Statistical Yearbook (2015-2024) and China Digital Economy Development Report.

R&D Intensity: Defined as the ratio of R&D expenditures to value-added in high-end service sectors, reflecting innovation input intensity (Table 1). Data sources: China Science and Technology Statistical Yearbook and Beijing Municipal Bureau of Statistics.

Table 1. Specialization agglomeration effects.

Variable	Coefficient	Standard Error	*P*-value	95%		Sample Size
Treat × Post	0.152***	0.032	0	0.089	0.215	180
R&D Intensity	0.045*	0.024	0.06	−0.002	0.092	180
Human Capital Density	0.067**	0.029	0.021	0.01	0.124	180
Digital Infrastructure Index	0.082***	0.025	0.001	0.033	0.131	180
Digital Infrastructure Index	Yes					
City Fixed Effect	Yes					
R-squared	0.78					

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Human Capital Density: Measured as the number of employees with a bachelor's degree or higher per 10,000 workers in high-end services. Data sources: Beijing Labor Statistical Yearbook and enterprise survey data from the Beijing Municipal Commerce Bureau.

4.2. Methods and Empirical Analysis

1) DID Model

Treatment Group. The treatment group consists of Beijing, as it is the only city in China with the dual policy advantages of the "National Comprehensive Demonstration Zone for Expanding Services Opening-up" and the "China (Beijing) Pilot Free Trade Zone". The policy shock is defined as the establishment of the Beijing Free Trade Zone in 2019.

Control Group. The control group includes other major cities with comparable economic and service sector development levels, specifically Shanghai, Shenzhen, Tianjin, and Hangzhou (Section 4.1). These cities were selected based on covariate

balance tests to ensure similarity in pre-policy trends of high-end service industry indicators.

Parallel-Trends Test. The parallel trends assumption was validated using an event study framework. Pre-policy (2015-2018) trends in total factor productivity (TFP) and industrial agglomeration indices between Beijing and the control group showed no statistically significant differences, confirming the validity of the DID identification strategy. A visual parallel-trends graph is provided in the supplementary appendix, illustrating aligned pre-policy trajectories.

2) Specialization Agglomeration Effect

As shown in Table 1, the coefficient of the policy variable (Treat × Post) is significantly positive, indicating that the free trade zone policy significantly promotes the specialization agglomeration of high-end services. Specifically, the coefficient of the policy variable is 0.152, indicating that the level of specialization agglomeration of high-end services in Beijing after the implementation of the policy is significantly higher than that of the control group. This result validates the effectiveness of the free trade zone policy in promoting industrial agglomeration.

Additionally, among the control variables, the positive effect of the digital infrastructure index is particularly prominent, indicating that the improvement of digital infrastructure significantly promotes the specialized agglomeration of high-end services. Research and development intensity and human capital density also exhibit certain promotional effects, further validating the importance of these factors in driving the innovative development of high-end services.

3) Diversification Agglomeration Effect

The results in Table 2 show that Beijing's industrial diversity has continued to improve since the establishment of the free trade zone, with the gap between Beijing and the control cities gradually widening. For example, Beijing's HHI was 0.45 in 2015 and decreased to 0.35 by 2024, indicating a significant improvement in industrial diversity. Compared with Shanghai, Tianjin, and Hebei, Beijing's policy effects were more pronounced, with the gap with Shanghai widening from −0.03 in 2015 to −0.045 in 2024.

Table 2. Diversification aggregation effects.

Year	Beijing HHI	Shanghai HHI	Tianjin HHI	Hebei HHI	Policy effects in Beijing	The gap between Beijing and Shanghai
2015	0.45	0.48	0.51	0.53	-	−0.03
2016	0.443	0.475	0.505	0.525	0.007	−0.032
2017	0.435	0.47	0.5	0.52	0.008	−0.035
2018	0.425	0.465	0.495	0.515	0.01	−0.04
2019	0.4	0.44	0.47	0.49	0.025	−0.04
2020	0.39	0.435	0.46	0.48	0.01	−0.045
2021	0.38	0.43	0.45	0.47	0.01	−0.05
2022	0.37	0.425	0.445	0.465	0.01	−0.055
2023	0.36	0.42	0.44	0.46	0.01	−0.06
2024	0.35	0.395	0.43	0.45	0.01	−0.045

4) Spatial Spillover Effects

Spatial weight matrix.

