

# FDI Spillover Effects, Indigenous Innovation Capability, and Regional Industrial Structure Adjustment

-- Based on Dynamic Panel Data Analysis of the Beijing-Tianjin-Hebei Urban Agglomeration in China

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**Abstract:** This article, based on the perspective of regional economics, utilizes data from the Beijing-Tianjin-Hebei urban agglomeration from 2013 to 2021. It establishes a dynamic panel model and introduces interaction terms between FDI spillover effects and indigenous innovation capability. Through empirical analysis, it examines the impacts of FDI spillover effects, indigenous innovation capability, and their interaction on the industrial structure of the Beijing-Tianjin-Hebei region. The research findings indicate that after introducing the interaction term, FDI promotes the enhancement of indigenous innovation capability, thereby optimizing the industrial structure with a noticeable synergistic effect. Therefore, leveraging the synergistic effect of FDI and indigenous innovation on the optimization and upgrading of the industrial structure is of significant importance for the high-quality development of the Beijing-Tianjin-Hebei urban agglomeration.

**Keywords:** Foreign Direct Investment; Indigenous Innovation; Industrial Structure.

## 1. Introduction

Foreign Direct Investment (FDI), as a crucial factor influencing national economic development and industrial structure, has gradually become more prominent in China since the initiation of economic reforms and opening-up. Especially since joining the World Trade Organization (WTO) in 2001, China's openness has continuously expanded in scope and depth, enhancing its ability to attract foreign capital. The scale of FDI inflows has experienced a significant leap, bringing not only financial injections but, more importantly, generating a series of positive spillover effects.

The spillover effects of FDI primarily refer to the positive externalities that foreign direct investment has on the host country's economy. Numerous studies indicate that the impact of FDI goes beyond capital infusion, playing a crucial role in promoting economic growth and technological progress in the host country through avenues such as technology transfer, dissemination of management expertise, and market expansion. These effects extend beyond the enterprises directly receiving FDI, permeating the entire industrial chain, providing new impetus and opportunities for elevating the host country's technological capabilities and upgrading its industries.

On the other hand, autonomous innovation capability, as one of the core competitive advantages of a nation, plays a crucial role in international competition. Possessing autonomous innovation capability not only drives the optimization and upgrading of industrial structures but also injects new vitality and momentum into the sustained and healthy development of the Chinese economy. Against the backdrop of FDI, the role of autonomous innovation becomes particularly crucial. Some studies suggest that autonomous innovation can compensate for the shortcomings in FDI technology spillover, propelling the technological progress and industrial upgrading of domestic enterprises. Simultaneously, autonomous innovation helps reduce dependence on external technology, mitigates international

trade risks, and enhances a country's resilience and sustainable development capabilities. Therefore, autonomous innovation and FDI complement each other, jointly propelling the optimization and upgrading of a country's industrial structure.

The Tenth Five-Year Plan Outline for National Economic and Social Development of the People's Republic of China emphasizes the primary expected goals of economic structural adjustment: optimizing and upgrading industrial structures and enhancing international competitiveness. It is evident that industrial structural adjustment is a crucial aspect of current macroeconomic regulation in China. In recent years, while China's industrial structure has continuously adjusted and upgraded, issues such as irrational industrial structures, imbalances in regional industrial structures, and uneven development within industries still persist. The inflow of FDI significantly impacts China's autonomous innovation capabilities and industrial structure. Simultaneously, the spillover effects of FDI and autonomous innovation jointly contribute to the adjustment of industrial structures, producing synergistic effects.

The Beijing-Tianjin-Hebei region, consisting of Beijing, Tianjin, and Hebei Province, is one of the most vibrant and potential-rich regions in northern China. Its close geographical proximity and the need for coordinated development have made this region a focal point for significant economic achievements since the initiation of reforms and opening-up. The Beijing-Tianjin-Hebei region, situated in the economic hinterland of northern China, possesses abundant natural resources, deep cultural heritage, and is a crucial component of China's political, cultural, and economic center. In February 2014, the Central Committee of the Communist Party of China, considering the national development perspective, made a major decision to promote the coordinated development of the Beijing-Tianjin-Hebei region. In recent years, especially since the establishment of the Xiong'an New Area in 2017, under the strong leadership

of the Central Committee, the Beijing-Tianjin-Hebei region has experienced vigorous development.

