

The Policy Benefits and Mechanisms of Service Sector Liberalization on the Innovative Development of Beijing's High-End Service Industry

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Abstract

Based on panel data from Beijing, this study employs a combination of the difference-in-differences (DID) method and the synthetic control method (SCM) to construct a counterfactual analysis framework, empirically testing the policy benefits of service sector liberalization and its underlying mechanisms. The findings indicate: First, the policy dividend effect is significant, with the expansion of service sector openness positively enhancing the total factor productivity (TFP) and international patent grant density of Beijing's high-end service sector. The policy effect exhibits a sustained cumulative characteristic, with the gap between the actual TFP value and the synthetic control value gradually widening over time; Second, the policy drives innovation through three mechanisms: technology spillovers, institutional coordination, and spatial restructuring; Third, digital infrastructure plays a significant moderating role, with its amplifying effect on policy efficacy gradually strengthening and its contribution rate steadily increasing over time; Fourth, regional heterogeneity is pronounced, with foreign-invested areas showing significantly higher increases in TFP than traditional service areas. Based on the above findings, this paper proposes a four-dimensional optimization path of "differentiated opening-up, digital infrastructure networking, dynamic policy iteration, and regional institutional coordination" to provide policy references for building an open innovation ecosystem.

Keywords

Expansion of Service Sector Opening-Up, High-End Services, Policy Dividends, Digital Infrastructure, Innovation Value Chain

1. Introduction

Against the backdrop of the deep restructuring of global value chains, high-end services—with their high intellectual intensity, strong industrial interconnectivity, and high value-added creation capabilities (Li, 2024)—have become the core vehicle for reshaping national competitive advantages. As the only city in China to simultaneously implement the “National Comprehensive Demonstration Zone for Expanding Services Sector Opening-Up” and “Free Trade Pilot Zone” policies, Beijing has successfully attracted the aggregation of international institutions through multiple pioneering institutional innovations (such as cross-border data white lists and equity trust registration), driving the rapid growth of core digital economy industries and significantly increasing the contribution rate of the information services sector to regional GDP.

However, the innovative development of Beijing’s high-end service industry still faces three structural contradictions: first, an imbalance in the innovation chain, with knowledge condensation efficiency significantly higher than market conversion efficiency, and a prominent bottleneck in the conversion of technological achievements into industrial value; second, regional development disparities, with significant gaps in total factor productivity levels across different regions and uneven release of policy dividend space; third, mismatched digital infrastructure, with insufficient coverage of forward-looking facilities and room for improvement in the compatibility of computing resources with scenario demands. Against this backdrop, scientifically quantifying the policy effects of expanding the opening-up of the service sector and systematically analyzing its mechanisms of action are of critical practical urgency for addressing the bottlenecks in the innovative development of the high-end service sector.

The value of this study is reflected in three dimensions: first, in terms of theoretical value, it breaks through the limitations of existing research that “emphasizes qualitative analysis over quantitative analysis” (Wei & Li, 2018), constructing a “policy-technology-space” three-dimensional mechanism model, deepening the theoretical implications of institutional openness for innovation-driven development; second, in terms of policy value, it provides empirical evidence for the formulation of precise policies such as dynamically adjusting the negative list for foreign investment access and establishing technology transaction bonded zones; third, in terms of practical value, it guides enterprises to optimize the allocation of innovation resources, such as reducing the marginal cost of technology conversion through digital infrastructure networks.

2. Literature Review

2.1. Theoretical Framework for Innovation in High-End Services

1) Evolution of Conceptual Framework and Measurement Methods

The conceptual framework of high-end services has evolved from the early “five high characteristics”, such as high intellectual intensity, high value-added, high industrial driving force, high openness, and low resource consumption (Du, 2007),

to the “innovation intermediary function” (Muller, 2021), emphasizing its core role in knowledge transfer and re-creation. In terms of measurement methods, existing research suffers from the flaw of relying solely on GDP share as a metric (Wu, 2020), necessitating the development of a multi-dimensional evaluation system that integrates international competitiveness, green development, and chain innovation efficiency (Wong, 2024).

2) Innovation-Driven Mechanisms

Innovation in high-end services is driven by both policy and market forces: tax incentives reduce innovation costs and strengthen industrial agglomeration effects (Zhang, 2023), while open competition drives service capability upgrades (Zhang et al., 2025). Additionally, digital technology significantly empowers industrial transformation, with increases in computing power clearly driving growth in patent authorizations (Liu, 2023). Spatial restructuring effects should also not be overlooked, as the specialized clustering of high-end services enhances regional collaborative innovation levels through knowledge spillovers (Sun & Tang, 2022; Glaeser, 2020).

2.2. Policy Effects of Expanding Service Sector Opening-Up

Existing research has identified two core pathways through which expanding service sector opening-up drives innovation: First, reducing institutional costs, with the “negative list + pre-establishment national treatment” model lowering barriers to foreign investment access (Teng & Shen, 2014), and regulatory sandbox mechanisms providing a trial-and-error space for the application of disruptive technologies; Second, optimizing factor allocation, cross-border data flow pilots enhance supply chain response efficiency (Li & Han, 2021), and international talent mobility facilitates the transfer of tacit knowledge (Yang & Du, 2021). Among these, the institutional design of cross-border data flow has a particularly significant impact on enhancing innovation outcomes in high-knowledge-intensive services (Foster, 2022).

Current studies have three limitations. First, there is a “black box” in the analysis of mechanisms, and there is a lack of quantitative testing of the synergistic effects of “policy-digital-space”; Second, the evaluation methods are single-dimensional and ignore the phased contributions of policy dividends; Third, there is insufficient adaptation to the Beijing context, failing to incorporate the policy characteristics of the “Two Zones” in designing a localized analytical framework (Li et al., 2023).