For Spatial Weight Matrix, the spatial weight matrix (W) was constructed based on economic distance, defined as the inverse of the squared GDP gap between Beijing and other regions, which prioritizes economic linkages over geographical proximity, as high-end service innovation spreads primarily through economic interactions rather than physical contiguity.

Robustness to Alternative Matrices: Supplementary robustness checks were conducted using two alternative matrices: 1) a geographical distance matrix, inverse of squared kilometers, and 2) a contiguity matrix,1 for adjacent regions, 0 otherwise. Results showed consistent significance of spatial spillover effects (indirect effect coefficient range: 0.16 - 0.20), confirming the stability of findings (Table 3).

Table 3. Robustness to alternative spatial weight matrices. (Dependent Variable: High-End Service TFP).

Spatial Weight Matrix Type	Baseline: Economic Distance Matrix	Alternative 1: Geographical Distance Matrix	Alternative 2: Contiguity Matrix
Direct Effect	0.12**	0.11**	0.10*
Standard Error	0.05	0.05	0.06
P-value	0.015	0.028	0.072
Indirect Effect	0.18***	0.16***	0.20***
Standard Error	0.04	0.05	0.06
P-value	0	0.001	0.001
Total Effect	0.30***	0.27***	0.30***
Standard Error	0.06	0.07	0.08
P-value	0	0	0

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level. The economic distance matrix (baseline) is defined as the inverse of squared GDP gaps; the geographical distance matrix uses inverse squared kilometers; the contiguity matrix assigns 1 to adjacent regions and 0 otherwise. Consistent significance of direct, indirect, and total effects across matrices confirms robustness of spatial spillover findings.

Spatial spillover effects.

As shown in Table 4, the free trade zone policy generates spatial spillover effects through both direct and indirect channels, and the total effect is significantly positive. Specifically, the coefficient of the direct effect is 0.12, indicating that the policy significantly enhances regional innovation capacity through direct channels. The coefficient of the indirect effect is 0.18, indicating that the policy further promotes regional innovation development through spatial spillover effects. The total effect is 0.30, indicating that the comprehensive effect of the policy is significantly positive.

Table 4. Spatial spillover effects.

Effect type	Indirect effect	Standard error	Standard error
Direct effect	0.12**	0.05	0.015
Indirect effect	0.18***	0.04	0
Indirect effect	0.03	0.07	0

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

4.3. Heterogeneity Analysis

Table 5 further indicates that the policy effects are more pronounced in foreign-invested areas, while the effects in traditional service areas are relatively limited. For example, the TFP coefficient in foreign-invested areas is 0.253, while the TFP coefficient in traditional service areas is only 0.078. This suggests that foreign-invested areas benefit more from the release of policy dividends, while the effects in traditional service areas are relatively limited. The results of the difference test further validate the industry heterogeneity of policy effects.

Table 5. Industry heterogeneity analysis.

Group	TFP Coefficient	TFP Standard Error	Patent Coefficient	Patent Coefficient	*P*-value
Foreign-Investment-Intensive Area	0.253***	0.042	0.18***	0.03	0.018
Foreign-Investment-Intensive Area	0.078	0.051	−0.027	0.038	0.482
Difference Test χ^2	25.31***	-	18.72***	-	0

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

4.4. Robustness Tests

Table 6. Robustness tests.

Test Method	Treat × Post Coefficient	Standard Deviation	*P*-value	Alternative Indicator Results
Alternative Indicator Results	0.152***	0.032	0	
PSM Matching	0.146***	0.035	0	LQ = 0.141***
Replace Cluster Hierarchy	0.149***	0.028	0	
Replace Cluster Hierarchy	0.011	0.025	0.659	

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

The robustness of the baseline regression results was verified using various methods, including PSM matching, changing the clustering level, and placebo tests. As

shown in Table 6, the coefficient of the policy variable is 0.146, consistent with the results of the baseline model. The results after changing the clustering level also show that the coefficient of the policy variable is 0.149. The placebo test results indicate that the coefficient of the policy variable is only 0.011, suggesting that the benchmark regression results exhibit high robustness.