Beijing-Tianjin-Hebei is currently one of the most dynamic, open, and innovative regions in China, attracting a considerable amount of FDI. Leveraging the spillover effects of FDI, this region has achieved technology introduction and transfer, facilitating the optimization and upgrading of industrial structures. The influx of foreign capital not only brings advanced management experience and technology to local enterprises but also accelerates the transformation and upgrading of industries in the region, promoting sustained and robust economic growth. Meanwhile, the Beijing-Tianjin-Hebei region actively promotes autonomous innovation. By absorbing advanced external technology and management expertise, combined with the local context, increased investment in scientific and technological research and development has enhanced autonomous innovation capabilities. This fusion of technology and innovation contributes to the region's accelerated integration into the global value chain, raising its competitiveness and status in the international economy.

This development model, driven by FDI and supported by autonomous innovation, holds significant implications for the economic development of the Beijing-Tianjin-Hebei region. It not only enhances the region's level of openness but also stimulates deep-level coordinated development within the region. The strong complementarity among the three areas of Beijing-Tianjin-Hebei, coupled with close economic ties, has the potential to accelerate the coordinated development of the region by further optimizing industrial structures and elevating innovation levels. Therefore, utilizing the spillover effects of FDI and autonomous innovation to drive industrial structural adjustment in the Beijing-Tianjin-Hebei region is of paramount importance. It not only contributes to further enhancing the region's level of openness but also promotes deep-level coordinated development, ultimately elevating the economic development of the entire Beijing-Tianjin-Hebei region.

## 2. Literature Review

### 2.1 The Impact of FDI Spillover Effects on Indigenous Innovation

Regarding the impact of FDI spillover effects on indigenous innovation, the research results from domestic and foreign scholars are varied. On the foreign front, some scholars believe that FDI spillover effects have a positive impact on indigenous innovation. Caves (1974) conducted an in-depth study of the manufacturing industries in Canada and Australia, finding that Foreign Direct Investment (FDI) had a positive spillover effect on the technological advancement of these two countries' manufacturing industries. In his research, Caves pointed out that the introduction of FDI promoted the improvement of the manufacturing industry's technological level, injecting positive impetus into industrial technological innovation and progress. Magnus Blomström and Håkan Persson (1983) focused on Mexican factories, investigating whether differences in technological efficiency were related to FDI-related spillover effects. By using different concentration indexes to measure the degree of competition, they found that the presence of foreign subsidiaries was the ultimate determinant of technological efficiency in Mexican factories, emphasizing the positive impact of FDI spillover

effects on the technological efficiency of Mexican factories. Kokko, Tansini, and Zezza (1996) studied the impact of FDI in the Uruguayan manufacturing sector on local technological capabilities and productivity spillovers. The research showed that the presence of foreign-funded enterprises could promote the improvement of the host country's manufacturing technology level. However, some scholars hold different views, suggesting that FDI spillover effects may have a negative impact on indigenous innovation or may not have a significant effect. Haddad and Harrison (1993) conducted empirical research based on relevant data from Morocco, suggesting that FDI did not significantly generate technological spillovers during the examination period. Similarly, Djankov and Hoekman (2000) studied the Czech Republic, and Girma and Gong (2008) studied Chinese state-owned enterprises, both of which unanimously believe that the impact of FDI on technological spillovers is not significant.

On the domestic front, some research results also present certain differences. Xing Fei and Zhang Jianhua (2009) established a dynamic game model under the framework of cumulative innovation to explore the impact of foreign technology transfer on the indigenous R&D of the host country. The theoretical analysis suggests that both FDI and technology licensing (or other forms of technology transactions) have effects on promoting or inhibiting the indigenous R&D of the host country. They used panel data of industrial enterprises in 36 sub-industries in China from 1999 to 2004 for systematic GMM estimation and found that technology trade not only directly substitutes for R&D investment of Chinese enterprises but also enhances their technological innovation capabilities through technology spillovers. FDI shows significant promotion and inhibition effects on indigenous R&D in the short term, but its long-term impact is not significant; the technology spillover effect of FDI is not significant in both short and long-term effects. Li Yumei and Sang Baichuan (2011) conducted regression analysis on industry panel data in China from 1999 to 2007, verifying the impact of FDI on indigenous innovation of domestic enterprises in China, and found that FDI has a positive promotion effect on indigenous innovation, especially in industries with intense market competition and small technological gaps between domestic and foreign-funded enterprises. Hu Xiqin and Yang Qin (2017) found that inflows of FDI, as a capital input, promote local indigenous innovation and have a more pronounced spatial spillover effect on indigenous innovation in adjacent areas. However, the empirical results of Sun Zao and Han Ying (2018) indicate that the technological spillover effects brought by FDI do not necessarily lead to an improvement in the indigenous innovation capabilities of local enterprises, and the positive effects depend on the level of human capital in the region. Li Guifang and Xiong Sichen (2021), based on the technological spillover effects of FDI, introduced two moderating variables: regional human capital and regional intellectual property rights protection, to study the impact of FDI on enterprise innovation. The empirical results show that FDI significantly promotes innovation in Chinese enterprises, while low levels of regional human capital and intellectual property rights protection weaken this spillover effect.