The study focus on the following aspects: first, the construction of a DID-SCM counterfactual analysis framework to precisely separate the net effects of policies; second, the proposal of a triple mechanism model of technological spillover, institutional synergy, and spatial restructuring to quantify the regulatory role of digital infrastructure; third, the innovation of a value chain efficiency decomposition method (DEA-SBM two-stage model) to diagnose the structural contradiction of “emphasizing R&D while neglecting conversion.”

3. Counterfactual Quantitative Assessment of Policy Benefits

3.1. Theoretical and Methodological Design

To scientifically assess the policy effects of expanding openness in the service sector on the innovative development of Beijing's high-end service industry, this study draws on Yang et al. (2025) and employs a combination of the difference-in-differences (DID) method and the synthetic control method (SCM) to construct a counterfactual analysis framework. By leveraging the complementary advantages of these two methods, the study enhances the robustness of its conclusions. As a classic identification strategy for quasi-natural experiments, the DID method compares the differences in high-end service industry innovation and development between the experimental group (Beijing) and the control group (other comparable cities) before and after policy implementation, effectively controlling for time trends and regional heterogeneity interference. The core of this method lies in satisfying the parallel trends assumption, which states that the development trends of the experimental group and control group should remain fundamentally consistent before policy implementation. To ensure this premise holds, this study uses event study methods to plot parallel trend test graphs and employs covariate balance tests to select the optimal control group cities. The basic econometric equation is as follows:

$$Y_{it} = \alpha + \beta_1 \text{Treat}_i \cdot \text{Post}_t + \beta_2 X_{it} + \mu_i + \lambda_t + \epsilon_{it}$$

Data sources encompass multi-dimensional information from statistical yearbooks, international patent databases, and negative lists for foreign investment access, ensuring the authority and comprehensiveness of the research's foundational data. Among these, Y is the core dependent variable; Treat denotes the experimental group's dummy variable, Post represents the policy time dummy variable, and X constitutes the set of control variables. Detailed definitions and measurement methods are outlined in **Table 1**:

Table 1. Variable definitions.

Variable	Definition
Y	Includes total factor productivity (TFP) in high-end services and international patent authorization density
Treat	Includes total factor productivity (TFP) in high-end services and international patent authorization density
Post	Year of policy implementation (before 2015 = 0, 2015 and after = 1)
X	Set of control variables (including R&D intensity, human capital density, and digital infrastructure index)
Ind	CSRC industry code from 2012; two-digit codes for manufacturing, and broad categories for other industries
Year	Year to which the observation belongs

The synthetic control method constructs a “virtual Beijing” through an optimization algorithm, with the objective function being:

$$\min_w \sum_{t=2010}^{2014} \left(Y_{Beijing,t} - \sum_j w_j Y_{j,t} \right)^2$$

where w_j is the weight of the control group city, satisfying $w_j \geq 0$ and $\sum w_j = 1$.

This method can simulate the potential development path of Beijing’s high-end service industry in the absence of policy intervention, thereby isolating the net policy effect.

And, to address the reproducibility of the dependent variable (total factor productivity, TFP) in high-end services, we clarify the computation method and data sources as follows:

TFP Calculation Formula: We adopted the Solow residual approach, a widely used method in productivity analysis, to estimate TFP. The production function is specified as:

$$TFP_{it} = \frac{Y_{it}}{K_{it}^\alpha L_{it}^\beta}$$

where Y_{it} denotes output, measured by value-added of high-end service sectors; K_{it}^α is capital input, measured by fixed-asset investment; L_{it}^β is labor input, measured by employed persons; and α and β are capital and labor elasticities, respectively. Elasticities were estimated using ordinary least squares (OLS) regression on the log-transformed production function, with $\alpha = 0.45$ and $\beta = 0.4$.

Data Sources. Output: Y_{it} is the value-added of high-end service sectors, including information transmission, software, technology services, etc., from the Beijing Statistical Yearbook (2015-2024). Capital input K_{it} : Fixed-asset investment in high-end services from the China Service Industry Statistical Yearbook. Labor input L_{it} : Number of employees in high-end service sectors from the Beijing Economic and Social Development Statistical Bulletin. These data are publicly available and widely used in regional productivity studies, ensuring transparency and reproducibility.

For data using, While aggregate city-level data was used in this study, its rationale and potential for refinement are noted: Rationale for Aggregate Data is that City-level data ensures coverage of the entire high-end service sector, encompassing sub-sectors like fintech, digital trade, and R&D services, and aligns with the study’s focus on macro policy effects, service sector liberalization is a city-wide policy in Beijing. It also avoids selection bias from incomplete firm-level datasets. Firm-level data from the Beijing Administration for Industry and Commerce Enterprise Registration Database, as well as the State Administration of Taxation VAT Invoice Data, are incorporated in the study.

3.2. Empirical Results Analysis

1) Regression Results Analysis Using the Difference-in-Differences Method

As shown in **Table 2**, the coefficient of the policy variable (Treat \times Post) is significantly positive, indicating that the policy of expanding openness in the service

industry has a statistically significant promotional effect on the innovative development of the high-end service industry. Specifically, the policy variable has a significant positive effect on total factor productivity (TFP). This indicates that Beijing's TFP is significantly higher than that of the control group after the policy implementation. This result not only validates the effectiveness of the policy but also highlights the important role of policy dividends in driving technological progress.

Further analysis of the impact of control variables reveals that the intensity of R&D investment has a significant positive effect on TFP. This indicates that increasing R&D investment is one of the key factors driving the innovative development of high-end services. Additionally, the digital infrastructure index has a particularly significant positive effect on TFP, further emphasizing the importance of digital infrastructure in technological progress. Human capital density also exhibits a certain promotional effect, indicating that the concentration of high-quality talent has a positive impact on innovative development.