4.5. Policy Selection Bias

For possible policy selection bias, since Beijing's status as a pilot free trade zone is non-random, as it was chosen for its advanced service sector and institutional innovation capacity, it potentially introduces selection bias.

Mitigation Strategies: To address this, we employed Propensity Score Matching (PSM) to balance observable characteristics, e.g., initial TFP, service sector size between Beijing and control cities. The PSM-DID results (policy coefficient = 0.146, ***P < 0.01) were consistent with the baseline DID findings, partially alleviating bias. However, unobservable factors, e.g., unmeasured policy support, may still persist, which is acknowledged as a limitation.

5. Research Findings

This paper draws the following conclusions through systematic theoretical and empirical analysis:

First, the free trade zone has significantly promoted the innovative development of Beijing's high-end service industry through four major mechanisms: demand expansion, knowledge spillover, efficiency improvement, and institutional optimization. The demand expansion mechanism has significantly increased the scale and structure of the market demand for high-end services by relaxing foreign investment access restrictions and expanding cross-border service trade pilot programs. This expansion of demand has not only created more business opportunities but also prompted enterprises to continuously improve service quality to meet the high standards of international markets. The knowledge spillover mechanism has formed an efficient knowledge diffusion network by attracting foreign-invested R&D centers, promoting international talent mobility, and establishing cross-border data sharing platforms. The formation of this network has facilitated technological exchange and diffusion, enhancing the technological capabilities and innovation capacity of domestic enterprises. The efficiency enhancement mechanism has effectively reduced information asymmetry and transaction costs by strengthening digital infrastructure and piloting cross-border data flows. This efficiency improvement has not only driven the transformation of the high-end service industry from a "single-point breakthrough" to a "system-wide collaboration" innovation model but has also significantly shortened the technology conversion cycle. The institutional optimization mechanism has significantly reduced institutional transaction costs through dynamic adjustments to the negative list and the deepening of "streamlining administration and delegating power" reforms. This optimization provides more efficient support for corporate innova-

tion activities and attracts the aggregation of more innovative resources.

Second, the policy effects manifest as enhanced specialization, improved industrial diversity, and significant spatial spillover effects. The enhancement of specialization indicates that the policy has effectively promoted the concentrated development of high-end services, enhancing the competitiveness of the industry. The improvement in industrial diversity shows that the policy has promoted development across different sectors, enhancing the stability of the regional economy. The significant spatial spillover effects indicate that the policy has not only generated positive impacts within Beijing but has also driven innovative development in surrounding regions through inter-regional economic linkages and knowledge spillover effects.

Third, an analysis of industry heterogeneity reveals that policy benefits are more pronounced in areas with a high concentration of foreign investment. This suggests that the effectiveness of policy implementation may vary depending on regional characteristics, necessitating the adoption of targeted policy design to narrow regional disparities. Areas with a high concentration of foreign investment can more effectively absorb the spillover effects of foreign technology, thereby significantly enhancing total factor productivity and technological innovation capabilities. In contrast, traditional service areas, with lower densities of foreign-invested enterprises, exhibit relatively weaker policy effects. This underscores the need for policy design to consider regional characteristics to ensure the full realization of policy benefits.

Finally, future efforts should focus on deepening institutional openness, leveraging digital infrastructure, and optimizing spatial layout to build an open and innovative ecosystem for high-end services. Deepening institutional openness requires the formulation of differentiated policies tailored to regional and industry characteristics to enhance policy targeting and effectiveness. Empowering digital infrastructure requires further strengthening digital infrastructure construction to achieve efficient inter-regional connectivity and facilitate rapid data transmission and processing. Optimizing spatial layout requires establishing regional cooperation platforms and improving policy coordination mechanisms to ensure inter-regional resource sharing and technological exchange, thereby enhancing the overall innovation capacity and competitiveness of the region.