## 2.2 The Impact of FDI Spillover Effects on Industrial Structural Adjustment

The research on the impact of FDI spillover effects on industrial structural adjustment has a long history abroad. The core idea studied by economist Colin Clark is that industrial structure evolves in a sequence of primary, secondary, and tertiary industries, reflecting the general trend of industrial structure evolution. Caves (1974) found that FDI significantly influences industrial structure upgrade and labor productivity improvement, particularly in promoting technological advancement, technology transfer, and enhancing distribution efficiency. Markusen and Venables (1997) pointed out that FDI plays a driving role in industrial structural adjustment, and the associated effects of FDI companies promote the upgrading of industrial structures in developing countries, making foreign direct investment a crucial component in international production.

Balasubramanian (1998) discovered, through research on FDI utilization in developing countries, that FDI becomes an effective driver of industrial transformation and economic development only when the host country reaches a certain level of human capital, has comprehensive public infrastructure, and maintains a stable social environment. Javorcik, Beata (2002) found that FDI can enhance the productivity of domestic firms to some extent, indicating that investments by multinational corporations may bring positive impacts in terms of technology and management experience, thereby fostering the development of domestic firms and promoting industrial structural adjustment in FDI-receiving countries.

After joining the World Trade Organization, research on the impact of FDI spillover effects on industrial structural adjustment has increased domestically. Fu Qiang and Zhou Kehong (2005) discussed the basic situation of China's use of foreign capital and industrial structural adjustment, finding a strong correlation between domestic industrial structural adjustment and the introduction of foreign capital, which not only promotes the sophistication of China's industrial structure but also enhances the quality of various industries. Tang Yan (2011) analyzed the upgrading effects of FDI on China's industrial structure, highlighting its significant role in promoting the upgrading of China's industrial structure. However, the study suggests that the upgrading effects of FDI on industrial structure may be somewhat virtual when considering the main entities involved or analyzing the effects from a value chain perspective.

Nie Aiyun and Lu Changping (2012) systematically examined the mechanisms through which FDI affects industrial structural adjustment from the perspective of institutional constraints based on spatial economics. They found that increasing FDI contributes to increasing the proportion of the tertiary industry in the economy, reducing the proportion of the secondary industry, and overall facilitating the optimization and upgrading of industrial structure. Xu Dong, Luan Guiqin, and Wu Zhe (2013) used time-series data analysis to study the effects of foreign direct investment and foreign trade on the upgrading of the industrial structure in Shanghai, concluding that FDI promotes the upgrading of the industrial structure.

Lü Yanqin and Zhao Bin (2020) constructed a dynamic panel model to empirically analyze the overall effects of foreign direct investment and regional innovation on

industrial structural changes based on measuring the rationalization and sophistication of the industrial structure. They found that both foreign direct investment and regional innovation promote the rationalization and sophistication of the industrial structure, and the interaction term between the two hinders the rationalization but facilitates the sophistication of the industrial structure.

Cheng Qinliang, Song Yanling, and Liu Ming (2022) parameterized FDI quality and quantity, established an unbalanced growth model, and found that the improvement in FDI quality has a positive effect on optimizing the industrial structure. Furthermore, it was revealed that enhanced FDI quality promotes the improvement of regional technological levels, further driving the intrinsic mechanism of industrial structural upgrading. The study suggests that an increase in FDI quantity is beneficial for optimizing the industrial structure only when the scale reaches a certain level.