In terms of international patent authorization density, the coefficient of the policy variable is 0.087, indicating that Beijing's patent authorization density is significantly higher than that of the control group after the implementation of the policy. This result reveals the positive role of the policy in promoting technological innovation and intellectual property protection. Among the control variables, R&D intensity and the digital infrastructure index also exhibit significance, further validating the importance of these factors in driving innovative development.

Table 2. Double difference (DID) regression results.

Variable	TFP coefficient	TFP standard error	<i>p</i> -value	95%		Patent density coefficient	Patent density standard error	<i>p</i> -value	95%	
Treat × Post	0.152***	0.032	0.000	0.089	0.215	0.087	0.021***	0.000	0.046	0.128
R&D intensity	0.045*	0.024	0.060	-0.002	0.092	0.062	0.018***	0.001	0.027	0.097
Human capital density	0.067**	0.029	0.021	0.010	0.124			-	-	-
Digital infrastructure index	0.082***	0.025	0.025	0.033	0.131			-	-	-
Observations	180					180				
Year fix effects	Yes					Yes				
City fix effects	Yes					Yes				
R-squared	0.78					0.71				

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

2) Analysis of Counterfactual Comparison Results Using the Synthetic Control Method

The results in **Table 3** further validate the promotional effect of the policy. After the policy was implemented, Beijing's actual development level remained consistently higher than the simulated path of the synthetic control group, with the gap widening year by year. For example, in 2015, Beijing's actual TFP was 1.35, while the synthetic TFP was 1.22, with a gap of 0.13; by 2024, the actual TFP was 1.82, while the synthetic TFP was 1.53, with the gap widening to 0.29. This trend indicates that the policy dividends have a sustained and cumulative promotional effect on the innovative development of Beijing's high-end service industry.

The gap in patent density also exhibits a similar trend. In 2015, Beijing's actual patent density was 18.6, while the synthetic patent density was 16.2, with a gap of 2.4; by 2024, the actual patent density is projected to reach 42.3, while the synthetic patent density is expected to be 27.9, with the gap widening to 14.4. This indicates that policies not only promote technological innovation in the short term but also sustainably drive the accumulation and conversion of technological achievements in the long term.

Table 3. Counterfactual comparison using the synthetic control method (SCM).

Year	Actual TFP	Synthetic TFP	TFP Gap	Patent Density	Synthetic Patent Density	Patent Density Gap
2015	1.35	1.22	0.13	18.6	16.2	2.4
2016	1.42	1.27	0.15	21.3	17.8	3.5
2017	1.49	1.33	0.16	24.8	19.5	5.3
2018	1.55	1.38	0.17	28.4	21.1	7.3
2019	1.62	1.41	0.21	32.7	22.6	10.1
2020	1.68	1.45	0.23	36.2	24.3	11.9
2021	1.73	1.48	0.25	38.9	25.7	13.2
2022	1.77	1.5	0.27	40.5	26.4	14.1
2023	1.8	1.52	0.28	41.8	27.2	14.6
2024	1.82	1.53	0.29	42.3	27.9	14.4

4. Theoretical Model Construction in an Open Economy

4.1. Theoretical Framework and Assumptions

Based on endogenous growth theory and new trade theory, this study constructed a three-sector theoretical model that includes technology spillovers, institutional frictions, and spatial spillovers. The production function is set as follows:

$$Y = A \cdot K^{\alpha} \cdot L^{\beta} \cdot F^{1-\alpha-\beta}$$

Among them, F represents the knowledge capital brought about by foreign investment, and A represents the total factor productivity driven by opening up to the outside world. The technology diffusion equation further reveals the dynamic process of technology absorption:

$$\dot{A} = \gamma \left(\frac{F}{Y} \right)^\theta \cdot D^\varphi$$

This equation shows that digital infrastructure (D) amplifies the spillover effects of foreign technology (φ) and becomes a key medium for promoting technological progress.

4.2. Equilibrium Analysis and Numerical Simulation

1) Results of Static Equilibrium Analysis

The results in **Table 4** indicate that the values of foreign technology elasticity ($\theta = 0.3$) and digital infrastructure elasticity ($\varphi = 0.5$) both satisfy the theoretical constraints. Specifically, the value of θ ranges from 0 to 0.5, indicating that the spillover effects of foreign technology have a significant positive impact on the improvement of total factor productivity, but do not overly rely on foreign technology. The value of φ is greater than 0.3, indicating that digital infrastructure plays an important role in amplifying the spillover effects of foreign technology, and its elasticity coefficient is relatively high, suggesting that improvements in digital infrastructure have a significant amplifying effect on the spillover effects of foreign technology.

The calibration values of other parameters also align with theoretical expectations. The capital-output elasticity ($\alpha = 0.45$) and labor-output elasticity ($\beta = 0.4$) satisfy the condition $\alpha + \beta < 1$, indicating that the production function in the model exhibits reasonable diminishing returns to scale. The technology absorption rate ($\gamma = 0.25$) is greater than 0, indicating that local firms possess a certain level of technology absorption capacity and can effectively utilize the spillover effects of foreign technology.

Table 4. Static equilibrium analysis results (calibration parameters).

Parameter	Parameter	Calibration Value	Theoretical Constrain
θ	Theoretical Constrain	0.3	$0 < \theta < 0.5$
φ	Digital Infrastructure Elasticity	0.5	$\varphi > 0.3$
α	Digital Infrastructure Elasticity	0.45	$\alpha + \beta < 1$
β	Labor-Output Elasticity	0.4	$\beta > 0.35$
γ	Labor-Output Elasticity	0.25	$\gamma > 0$

2) Static Equilibrium Simulation Results

The results in **Table 5** show that the model's predicted values are highly consistent with the actual observed values, validating the model's explanatory power. Specifically, between 2015 and 2024, the gap between the model's predicted total factor productivity and the actual observed values is small and narrows year by year. For example, in 2015, the model predicted TFP at 1.32, with an actual value of 1.35, resulting in a technology gap of 0.03; by 2024, the model predicted TFP at 1.77, with an actual value of 1.82, resulting in a technology gap of 0.05. This indi-

cates that the model effectively captures the trend of changes in actual data.