In summary, the free trade zone has significantly promoted the innovative development of Beijing's high-end services sector through four mechanisms: demand expansion, knowledge spillover, efficiency improvement, and institutional optimization. Policy effects manifest as enhanced specialization and clustering, increased industrial diversity, and significant spatial spillover effects. Industry heterogeneity analysis reveals that policy benefits are more pronounced in areas with high concentrations of foreign investment. Moving forward, it is necessary to deepen institutional openness, leverage digital infrastructure, and optimize spatial layout to build an open and innovative ecosystem for the high-end service industry, driving the sustained prosperity and innovative development of the re-

gional economy.

6. Policy Implications

6.1. Deepening Institutional Opening-Up

1) Dynamically Optimizing the Negative List

Dynamically optimizing the negative list is an important policy tool for promoting regional economic opening-up and industrial upgrading. By focusing on relaxing cross-border restrictions in cutting-edge technology fields, more foreign-invested enterprises can be attracted to settle in the region, leveraging the spillover effects of technology to drive the innovative development of local enterprises, thereby achieving high-quality regional economic development.

First, dynamically optimizing the negative list enhances the flexibility and adaptability of policies. As science and technology rapidly develop and market demands evolve, timely adjustments to the negative list ensure that policies align with current economic conditions. This flexibility not only facilitates foreign investment but also creates a more open and competitive market environment for local enterprises.

Second, optimizing the negative list can significantly enhance the technology spillover effect. The entry of foreign-invested enterprises brings advanced technology and management experience, which are disseminated to local enterprises through cooperation, demonstration, and competition, promoting technological upgrading and enhancing the innovation capabilities of local enterprises. This technology diffusion effect is of great significance for promoting industrial upgrading and enhancing regional competitiveness.

Third, adjusting the negative list can help optimize resource allocation within the region. By lifting cross-border restrictions in cutting-edge technology fields, more foreign investment can be attracted into these areas, filling gaps in local technology and industries. This not only helps to enhance the overall technological level of the region but also drives the coordinated development of related industrial chains, forming an industrial cluster effect.

Additionally, dynamically optimizing the negative list can enhance the region's international competitiveness. By lowering the barriers to entry for foreign investment, the region can attract more internationally renowned enterprises and high-end talent, enhancing its reputation and influence. This agglomeration effect helps create an international business environment, attracting more foreign investment and advanced technologies.

Meanwhile, adjustments to the negative list can also promote market competition within the region. The entry of foreign-invested enterprises increases market competition pressure, prompting local enterprises to continuously improve their technological capabilities and management skills. This competition not only enhances market efficiency but also drives technological progress and industrial upgrading across the entire industry.

Finally, the dynamic optimization of the negative list provides policy safeguards

for the sustainable development of the regional economy. By continuously adjusting and optimizing the negative list, the continuity and stability of policies can be ensured, providing foreign-invested enterprises with a predictable policy environment. This stability helps enhance investor confidence and promotes the long-term stable development of the regional economy.

In summary, the dynamic optimization of the negative list attracts more foreign-invested enterprises by focusing on relaxing cross-border restrictions in cutting-edge technology fields, leveraging the spillover effects of technology to drive the innovative development of local enterprises. This policy tool not only enhances the region's international competitiveness and resource allocation efficiency but also provides strong support for the high-quality development of the regional economy.

2) Pilot "Technology Export Bonded Zone"

The pilot "Technology Export Bonded Zone" is an important policy tool for enhancing the international competitiveness of technology exports. Through tax incentives and bonded policies, the costs of technology exports can be significantly reduced, promoting the commercialization and internationalization of technological achievements.

First, tax incentive policies can effectively alleviate the economic burden on enterprises. Technology export enterprises typically face high R&D costs and market promotion pressures. By implementing tax incentives such as tariff exemptions and value-added tax reductions, enterprises can allocate more resources to technological R&D and market expansion. This policy support not only enhances the international competitiveness of enterprises but also strengthens their bargaining power in international markets.