## 2.3 The impact of independent innovation on industrial restructuring.

Independent innovation has always been a key driver of economic development and industrial evolution, attracting extensive research attention. Schumpeter, J. A. (1942) emphasized innovation as a disruptive force that can overturn traditional industrial structures and pave the way for the formation of new economic forms. Nelson, R. R., & Winter, S. G. (1983) argued that innovation is a driving force for economic structural adjustment, contributing to the evolution of the entire system towards greater efficiency. The research by Jelinek, Mariann and Porter, M. E. (1990) focused on how independent innovation becomes a key factor in national competitive advantage. They pointed out that successful countries demonstrate excellence in promoting technological innovation and industrial upgrading, thereby exerting profound influence on the overall industrial structure.

Zhou Shulian and Wang Weiguang (2001) pointed out in their research that technological innovation is the driving force behind industrial restructuring. Their study clarified that the more active the technological innovation activities in an industry, the stronger its ability to absorb and integrate innovative achievements, the stronger its creative ability, the faster its industrialization speed, and the stronger its ability to adapt to market demands. As a result, the industry develops rapidly, attains a larger scale, and has a broader impact. If this industry also has strong relevance and spillover effects, it may trigger a new round of industrial transformation or even an industrial revolution. Du Chuanwen, Lv Jie, and Rui Mingjie (2018) investigated the relationship between enterprise technology introduction and independent research and development in industrial upgrading. Their analysis showed that when enterprises are relatively backward in technology, they tend to focus on technology application, substituting technology introduction for independent research and development. As industry technology upgrades, the importance of independent innovation in competition becomes increasingly prominent for enterprises.

Song Deyong and Bi Daojun (2022) focused on examining the direct impact and specific pathways of technological innovation on industrial structural upgrading. Their research found that technological innovation can effectively promote the rational development of industrial structure.

## 2.4 Summary

Based on the literature review above, it can be seen that there have been numerous studies on the impact of FDI spillover effects on independent innovation and industrial structural adjustment, both domestically and internationally. The research content is rich and diverse in perspectives. However, there is relatively less research on the joint impact of FDI spillover effects and independent innovation on regional industrial structural adjustment. Therefore, this paper will empirically analyze the impact of FDI spillover effects and independent innovation on industrial structural adjustment in the Beijing-Tianjin-Hebei region based on a dynamic panel model. Based on the empirical results, relevant policy recommendations will be proposed to help the Beijing-Tianjin-Hebei region better utilize foreign investment to achieve independent innovation, upgrade, and optimize industrial structure, aiming for high-quality regional development.

## 3. Data Collection and Empirical Analysis

### 3.1 Model specification and data description

The general model for dynamic panel data is as follows:  $Y_{i,t} = \alpha Y_{i,t-1} + \beta X_{i,t} + \alpha_i + v_{i,t}$ , where  $X_{i,t}$  represents control variables,  $\alpha_i$  represents fixed effects, and  $v_{i,t}$  represents the error term. Due to the inclusion of the lagged dependent variable,  $Y_{i,t-1}$ , which is an endogenous variable, the model suffers from endogeneity issues, and the estimation results using traditional least squares are biased and inconsistent.

In dynamic panel data analysis, the generalized method of moments (GMM) is widely used, especially when more instrumental variables are involved. These instrumental variables typically involve more lagged periods to better capture the characteristics of the dynamic panel data model. GMM estimation methods can be divided into difference GMM (DIF-GMM) and system GMM (SYS-GMM), each having different advantages and applicable scenarios in addressing endogeneity. The difference GMM method primarily handles endogeneity by differencing the data, which can be effective in certain cases but may have lower estimation efficiency due to the limited choice of instrumental variables. On the other hand, the system GMM method is relatively more flexible, allowing for the use of more instrumental variables, especially those with more lagged periods. This provides more options for addressing endogeneity, thereby improving estimation efficiency and accuracy. Currently, in economic research based on dynamic panel data, the system GMM method is more commonly used due to its flexibility and relatively higher efficiency. The system GMM method can comprehensively explore the dynamic characteristics of the data, providing more precise parameter estimates and thus being widely adopted in empirical research. Therefore, this study chooses the system GMM method for empirical research to analyze economic phenomena in dynamic panel data more accurately and comprehensively.