Further analysis of the contribution rates of foreign technology spillovers and digital infrastructure reveals that the contribution rate of foreign technology spillovers has been decreasing annually, while the contribution rate of digital infrastructure has been increasing annually. For example, in 2015, the contribution rate of foreign investment was 62%, and the contribution rate of digital infrastructure was 28%; by 2024, the contribution rate of foreign investment had decreased to 41%, while the contribution rate of digital infrastructure had increased to 48%. This trend indicates that as policies continue to be implemented, the importance of digital infrastructure in driving technology spillover is increasingly evident, gradually becoming a key driver of technological innovation.

Table 5. Dynamic equilibrium simulation results (2015-2024).

Year	Actual TFP	Model-Predicted TFP	Technology Gap	Technology Gap	Digital Infrastructure Contribution Rate
2015	1.35	1.32	0.03	62%	28%
2016	1.42	1.38	0.04	58%	31%
2017	1.49	1.45	0.04	55%	34%
2018	1.55	1.51	0.04	53%	36%
2019	1.62	1.57	0.05	51%	38%
2020	1.68	1.63	0.05	49%	40%
2021	1.73	1.68	0.05	47%	42%
2022	1.77	1.72	0.05	45%	44%
2023	1.8	1.75	0.05	43%	46%
2024	1.82	1.77	0.05	41%	48%

5. Empirical Testing of the Mechanism of Action

5.1. Model and Data

To examine the transmission channels of policy dividends, this study adopts the DEA-SBM model to conduct a two-stage efficiency decomposition of the innovation value chain, following the design proposed by Wu Yuanren in 2015. In the knowledge crystallization stage, the inputs are the density of R&D personnel and the number of international patent citations, while the output is the number of granted invention patents. In the market conversion stage, the input is the number of granted invention patents, and the outputs are the proportion of new product sales revenue and the amount of technology exports. The spatial econometric model is set up as follows:

$$y_{it} = \rho W y_{it} + \beta_1 Open_{it} + \beta_2 (Open_{it} \cdot D_{it}) + \beta_3 X_{it} + \mu_i + \lambda_t + \int_{it}$$

Among them, the spatial weight matrix (W) is constructed based on economic distance weighting, and D_{it} is the digital infrastructure index.

5.2. Empirical Results Analysis

1) Spatial Econometric Regression Results

The results in **Table 6** indicate that the expansion of service sector openness significantly influences regional innovation development through both direct and indirect effects, and that the moderating effect of digital infrastructure is significantly positive. Specifically, the coefficient of the direct effect is -0.18 , indicating that the policy significantly enhances regional innovation capacity through direct channels. This result indicates that after the policy was implemented, technological innovation activities in Beijing's high-end service sector were significantly enhanced, and enterprises' R&D efficiency and innovation capabilities were significantly improved.

The coefficient of the indirect effect is -0.12 , indicating that the policy further promotes regional innovation development through spatial spillover effects. This suggests that the policy not only has a positive impact within Beijing but also drives innovation development in surrounding regions through interregional economic linkages and knowledge spillover effects. For example, Beijing's technological innovation achievements may have promoted the enhancement of innovation capabilities in surrounding cities through technological diffusion and talent mobility.

Additionally, the moderating effect of digital infrastructure is significantly positive, indicating that digital infrastructure has played an amplifying role in the implementation of the policy. The improvement of digital infrastructure has not only enhanced corporate operational efficiency but also facilitated the realization of technological spillover effects. For example, the application of high-speed internet and cloud computing technologies enables enterprises to more quickly access and process information, thereby improving R&D and production efficiency.

The attenuation coefficient is -0.07 , indicating that the policy effect gradually weakens with increasing spatial distance. This suggests that the spillover effects of the policy are primarily concentrated in Beijing and its surrounding areas, while its influence on more distant regions is relatively weak. This result implies that the effectiveness of policy implementation may vary depending on the strength of economic ties and geographical distance between regions.

Table 6. Spatial econometric regression results.

Effect Type	Coefficient	Standard Error	<i>p</i> -value	95% Lower Bound	95% Upper Bound
Direct Effect	-0.18^{***}	0.05	0	-0.278	-0.082
Indirect Effect	-0.12^{***}	0.04	0.003	-0.198	-0.042
Digital Infrastructure Moderation	0.15^{***}	0.04	0	0.072	0.228
Attenuation Coefficient	-0.07^{***}	0.02	0	-0.109	-0.031

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

2) Innovation Value Chain Efficiency Breakdown

As shown in the results of **Table 7**, Beijing maintains high efficiency in both the knowledge crystallization and market conversion stages. Beijing's knowledge crystallization efficiency is 0.92, market conversion efficiency is 0.85, and overall efficiency is 0.88, all of which are higher than those of other cities. This indicates that under the impetus of policy dividends, Beijing not only performs well in the technology R&D stage but also has a significant advantage in the commercialization of technology.

Specifically, in the knowledge condensation stage, the inputs are the density of R&D personnel and the number of international patent citations, while the output is the number of granted invention patents. Beijing's high efficiency in this stage indicates that the high density of R&D personnel and the increase in international patent citations have significantly boosted the number of granted invention patents. This reflects Beijing's strong capabilities in technological R&D.

In the market conversion stage, the number of granted invention patents serves as the input, while the proportion of new product sales revenue and technology export volume serves as the output. Beijing's high efficiency in this stage indicates that its market conversion capabilities for invention patents are strong, with both the proportion of new product sales revenue and technology export volume at relatively high levels. This demonstrates that Beijing holds a significant advantage in technology commercialization, capable of swiftly converting technological innovation outcomes into economic benefits.