Second, bonded policies simplify the process of technology exports. By establishing bonded zones, enterprises can conduct technology development, testing, and transactions within the zones without immediately paying tariffs or other taxes. This mechanism provides enterprises with a more flexible operational environment, reducing the time and costs associated with cross-border technology transactions. Additionally, the regulatory environment within bonded zones is relatively lenient, enabling enterprises to collaborate more efficiently with international partners and accelerate the commercialization of technological achievements.

In addition, the establishment of a technology export bonded zone can attract more international resources and talent. The policy advantages of the bonded zone have not only attracted domestic enterprises to participate in technology exports but also attracted international enterprises and research institutions to settle there. This agglomeration effect has promoted technological exchange and cooperation, advanced the internationalization of technical standards, and further enhanced the region's technological innovation capabilities.

The policies of the technology export bonded zone also promote the commercialization of technological achievements. By optimizing tax and bonded policies,

enterprises can more efficiently convert technological achievements into practical applications, shortening the cycle from R&D to market promotion. This not only improves the conversion rate of technological achievements but also enhances the vitality and attractiveness of the technology market.

Finally, this policy mechanism helps build a more open technological innovation ecosystem. By reducing the institutional costs of technology exports, the bonded zone facilitates cross-border technology flows and international cooperation. This open innovation environment not only promotes the widespread application of technology but also injects new momentum into the high-quality development of the regional economy.

In summary, the pilot "technology export bonded zone" significantly enhances the international competitiveness of technology exports and promotes the commercialization and internationalization of technological achievements through tax incentives and bonded policies. This policy mechanism not only provides enterprises with a more favorable innovation environment but also drives the high-quality development of the regional economy and technological progress.

6.2. Strengthening Digital-Institutional Synergy

1) Building Cross-Regional Data Infrastructure

Building a cross-regional data infrastructure is an important measure for promoting digital economic development. By promoting the sharing of computing resources and optimizing the allocation of digital resources between regions, the coverage and efficiency of digital services can be significantly improved.

First, the sharing of computing resources is key to achieving efficient data processing. By constructing cross-regional data centers and computing platforms, computing resources can be reasonably allocated and efficiently utilized. This sharing mechanism not only reduces operational costs for enterprises but also improves resource utilization efficiency, avoiding duplicate construction and resource waste.

Second, optimizing the allocation of digital resources across regions is the foundation for enhancing overall digital service levels. Through coordinated planning and coordination, ensuring that digital infrastructure construction in different regions aligns with local actual needs can break geographical barriers, promote the flow and sharing of digital resources, and enhance inter-regional synergy effects.

In addition, expanding the coverage and efficiency of digital services is an important goal for achieving digital inclusion. By constructing high-speed network connectivity channels and edge computing nodes, data can be transmitted and processed quickly. This not only meets the needs of urban central areas but also extends digital services to remote and ecologically sensitive regions, narrowing the service gap between regions.

The construction of cross-regional data infrastructure also promotes economic ties and cooperation between regions. Through data sharing and collaborative work, enterprises and institutions in different regions can better integrate re-

sources and engage in joint research and development and innovation activities. Such cooperation not only enhances the overall innovation capacity of the region but also drives the coordinated development of related industrial chains.

At the same time, the construction of such infrastructure helps to enhance the digital governance capabilities of the region. By establishing a unified data management and analysis platform, government departments can make decisions and conduct supervision more effectively, improving the quality and efficiency of public services. This helps to build a smarter and more efficient digital government, enhancing the overall competitiveness of the region.

In summary, the construction of cross-regional data infrastructure provides a solid foundation for the development of the digital economy by promoting the sharing of computing resources, optimizing the allocation of digital resources, and improving the coverage and efficiency of digital services. This infrastructure not only promotes balanced development between regions but also enhances the overall level of digitalization, providing strong support for the sustainable development of the economy and society.

2) Establishing a "Digital Regulatory Sandbox"

Establishing a "digital regulatory sandbox" is an important measure to promote technological innovation and industrial upgrading. The digital regulatory sandbox provides a testing environment for cutting-edge technologies, effectively reducing the trial-and-error costs for innovative enterprises and facilitating the rapid conversion of technological achievements.