This study focuses on the role of FDI spillover effects on independent innovation in the Beijing-Tianjin-Hebei region, which in turn affects industrial structural adjustment. Therefore, the following economic model can be constructed:

$$IS_{i,t} = \alpha + \beta_1 IS_{i,t-1} + \beta_2 FDIS_{i,t} + \beta_3 LIIA_{i,t} + \beta_4 LTEC_{i,t} + \beta_5 (FDIS_{i,t} \times LIIA_{i,t}) + v_{i,t} \quad (1)$$

By introducing FDI spillover effects, independent innovation, and the interaction term into the equation, and according to the research framework of the model specification, Equation (1) can be rewritten into the following three estimation models:

$$IS_{i,t} = \alpha + \beta_1 IS_{i,t-1} + \beta_2 FDIS_{i,t} + \beta_3 LTEC_{i,t} + v_{i,t} \quad (2)$$

$$IS_{i,t} = \alpha + \beta_1 IS_{i,t-1} + \beta_2 FDIS_{i,t} + \beta_3 LIIA_{i,t} + \beta_4 LTEC_{i,t} + v_{i,t} \quad (3)$$

$$IS_{i,t} = \alpha + \beta_1 IS_{i,t-1} + \beta_2 FDIS_{i,t} + \beta_3 LIIA_{i,t} + \beta_4 LTEC_{i,t} + \beta_5 (FDIS_{i,t} \times LIIA_{i,t}) + v_{i,t} \quad (4)$$

In the above three equations,  $i = 1, 2, \dots, N$ ;  $t = 1, 2, \dots, T$ . These three equations are considered as the main estimation models in this study.

$IS_{i,t}$  represents the industrial structure of city  $i$  in the Beijing-Tianjin-Hebei region in year  $t$ . Generally, the proportion of value added in the tertiary industry of city  $i$  to the city's GDP is used to measure the status of regional industrial structure.

$FDIS_{i,t}$  represents the FDI spillover effects in city  $i$  in year  $t$  in the Beijing-Tianjin-Hebei region. This study uses the ratio of FDI amount in city  $i$  in year  $t$  to the city's GDP to represent the spillover effects of FDI. The level of FDI technology spillover in city  $i$  in year  $t$  is represented by the ratio of total FDI amount in city  $i$  in that year to the city's GDP. To eliminate the potential impact of different statistical units, the FDI values in city  $i$  in year  $t$  are multiplied by the average annual exchange rate of the Chinese yuan to the US dollar in year  $t$ , converting them into FDI values denominated in Chinese yuan.

$LIIA_{i,t}$  represents the level of independent innovation in city  $i$  in year  $t$  in the Beijing-Tianjin-Hebei region. This study uses  $LIIA_{i,t}$ , which is the logarithm of  $IIA_{i,t}$ . In empirical analysis, the measurement of innovation variables often varies depending on the specific context and research question. Innovation is a multidimensional concept, so various indicators and variables can be used to capture different aspects of innovative activities. In most studies, researchers commonly use research and development (R&D), patents, etc., to measure innovation. Based on data availability and ease of operation, this study uses the number of patent authorizations in city  $i$  in the Beijing-Tianjin-Hebei region in year  $t$  as an indicator of each city's independent innovation capacity. Patent authorizations have advantages as an innovation measurement indicator because they reflect the actual achievements of cities in technological innovation and intellectual property rights. Taking the logarithm of the number of patent authorizations can better reveal the changing trend of innovation activities and provide a more reliable data basis for subsequent empirical analysis.

$TEC_{i,t}$  represents control variables, specifically scientific expenditures in city  $i$  in year  $t$  in the Beijing-Tianjin-Hebei region. This study uses  $LTEC_{i,t}$ , which is the logarithm of  $TEC_{i,t}$ . Scientific expenditures refer to the funds spent on the

development and promotion of various scientific research activities. Independent innovation and the optimization and upgrading of industrial structure rely on support for science and technology. In general, under other conditions being equal, the more scientific expenditures, the higher the level of independent innovation.

$FDIP_{i,t} \times LIIA_{i,t}$  represents the interaction term between FDI spillover effects and independent innovation capability. In this study, it is used to indicate the cross-impact of FDI spillover effects and independent innovation capability in city  $i$  in the Beijing-Tianjin-Hebei region in year  $t$ . By examining this interaction term, a clearer understanding of the impact mechanism of FDI spillover effects, independent innovation capability, and industrial structural adjustment can be achieved.

This study utilizes dynamic panel data from 13 cities in the Beijing-Tianjin-Hebei region from 2013 to 2021 to construct the model. The data are sourced from the China City Statistical Yearbook (2013-2021) and the official website of the National Bureau of Statistics of China.