Table 7. Efficiency decomposition of the innovation value chain.

City	Knowledge Condensation Efficiency	Market Conversion Efficiency	Comprehensive Efficiency
Beijing	0.92	0.85	0.88
Shanghai	0.88	0.78	0.83
Shenzhen	0.85	0.82	0.84
Hangzhou	0.8	0.75	0.78

3) Robustness Checks

To reinforce result reliability, the following robustness checks were conducted, supplementary to the existing DID and SCM frameworks (**Table 8**).

Parallel Trend Test. Event study methodology confirmed that pre-policy trends of the treatment (Beijing) and control groups were parallel (Section 3.1), satisfying the DID assumption.

Alternative Control Group. We re-estimated results using Tianjin and Shenzhen as alternative controls (instead of synthetic controls), yielding consistent positive policy effects (TFP coefficient = 0.148, $p < 0.01$).

Placebo Test. Randomly assigning "policy implementation years" to control cit-

ies showed no significant effects, ruling out spurious correlations.

Sensitivity Analysis. Adjusting capital/labor elasticities did not alter the sign or significance of key coefficients.

Table 8. Robustness checks.

Test Type	Methodology	Key Result	Significance
Parallel Trend Test	Event study framework; examining pre-policy trends (2010-2014)	No significant differences in TFP growth trends between Beijing and controls before policy implementation	ns
Alternative Control Group	Re-estimating the DID model using Tianjin and Shenzhen as controls (instead of synthetic control)	Policy coefficient for TFP: 0.148 (vs. original 0.152)	***($p < 0.01$)
Placebo Test	Randomly assigning “policy implementation years” to 10 control cities	Average placebo policy coefficient: 0.023	ns ($p = 0.68$)
Sensitivity Analysis	Adjusting capital elasticity ($\alpha = 0.4, 0.5$) and labor elasticity ($\beta = 0.35, 0.45$)	TFP coefficients range: 0.145 - 0.156 (all positive)	***($p < 0.01$ for all)

Note: ***: indicates significance at the 1% level; ns indicates not significant. Results confirm the robustness of the core finding that service sector liberalization positively impacts high-end service industry TFP.

These checks confirm the robustness of our findings.

4) Heterogeneity Analysis

The results in **Table 9** further indicate that the policy effects are more pronounced in foreign-invested areas. For example, the TFP coefficient in foreign-invested areas is 0.25, while that in traditional service areas is only 0.07. This suggests that foreign-invested areas benefit more from the release of policy dividends, while the effects in traditional service areas are relatively limited.

This result suggests that the implementation effects of policies may vary depending on regional characteristics. Foreign-invested dense areas, due to the high density of foreign-invested enterprises, 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 indicates that the precise design of policies must consider regional characteristics to ensure the full realization of policy benefits.

Table 9. Results of heterogeneity analysis.

Group	TFP Coefficient	TFP Standard Error	Patent Coefficient	Patent Standard Error	<i>p</i> -value
Foreign-Investment-Intensive Area	0.25***	0.04	0.18***	0.03	0.005
Traditional Service Area	0.07	0.05	0.03	0.04	0.351
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.

6. Results

Through systematic theoretical and empirical analysis, this study draws the following conclusions:

1) The expansion of openness in the service sector has significantly promoted the innovative development of Beijing's high-end service industry through three mechanisms: technology spillover, institutional coordination, and spatial restructuring. Specifically, the technology spillover effect is mainly reflected in the entry of foreign-invested enterprises, which bring advanced technologies and management experience. These technologies and experiences promote the technological upgrading and innovation capabilities of local enterprises through cooperation, demonstration, and competition. Institutional synergy optimizes the policy environment and institutional arrangements, reducing transaction costs and institutional barriers for enterprises, thereby stimulating market vitality. Spatial restructuring promotes the flow and optimal allocation of resources across regions, enhancing the region's overall innovation capacity and competitiveness.

2) Counterfactual analysis indicates that policy dividends play a dominant role in boosting total factor productivity, but the contradiction between "emphasizing R&D and neglecting commercialization" in the innovation chain still needs to be resolved. Although policies have significantly enhanced the intensity and level of R&D activities, there is still room for improvement in the efficiency of market conversion of technological achievements. This requires further improvement of the technology transaction market system and intellectual property protection mechanisms to facilitate the rapid conversion and application of technological achievements.

3) Regional heterogeneity analysis reveals that policy effects are more pronounced in foreign-invested areas, necessitating precise policy design to narrow regional disparities. Foreign-invested areas, due to the high density of foreign-invested enterprises, 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 indicates that precise policy design must consider regional characteristics to ensure the full realization of policy benefits.

4) We acknowledge the need to elaborate on the interactions between the three

mechanisms (technology spillovers, institutional coordination, and spatial restructuring). Their synergistic effects are clarified as follows: Technology Spillovers \times Institutional Coordination: Institutional coordination reduces transaction costs for foreign-invested enterprises, enabling smoother technology diffusion. For instance, relaxed cross-border data flow policies amplified technology spillovers from multinational R&D centers. Institutional Coordination \times Spatial Restructuring: Institutional innovations like tax revenue sharing and resource-sharing platforms facilitated cross-regional resource flow, transforming spatial patterns from “core agglomeration” to “networked collaboration.” This is supported by spatial econometric results showing significant indirect effects. Technology Spillovers \times Spatial Restructuring: Digital infrastructure served as a “bridge” for technology spillovers across regions, mitigating spatial attenuation of policy effects. These interactions collectively strengthen the overall policy effect, with digital infrastructure playing a critical moderating role.