The core of the digital regulatory sandbox is to provide innovative enterprises with a relatively relaxed yet controlled testing environment. In this environment, companies can test new technologies, business models, and products without being fully constrained by traditional regulatory frameworks. This mechanism allows companies to identify potential issues at an early stage, optimize technical solutions, thereby reducing innovation risks and costs.

By providing a safe testing environment, the Digital Regulatory Sandbox helps accelerate the process of transforming technology from the laboratory to the market. Companies can validate the feasibility and market potential of technologies in real-world application scenarios and promptly adjust their R&D directions and business models. This rapid iteration and verification mechanism significantly shortens the technology conversion cycle and improves innovation efficiency.

Additionally, the digital regulatory sandbox promotes interaction and cooperation between regulatory authorities and innovative companies. Regulatory authorities can better understand the characteristics and risks of new technologies through the sandbox mechanism and formulate more precise and effective regulatory policies. This cooperation not only helps reduce companies' compliance costs but also enhances the adaptability and flexibility of regulation.

The establishment of the digital regulatory sandbox also promotes the formulation and improvement of technical standards. In the sandbox environment, companies can explore the boundaries of technology application and provide practical

basis for the formulation of industry standards. The formulation of such standards helps to standardize market order and promote the widespread application and promotion of technology.

At the same time, the digital regulatory sandbox provides a unified testing platform for technological innovation in different fields. The establishment of such a platform helps to break down industry barriers and promote cross-industry technological integration and innovation. For example, in fields such as fintech, medtech, and green tech, the sandbox mechanism can support the collaborative innovation of multiple technologies and drive the development of emerging industries.

In summary, the establishment of a "digital regulatory sandbox" provides strong support for the development of cutting-edge technologies by offering a testing environment, reducing trial-and-error costs, and promoting technology conversion. This mechanism not only helps enhance the innovation capabilities of enterprises but also promotes the modernization of the regulatory system, creating a favorable policy environment for technological innovation and industrial upgrading.

6.3. Optimizing Spatial Layout

1) Promoting Regional Coordination and Development through the "Innovation Enclave" Model

Promoting regional coordination and development through the "innovation enclave" model is an important strategy for achieving balanced development between regions. Deploying edge computing nodes in ecologically sensitive areas and remote regions can effectively enhance the coverage and efficiency of digital services, thereby driving balanced development between regions.

The "innovation enclave" model introduces advanced technologies and management experiences to remote regions by establishing innovation nodes there, thereby promoting local economic development. This model not only breaks geographical barriers but also optimizes resource allocation, enhancing the overall innovation capacity of the region. The deployment of edge computing nodes further enhances the effectiveness of this model. Edge computing nodes can process data locally, reducing data transmission distance and time, and improving service efficiency. The application of this technology enables enterprises and residents in remote areas to enjoy digital services at the same level as urban centers, narrowing the service gap between regions.

Additionally, the "innovation enclave" model promotes resource sharing and technological exchange between regions. This model breaks through traditional administrative boundaries, enabling enterprises, research institutions, and government departments from different regions to collaborate more closely. Such cooperation not only enhances the overall innovation capacity of the region but also drives the economic development of surrounding areas, forming a virtuous cycle of regional coordinated development.

At the same time, this model also helps to improve the digitalization level of

remote areas. By introducing advanced digital technologies and management experience, enterprises in remote areas can better adapt to market demands and enhance their competitiveness. This digital transformation not only promotes local economic development but also provides new impetus for balanced development between regions.

In summary, promoting regional coordinated development through the "innovation enclave" model can effectively expand the coverage and efficiency of digital services, driving balanced development across regions. This model not only breaks geographical barriers but also optimizes resource allocation, enhances the region's overall innovation capacity, and provides strong support for the sustainable development of the regional economy.

2) Exploring Integration Pathways for Green Service Trade and Carbon Credit Trading

Exploring integration pathways for green service trade and carbon credit trading is an important measure for promoting regional sustainable development. Through policy guidance, green technological innovation and application can be effectively promoted, thereby enhancing the overall sustainable development capacity of the region.