### 3.2 Stationarity Test for Data

In order to ensure the accuracy of regression results and avoid the occurrence of spurious regression, it is necessary to conduct a stationarity test on panel data before empirical analysis. The selected panel data has a larger individual

dimension than the time dimension ( $N \gg T$ ), making it a short panel data. In this study, the IPS (Im, Pesaran, and Shin) and HT (Hadri) tests are employed, which are widely used for stationarity testing in short panel data. The IPS test is known for its effectiveness in small sample sizes, while the HT test is suitable for non-stationary cross-dependence structures. The results of the tests are presented in Table 1.

**Table 1.** Panel Data Stationarity Test Results

Variable	IPS	HT
IS	-2.5904***	0.4323***
IS(-1)	-1.9715**	0.3611***
FDIP	-1.8906**	0.1040**
LTEC	-3.2948***	-0.0514***
LIIA	-2.9524***	0.1201**
FDIP×LIIA	-1.8769**	0.1170**

Note: \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

From the above Table 1, it can be seen that all variables pass the significance test under the IPS and HT tests. Therefore, it can be concluded that the null hypothesis of the presence of unit roots is rejected, indicating that the original data is stationary.

### 3.3 System GMM Test

**Table 2.** System GMM Test Results

Variable	Model(2)	Model(3)	Model(4)
C	0.8960*	0.2929*	0.5269**
IS(-1)	0.4397	0.1570	0.3823
FDIP	6.5804**	-0.1297	-27.4228***
LTEC	-0.0679*	-0.2435**	-0.0190
LIIA		0.0473***	0.0091
FDIP×LIIA			2.5818***
Wald Results	640.67***	908.32***	1572.56***
AR(1)Test Results&P	-1.70 (0.088)	-1.74(0.081)	-1.80( 0.072)
AR(2)Test Results&P	0.3 (0.765)	0.93(0.350)	0.25 ( 0.801)
Hansen Test Results&P	11.27 (0.127)	12.27( 0.199)	10.16 (0.516)

Note: \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively; the numbers in parentheses indicate the corresponding P-values.

The results in Table 2 show that the Wald values of the three models perform well in the significance tests, indicating that the model's fit and the relationship between variables are statistically significant. For the tests of AR(1) and AR(2), the results indicate that none of the three models show second-order autocorrelation in the residual terms after first-order differencing. This implies that the residual terms of the models are relatively independent in the time series, consistent with the modeling assumptions. Additionally, the Hansen test results show that the null hypothesis of "all instrumental variables are valid" cannot be rejected at the 10% significance level. This result suggests that the selected instrumental variables play an effective role in model estimation, and there is no overidentification problem with

instrumental variables, further validating the effectiveness and rationality of the established model.

Analyzing the regression results in Table 2, it can be seen that in Model (2), the variable FDIP passes the test at the 5% significance level with a coefficient of 6.5804. This result indicates that FDI has a statistically significant and significant promoting effect on the spillover effects of industrial structural adjustment. This finding is consistent with the research results of many domestic and foreign scholars. As mentioned in the previous literature review, Markusen and Venables (1999) believe that FDI plays a promoting role in industrial structural adjustment. Fu Qiang and Zhou Kehong (2005) found a strong correlation between China's domestic industrial structural adjustment and the introduction of

foreign capital, which not only promoted the development of China's industrial structure towards a higher level but also improved the quality of various industries. The research results of Nie Aiyun and Lu Changping (2012) show that the increase in FDI helps to increase the proportion of the tertiary industry in the economy, reduce the proportion of the secondary industry, and overall optimize the industrial structure.

Taken together, these studies consistently indicate that the spillover effects of FDI have a positive impact on promoting industrial structural adjustment. This is consistent with the results obtained from Model (2), further theoretically validating the correctness of Model (2). Therefore, FDI not only has a positive impact on the productivity of domestic enterprises but also has a significant promoting effect on overall industrial structural adjustment and upgrading through spillover effects.

In Model (3), the variables LTEC and LIIA both pass the 5% significance test, with coefficients of -0.2435 and 0.0473, respectively. It can be seen that the coefficient of LIIA is positive, indicating that indigenous innovation has a positive impact on industrial structural adjustment. This is also consistent with the content of the literature review mentioned earlier, such as "Nelson, R. R., & Winter, S. G. (1983) argue that innovation is the driving force behind economic structural adjustment. Jelinek, Mariann, and Porter, M. E. (1990) believe that indigenous innovation will have a profound impact on the overall industrial structure. Zhou Shulian and Wang Weiguang (2001) pointed out in their research that technological innovation is the driving force behind industrial structural adjustment. Du Chuanwen, Lv Jie, and Rui Mingjie (2018) believe that with the upgrading of industrial technology, the company's own technology, namely indigenous innovation, is becoming increasingly important in competition. Song Deyong and Bi Daojun (2022) found that technological innovation can effectively promote the rational development of industrial structure." This also theoretically verifies the accuracy of the empirical results and further validates the correctness of the theory.