5) In the future, it is necessary to advance the comprehensive efficiency of the innovation system across its entire lifecycle through the precision of open policies, the networking of digital infrastructure, and the institutionalization of regional collaboration. Precision-targeted open policies require the formulation of differentiated policies based on regional and industry characteristics to enhance policy targeting and effectiveness. Digital infrastructure networking necessitates further strengthening of digital infrastructure construction to achieve efficient inter-regional connectivity, facilitating rapid data transmission and processing. Institutionalized regional collaboration requires the establishment of regional cooperation platforms and the improvement of policy coordination mechanisms to ensure resource sharing and technological exchange among regions, thereby enhancing the region’s overall innovation capacity and competitiveness.

It should be noted that this study has some limitations. First, the long-term trends of policy effects still require ongoing monitoring and observation. Although this study validated the short-term effects of policies through counterfactual analysis, the long-term impacts and sustainability of policies still require further research. Second, the analysis of the differentiated impacts on sub-sectors of the service industry is not sufficiently in-depth. Due to data limitations, this study was unable to conduct an in-depth analysis of sub-sectors within the service industry. Future research could utilize more detailed data to further explore the impacts of policies on different sub-sectors. Third, the international comparative perspective is relatively lacking. This study primarily focuses on the situation in Beijing and lacks a comparative analysis with other countries and regions. Future research could introduce an international comparative perspective, draw on international experience, and provide a more comprehensive reference for policy optimization. These limitations provide direction for subsequent study and contribute to further refining the understanding and evaluation of policies for the expansion of service sector openness.

In addition, qualitative evidence was integrated to complement quantitative anal-

ysis, enhancing mechanism validity: first, policy Document Analysis. Content analysis of 87 pioneering institutional innovations, e.g., cross-border data white lists, revealed how institutional coordination reduced administrative barriers, supporting the institutional synergy mechanism; second, case Studies. In-depth cases of foreign-invested enterprises, e.g., Standard Chartered Securities, and domestic firms, e.g., Alibaba's "Beijing International Station", illustrated technology spillover channels (knowledge sharing, joint R&D, and market conversion efficiency improvements); third, stakeholder Interviews. Insights from 15 interviews with government officials, the Beijing Municipal Commerce Bureau, and industry experts highlighted the role of spatial restructuring in resource allocation, e.g., technology transfer from core to suburban areas. These qualitative data triangulate with quantitative results, providing a holistic understanding of policy mechanisms.

7. Policy Implications

7.1. Differentiated Opening-Up Strategy

A differentiated opening-up strategy is a key means of promoting the innovative development of high-end services. Its core philosophy is to tailor precise policy measures based on the characteristics of different regions and industries, thereby stimulating innovation and potential across various sectors. In knowledge-intensive fields such as artificial intelligence and quantum computing, policymakers should consider dynamically adjusting the negative list for foreign investment access, gradually relaxing restrictions on foreign investment entry. Taking the artificial intelligence sector as an example, given its central role in global technological innovation, Beijing can leverage its pioneering advantage to allow foreign-invested enterprises to establish wholly-owned or joint-venture companies in key areas of artificial intelligence, such as technology R&D and application promotion. Such a policy can attract the inflow of cutting-edge international technologies and management expertise while creating opportunities for local enterprises to collaborate with global giants, thereby accelerating technological iteration and innovation breakthroughs.

While lowering the barriers to foreign investment access, policies should also focus on cultivating and improving the technology transaction market. Tax incentives are an effective tool for stimulating market vitality. Implementing tax exemptions for technology transaction activities can directly reduce the burden on enterprises and encourage more entities to participate in technology transactions. Additionally, establishing a technology transaction bonded zone that allows related equipment and materials to circulate freely within the zone can further reduce transaction costs and improve transaction efficiency. The establishment of such a bonded zone not only facilitates technology transactions but also builds a bridge for cross-border technology cooperation, promoting the cross-border flow and optimal allocation of technological elements.

To ensure the standardization and transparency of technology transactions, establishing a unified technology transaction platform is necessary. The platform

should have sound transaction rules and regulatory mechanisms to ensure the authenticity of technological achievements and the fairness of transactions. Through the operation of the platform, the process of converting technological achievements from the laboratory to the market can be accelerated, enabling innovative value to be released more efficiently. Additionally, the platform's credibility can help attract more investors and innovators to participate, forming a virtuous cycle of an innovative ecosystem.

In implementing a differentiated opening-up strategy, it is also necessary to consider the long-term impact and sustainability of policies. Policy makers should continuously monitor policy outcomes and adjust policy direction and intensity in a timely manner based on market feedback and technological trends. For example, as artificial intelligence technology matures, policies can gradually shift from attracting foreign investment to supporting local enterprises, encouraging them to compete in international markets. Additionally, policies should focus on cultivating local talent, enhancing the region's overall innovation capacity and competitiveness, ensuring autonomy and security in regional economic development while maintaining openness and cooperation.

In summary, a differentiated opening-up strategy can effectively promote the innovative development of high-end services through precise policy design. In the specific implementation process, it is necessary to comprehensively utilize various measures such as adjustments to foreign investment access policies, cultivation of technology transaction markets, tax incentives, and bonded policies to jointly build a policy environment conducive to technological innovation and industrial upgrading. At the same time, the implementation of policies should emphasize dynamic adjustments and long-term planning to adapt to the ever-changing market and technological environment, ensuring the sustained prosperity and innovative development of the regional economy.

7.2. Empowering Digital Infrastructure

Digital infrastructure is a key enabler of technological innovation and industrial upgrading. In today's digital age, building a robust digital infrastructure not only enhances a region's technological innovation capabilities but also provides strong momentum for the development of high-end services. It is recommended to establish a cross-regional collaborative digital infrastructure network to optimize the efficiency of computing resource allocation. For example, in the Beijing-Tianjin-Hebei region, by coordinating the planning of data center layouts, efficient allocation of computing resources can be achieved. Such coordinated planning ensures the rational allocation of resources, avoids duplicate construction and resource waste, while enhancing overall computing capacity and data processing efficiency.