Policy guidance plays a crucial role in promoting green technological innovation and application. Governments can establish incentive policies, such as tax incentives, fiscal subsidies, and special funds, to encourage enterprises to increase their investment in green technology research and development. Support green technology enterprises in conducting technological breakthroughs in key areas, overcoming core green technologies, and cultivating green technology innovation enterprises and green low-carbon technology enterprises. These policies not only stimulate the innovative vitality of enterprises but also promote the market application of green technologies and drive the development of the green industry.

The integration of green service trade and carbon credit trading is an important pathway to achieving regional sustainable development. By innovating the "service trade + ecological carbon sink" model, the development of green service trade can be promoted. Establishing a green technology trading market can facilitate the transfer and conversion of green technologies, enhancing their market competitiveness. Additionally, through carbon credit trading mechanisms, enterprises can be incentivized to reduce carbon emissions in production and service processes, driving green and low-carbon development.

Enhancing regional sustainable development capacity requires a multi-faceted approach. Optimizing industrial structure is key, including promoting the green and low-carbon transformation and upgrading of traditional industries, accelerating the development of strategic emerging industries, and building a modern industrial system that is green and low-carbon. Promoting an energy revolution, strengthening the clean and efficient use of fossil fuels, vigorously developing non-fossil energy sources, accelerating the construction of a new power system, reducing dependence on fossil fuels, and increasing the proportion of clean energy.

Strengthening ecological and environmental protection, advancing ecological civilization construction, implementing ecological protection and restoration projects, and improving the quality and stability of ecosystems.

Regional cooperation and coordinated development are important means to enhance regional sustainable development capacity. Establishing effective cooperation mechanisms and platforms to promote resource sharing, information exchange, and mutually beneficial cooperation among regions is essential. In the field of green technology, cross-regional cooperation should be leveraged to jointly conduct green technology research and development and international standard cooperation, thereby facilitating the development of green service trade. Through these comprehensive measures, the overall sustainable development capacity of the region can be effectively enhanced, achieving coordinated development of the economy, society, and environment.

7. Conclusion

This paper systematically examines the mechanisms and effects of free trade zone policies on the innovative development of Beijing's high-end service industry through theoretical and empirical analysis. The study found that free trade zones have significantly promoted the innovative development of high-end services through policy tools such as dynamically optimizing negative lists, building cross-regional data infrastructure, establishing "digital regulatory sandboxes," and piloting "technology export bonded zones." These policies have not only enhanced the region's technological capabilities and innovation capacity but also promoted balanced development among regions and strengthened international competitiveness.

In the future, efforts should continue to deepen the implementation of free trade zone policies, optimize the institutional environment, and drive the upgrading of high-end services toward higher-value-added segments in the global value chain. Specifically, the negative list should be dynamically adjusted on an ongoing basis to further relax cross-border restrictions in cutting-edge technology fields, attract more foreign-invested enterprises to establish operations, and leverage technology spillover effects to stimulate innovation and development among local enterprises. Concurrently, cross-regional data infrastructure should be strengthened to optimize the allocation of digital resources and enhance the coverage and efficiency of digital services. Furthermore, the "digital regulatory sandbox" mechanism should be utilized to provide testing environments for cutting-edge technologies, reduce the trial-and-error costs for innovative enterprises, and facilitate the rapid commercialization of technological achievements. In addition, piloting "technology export bonded zones" through tax incentives and bonded policies can enhance the international competitiveness of technology exports and promote the marketization and internationalization of technological achievements. Finally, the current study already includes heterogeneity analysis, showing stronger policy effects in foreign-invested intensive areas compared to traditional service areas. To

further explore geographical and sectoral heterogeneity, future extensions could: Include comparative case studies of free trade zones in other regions to contrast policy mechanisms. And high-end services could be disaggregated into sub-sectors using firm-level data to identify sector-specific policy responses, leveraging datasets like the Beijing High-Tech Enterprise Directory.

Through the continuous optimization and implementation of these policies, Beijing's high-end service industry can further enhance its innovation capabilities and international competitiveness, providing strong support for the high-quality development of the regional economy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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