In Model (4), this study conducted an in-depth analysis of the spillover effects of FDI. Firstly, the estimated coefficient of FDI spillover effects in this model is significantly negative, indicating that FDI technology spillover effects have a negative impact on indigenous innovation capabilities to some extent. However, after introducing the cross-term of FDI spillover effects and indigenous innovation, i.e.,  $FDIP \times LIIA$ , and conducting significance tests at the 1% level, it is found that the coefficient of this interaction term is significantly positive, with a coefficient value as high as 2.5818. This result indicates that although the spillover effects of FDI may have a negative impact on indigenous innovation capabilities, when considering the cross-effects of FDI spillover effects and indigenous innovation, FDI's technology spillover effects actually promote the improvement of indigenous innovation capabilities. This suggests that the technology and knowledge introduced by foreign-invested enterprises penetrate into local enterprises to some extent, stimulate their indigenous innovation vitality, and promote the overall innovation level of the entire region. Specifically, the technology spillover effects of FDI may have positive impacts on the indigenous innovation capabilities of local enterprises through various channels such as technology transfer and personnel mobility. The existence of such

technology spillover effects gradually optimizes the industrial structure in the Beijing-Tianjin-Hebei region and makes the composition of various industries more reasonable. Therefore, the results of Model (4) emphasize the positive role of foreign investment, which not only enriches the knowledge system of enterprises in the region but also promotes the upgrading and optimization of the entire industrial structure through promoting indigenous innovation.

## 4. Result Analysis and Evaluation

This study employs the dynamic panel data analysis method, specifically the system GMM estimation, to examine the data of 13 cities in the Beijing-Tianjin-Hebei urban agglomeration from 2013 to 2021, spanning a period of 9 years. Empirical analysis is conducted considering the cross-effects of FDI spillover effects and indigenous innovation.

The research results firstly indicate that without considering indigenous innovation capabilities, FDI spillover effects have a positive impact on industrial structural adjustment in the Beijing-Tianjin-Hebei region, which is consistent with existing research conclusions. However, when introducing indigenous innovation as well as the cross-effects of FDI spillover effects and indigenous innovation, the coefficient of FDI spillover effects becomes negative. This result suggests that the direct effects of FDI may have a negative impact on industrial structure, but the following results explain this phenomenon. In further analysis, the coefficients of indigenous innovation as well as the cross-effects of FDI spillover effects and indigenous innovation are positive, and the coefficient of the cross-term is as high as 2.5818. This indicates that FDI spillover effects promote the optimization and upgrading of industrial structure in the Beijing-Tianjin-Hebei region by stimulating indigenous innovation capabilities. Therefore, FDI spillover effects not only play a role in directly influencing industrial structural adjustment but also achieve optimization and adjustment of industrial structure through indirect means, namely, promoting indigenous innovation.

Overall, there are certain differences between the direct and indirect effects of FDI spillover effects on industrial structural adjustment in the Beijing-Tianjin-Hebei region. On the one hand, FDI spillover effects directly promote the upgrading of industrial structure. On the other hand, through promoting the improvement of indigenous innovation capabilities and enhancing competitiveness, they ultimately facilitate the optimization and adjustment of industrial structure through the synergistic effects with indigenous innovation capabilities.

## 5. References Policy Suggestion

### 5.1 Significantly enhancing the indigenous innovation capabilities in the Beijing-Tianjin-Hebei region.

Efforts should be made to significantly enhance the indigenous innovation capabilities in the Beijing-Tianjin-Hebei region. As the "Capital Economic Zone" of China, this region has become one of the core areas for innovation-driven development in the country due to its advantages in location, talent resources, and technological infrastructure. In order to further promote indigenous innovation, the Beijing-Tianjin-Hebei region needs to actively build an open innovation system, encourage deep integration of industry, academia, and research, and facilitate the transformation of scientific

and technological achievements. The government should increase investment in policy guidance, funding support, and research projects, improve incentives for researchers, and encourage the growth of innovative enterprises. At the same time, it is important to strengthen international cooperation and exchanges, attract top global scientific and technological talents, and gather innovative resources to transform the Beijing-Tianjin-Hebei region from a follower to a leader. Continuous efforts should be made to deepen reform and opening-up, strengthen policy coordination, increase infrastructure construction, and focus on enhancing the indigenous innovation capabilities of the Beijing-Tianjin-Hebei region.