To ensure rapid data transmission and processing, the construction of high-speed network connectivity channels is indispensable. High-speed network connectivity channels can significantly reduce data transmission latency and increase

data flow speed, which is particularly important for applications with high real-time requirements. For example, in fields such as financial transactions, telemedicine, and autonomous driving, rapid data transmission can ensure the efficiency and accuracy of services.

Deploying edge computing nodes in ecologically sensitive areas can effectively reduce the marginal cost of digital services. Edge computing nodes process data near the data source, reducing the distance and time required for data transmission and thereby improving service efficiency. For example, deploying edge computing nodes in Beijing's ecological protection zones can support local environmental monitoring and ecological conservation efforts. Through edge computing technology, environmental monitoring data can be processed in real time, improving monitoring efficiency and accuracy, which is critical for promptly identifying and addressing environmental issues.

The construction of digital infrastructure not only enhances technology spillover effects but also significantly reduces corporate operational costs. Taking cloud computing as an example, enterprises can significantly reduce IT equipment procurement and maintenance costs and improve resource utilization efficiency by using cloud computing services. The elastic computing capabilities of cloud computing enable enterprises to flexibly adjust computing resources according to business needs, avoiding resource waste in traditional IT architectures. Additionally, cloud computing provides a wealth of application programming interfaces (APIs) and development tools, promoting technology diffusion and knowledge spillovers, and driving collaborative development across the entire industrial chain.

During the construction of digital infrastructure, data security and privacy protection must also be considered. As data volumes continue to grow and the value of data increases, data security issues have become increasingly prominent. It is recommended to establish a comprehensive data security protection system, including measures such as data encryption, access control, and security audits, to ensure the security and integrity of data. At the same time, data privacy protection should be strengthened, and strict rules for data use and sharing should be established to safeguard users' legitimate rights and interests.

Furthermore, the construction of digital infrastructure should also focus on compatibility and interoperability with existing systems. By adopting open standards and protocols, seamless integration between different systems can be ensured, promoting data circulation and sharing. This not only helps improve the overall efficiency of digital infrastructure but also reduces enterprises' technical transition costs and enhances market competitiveness.

To promote the sustainable development of digital infrastructure, the government should increase investment in the research, development, and application of related technologies. It should encourage enterprises and research institutions to conduct cutting-edge research in areas such as artificial intelligence, big data analysis, and the Internet of Things to enhance the technological level of digital infrastructure. At the same time, through policy guidance and financial support, it should promote the

application and popularization of digital infrastructure in more fields, such as smart cities, smart transportation, and smart healthcare, to provide strong support for the comprehensive development of the social economy.

In terms of international cooperation, actively participate in the standardization of global digital infrastructure construction and promote the internationalization of China's technical standards. Through cooperation with international organizations and other countries, jointly formulate technical specifications and standards for digital infrastructure to enhance China's influence and voice in the global digital field.

In summary, the construction of digital infrastructure is key to driving technological innovation and industrial upgrading. By constructing a cross-regional collaborative digital infrastructure network, optimizing computing resource allocation, building high-speed network connection channels, and deploying edge computing nodes, we can effectively enhance regional technological innovation capabilities and service levels. At the same time, focusing on data security and privacy protection, ensuring system compatibility and interoperability, increasing investment in technological research and development, and actively participating in international cooperation will further promote the high-quality development of digital infrastructure and provide a solid foundation for the innovative development of high-end services.

7.3. Dynamic Policy Iteration

The rapid development of technology requires policies to be highly flexible and adaptive. It is recommended to establish a dynamic matching mechanism between policies and technological development to ensure that policies can respond promptly to the demands of technological change. By breaking through institutional bottlenecks through "regulatory sandbox" pilot programs, regulatory sandboxes can be established in specific regions, allowing enterprises to conduct innovation pilots and test new technologies and business models within these sandboxes. This mechanism provides a relatively relaxed environment for technological innovation while ensuring the effectiveness of regulation. For example, in the fintech sector, regulatory sandboxes can allow companies to test new payment systems or blockchain applications without immediately meeting all traditional regulatory requirements. Through the sandbox mechanism, issues of mismatch between policy and technological development, such as data privacy and security standards, can be promptly identified and addressed.

Additionally, based on pilot results, policies can be adjusted in a timely manner to ensure alignment with technological advancements. For example, if a pilot finds that a particular technology is difficult to promote under the existing policy framework, policymakers should swiftly assess and adjust relevant policies to remove institutional barriers. This dynamic adjustment not only facilitates the promotion of technological innovation but also enhances market confidence in new technologies. Furthermore, the dynamic matching mechanism can promote interdepart-

mental collaboration, as technological innovation often spans multiple regulatory domains and requires coordination and cooperation among different departments.

In addition, it is crucial to strengthen the ability of policy tools to respond to market demand. Regular market research should be conducted to understand the actual needs and challenges faced by enterprises, providing a basis for policy adjustments. Market research can be conducted through various methods, such as surveys, industry roundtables, and case studies, to ensure the information collected is comprehensive and accurate. Additionally, establishing a policy feedback mechanism is essential to promptly collect feedback from businesses and the public, evaluate policy effectiveness, and optimize policy design. For example, a dedicated online platform can be established to allow businesses and the public to conveniently submit their opinions and suggestions, while policymakers regularly review this feedback to ensure continuous policy improvement.

Dynamic policy adjustments must also consider long-term impacts and potential risks. While promoting technological innovation, it is essential to ensure that policies do not trigger new market imbalances or social issues. Therefore, policymakers must adopt a forward-looking perspective, not only focusing on current technological trends but also predicting future technological and market changes. This may require leveraging expert consultations, academic research, and international experience.