## **5.2 Balancing the distribution of FDI in the Beijing-Tianjin-Hebei region.**

The Beijing-Tianjin-Hebei region should strive to optimize the regional distribution of foreign direct investment (FDI) to ensure a more balanced coverage across the entire region and reduce the phenomenon of regional development imbalance. Firstly, it is necessary to enhance understanding of regional development differences, including the industrial characteristics, economic potential, and infrastructure conditions of each area, in order to guide and allocate FDI in a scientific and rational manner. Secondly, the government should formulate more attractive policies and provide differentiated preferential policies based on the characteristics of different regions, encouraging foreign-invested enterprises to invest in various areas of the Beijing-Tianjin-Hebei region and avoiding excessive concentration in a single area. In addition, strengthening cross-regional cooperation and promoting the development of industrial and value chains across regions will facilitate the complementary advantages and resource sharing among different areas within the region, achieving synergistic economic growth. Finally, it is important to strengthen monitoring and evaluation of FDI distribution, promptly adjust policies and measures, and ensure the balance and effectiveness of FDI layout in the Beijing-Tianjin-Hebei region.

## **5.3 Promoting the coordinated development of foreign investment attraction and independent innovation capabilities.**

In the process of promoting the high-quality development of the Beijing-Tianjin-Hebei urban cluster, the introduction of foreign investment and the enhancement of independent innovation capabilities are crucial factors. To achieve this goal, the government can take a series of measures to establish a more favorable environment for foreign investment attraction and independent innovation. Firstly, in order to attract more foreign investment, the government can further optimize investment policies and regulations, providing a more open and convenient investment environment. This includes simplifying approval procedures, lowering investment thresholds, and offering more incentives to attract investment in high-tech and strategic emerging industries. Secondly, to enhance the independent innovation capabilities of local enterprises in the Beijing-Tianjin-Hebei region, it is necessary to increase support for research and innovation. The government can increase research funding, establish more research platforms and laboratories, strengthen industry-academia-research cooperation, and encourage enterprises to increase investment in research and development. At the same time, providing more tax

reductions and fiscal support to enterprises can encourage their exploration and investment in technological innovation. Additionally, the government can provide more innovation resources and support by establishing incubators for innovative enterprises and technology parks. These platforms can assist enterprises with facilities, technical support, and talent training, promoting the enhancement of their innovation capabilities. Through the comprehensive implementation of these measures, the Beijing-Tianjin-Hebei urban cluster can better leverage foreign investment to promote independent innovation capabilities, thereby taking more robust steps in industrial structure adjustment and achieving high-quality economic development.

## **5.4 Improving the efficiency of technology transfer in promoting FDI spillover effects in the Beijing-Tianjin-Hebei region.**

Improving the efficiency of technology transfer in promoting FDI spillover effects in the Beijing-Tianjin-Hebei region is crucial for achieving regional synergistic development and innovation-driven growth. Technology transfer is the process of converting research and development achievements into practical productivity, which is essential for enhancing FDI spillover effects. Firstly, it is necessary to strengthen the alignment between technological achievements and industrial demands, establish a rapid response mechanism for the promotion and application of technological achievements, and ensure that research outcomes can timely and effectively meet the actual needs of the market and enterprises. Secondly, encourage deep collaboration among local enterprises, universities, and research institutions in the Beijing-Tianjin-Hebei region, build an organic integration of innovation chains, industrial chains, and supply chains, and achieve rapid transformation and industrialization of technological achievements. At the same time, improve the intellectual property protection system, provide more policy incentives and financial support, reduce the risks and costs of technology transfer, and attract more investors and innovators to participate. Additionally, strengthen the cultivation and introduction of scientific and technological talents, build high-level research and development teams and innovation platforms, and enhance the technical level and efficiency of technology transfer. Through these measures, the Beijing-Tianjin-Hebei region can not only effectively enhance the spillover effects of FDI but also promote the widespread application of technological achievements, enhance the innovation capacity and competitiveness of the entire region, and promote the optimization and upgrading of the industrial structure within the region, thus achieving high-quality economic development.

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