Additionally, policy transparency and predictability are also important components of the dynamic matching mechanism. Businesses need clear policy guidance to reasonably plan their innovation activities and investment directions. Therefore, when adjusting policies, policymakers should ensure the rationality and predictability of policy changes, avoiding frequent and drastic policy shifts that could unnecessarily disrupt the market.

In terms of international cooperation, the dynamic matching mechanism can also promote cross-border policy coordination. Technological development is often global in nature, so policies also need to be coordinated at the international level. Through cooperation with other countries and international organizations, common technical standards and regulatory frameworks can be established to promote the cross-border flow and application of technology, while mitigating risks associated with potential international technological competition.

In summary, establishing a dynamic matching mechanism between policy and technological development is key to addressing rapid technological advancements. Through measures such as regulatory sandbox pilots, timely policy adjustments, market research, and feedback mechanisms, the flexibility and adaptability of policies can be ensured, promoting technological innovation and industrial upgrading while safeguarding market stability and public interests. This mechanism not only supports current technological development but also lays a solid foundation for future innovation.

7.4. Regional Collaboration and Institutional Innovation

Regional collaborative development requires institutional safeguards. In today's context of globalization and regional integration, cooperation and collaboration between regions have become increasingly important. It is recommended to establish a regional cooperation platform, which can effectively promote resource sharing and technological exchange among regions, break geographical barriers, and achieve complementary advantages. For example, in the Beijing-Tianjin-Hebei region, by establishing a unified technological innovation cooperation platform, resources from universities, research institutions, and enterprises within the region can be integrated to jointly conduct research projects and share experimental equipment and data resources. This not only avoids duplicate investments but also improves resource utilization efficiency and accelerates the conversion of scientific and technological achievements.

At the same time, it is necessary to improve policy coordination mechanisms, strengthen policy coordination and alignment among regions, ensure the consistency and continuity of policies, and avoid resource waste and market segmentation caused by policy differences. When formulating policies, different regions should consider the overall interests of regional coordinated development and avoid acting independently. For example, in areas such as tax policies and industrial policies, regions should establish coordination mechanisms to ensure policy consistency, thereby enhancing the region's overall innovation capacity and competitiveness.

In the future, it is recommended to further refine open policies and formulate differentiated policies tailored to the characteristics of different industries and regions. For areas with a high concentration of foreign investment, policy support should be strengthened to attract more foreign-invested enterprises, leveraging the spillover effects of technology to drive the innovative development of local enterprises. For example, tax incentives and simplified approval procedures can be provided to create a favorable business environment for foreign-invested enterprises. At the same time, foreign-invested enterprises should be encouraged to collaborate with local enterprises to promote technological exchange and knowledge sharing.

For traditional service areas, policy guidance can be used to promote industrial upgrading and technological transformation, enhancing their competitiveness in high-end services. For example, fiscal subsidies and special funds can be used to support traditional service enterprises in their digital transformation, improving service quality and efficiency. At the same time, talent cultivation and recruitment should be strengthened to provide intellectual support for the transformation and upgrading of traditional services.

The construction of digital infrastructure requires further networking to achieve efficient connectivity between regions. It is recommended to build cross-regional high-speed network channels to ensure rapid data transmission and processing. For example, in economically developed regions such as the Beijing-Tianjin-He-

bei region and the Yangtze River Delta, dedicated high-speed network channels can be constructed to meet the needs of big data, cloud computing, and other services within the region. At the same time, edge computing nodes can be deployed in ecologically sensitive areas and remote regions to expand the coverage and efficiency of digital services, reduce the marginal costs of digital services, and promote the application and dissemination of digital technology in broader regions. For example, deploying edge computing nodes in remote mountainous areas can provide real-time data processing and analysis services for local agriculture, tourism, and other industries, driving local economic development. Through these measures, the efficiency and effectiveness of regional collaboration can be significantly enhanced, driving the innovative development of high-end services and the overall competitiveness of the region.

8. Conclusion

Following a systematic assessment of the policy effects and mechanisms of action of expanding openness in the service sector on the innovative development of Beijing's high-end service industry, it is evident that a comprehensive analytical framework has been established, encompassing "counterfactual quantitative assessment— theoretical model construction—verification of action pathways." This framework fully reveals the patterns of benefit realization and the core driving logic of openness policies. Through counterfactual analysis using the difference-in-differences method and synthetic control method, the expansion of service sector opening-up has significantly improved the total factor productivity and international patent authorization density of the high-end service sector. The gap between the actual development level and the simulated path has widened year by year after the implementation of the policy, confirming the sustainability and cumulative nature of the policy benefits. Theoretical models and spatial econometric tests further indicate that the policy exerts its effects through three mechanisms: technology spillovers, institutional synergy, and spatial restructuring. The regulatory effect of digital infrastructure has significantly amplified the policy's effectiveness.

However, the contradiction of the innovation chain being "heavy on R&D and light on conversion" has not been fundamentally resolved, and the policy effects show significant regional heterogeneity differences between foreign-invested areas and traditional service areas, necessitating further improvements in policy precision and coordination. Future efforts should focus on four key areas: first, implementing differentiated opening-up strategies, dynamically adjusting foreign investment access lists, improving technology transaction markets and bonded policies, and stimulating innovation vitality in niche sectors; second, strengthening digital infrastructure empowerment, building cross-regional collaborative networks, optimizing computing power allocation and high-speed channels, and reducing the marginal costs of digital services; third, establishing a dynamic policy iteration mechanism, adjusting through regulatory sandbox pilots and market feedback to ensure policy alignment with technological development; Fourth, pro-

mote the institutionalization of regional collaboration, establish cooperation platforms and policy coordination frameworks, and bridge regional development gaps. Beijing's policy practices in expanding the opening-up of its service sector will also provide replicable institutional experiences for China's high-end service sector opening-up and innovation, offering a "Beijing model" for the nation to build an open innovation ecosystem and enhance global competitiveness.

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Conflicts of Interest

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

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