Beijing-Tianjin-Hebei Coordinated Development Strategy and Regional Economic Growth

Analysis of 13 Cities' Panel Data in the Beijing-Tianjin-Hebei Region using PSM-DID Method

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Abstract This paper employs the PSM-DID method and Dynamic DID to analyze the impact of the Beijing-Tianjin-Hebei coordinated development strategy on the economic development of 13 covered cities. The results indicate that: (1) Overall, the implementation of the Beijing-Tianjin-Hebei coordinated development policy has a positive effect on promoting economic development in the policy-covered areas, but this effect gradually becomes evident only after 1-2 years. (2) For cities like Beijing, Shijiazhuang, Baoding, Hengshui, and Langfang, this policy has promoted their economic development. However, for cities like Tangshan, Handan, Zhangjiakou, and Chengde, the implementation of this policy has hindered the growth of per capita GDP and GDP. (3) The economic growth in this region has primarily exhibited a diffusion effect towards the south and a polarization effect towards the north. Furthermore, centered around Beijing, the closer the distance, the more pronounced the effects observed. Based on these findings, this paper proposes recommendations for promoting the coordinated and interconnected development of the Beijing-Tianjin-Hebei region. These recommendations include government-led efforts to break down administrative barriers, focusing on the flow of educational resources and innovation outcomes, strengthening the interrelatedness of industrial structures, promoting advanced industrialization, mitigating household registration disparities, and advancing deeper integration of public services.

Keywords: Beijing-Tianjin-Hebei Integration; Coordinated Development; Policy Evaluation; PSM-DID; Dynamic DID

1 Introduction

In 2015, the Central Political Bureau of the Communist Party of China approved the "Outline of the Beijing-Tianjin-Hebei Coordinated Development Plan" (hereinafter referred to as the "Outline"). The 19th National Congress Report also emphasized the active implementation of the regional coordinated development strategy to alleviate the non-capital functions of Beijing, which serve as the "leading driver," and promote the coordinated development and economic integration of the Beijing-Tianjin-Hebei region. Regional economic integration is a crucial component of the regional integration process. It is based on the differences in regional resource endowments and existing economic foundations, aiming to improve the imbalances in regional development by breaking down administrative barriers resulting from regional divisions, integrating the allocation of production factors within the region, and deepening cooperation and division of labor among regions. The ultimate goal is to achieve shared development of the regional economy.

The ultimate goal of regional economic integration is to achieve shared prosperity, with wealth generated initially in prosperous areas benefiting less-developed regions, ultimately leading to the common prosperity of the people. Examples of successful regional coordinated development include the Yangtze River Delta Regional Integration and the Pearl River Delta Regional Integration. In 2019, the combined GDP of the Yangtze River Delta and Pearl River Delta economic regions reached 2.91 trillion yuan, accounting for 29.1% of the national GDP. Within the Yangtze River Delta strategy, Shanghai, Jiangsu Province, and Zhejiang Province ranked 1st, 4th, and 5th in per capita GDP in China in 2010, with values of 76,074 yuan, 52,840 yuan, and 51,711 yuan, respectively. By 2019, their per capita GDP had risen to 157,279 yuan, 123,607 yuan, and 107,624 yuan, respectively, ranking 2nd, 3rd, and 4th in the country. Shanghai, in particular, played a leading role and drove the surrounding areas to develop together, resulting in a narrowing of economic disparities among the regions.

However, the Beijing-Tianjin-Hebei integration strategy, another major regional economic development strategy, had different outcomes. Initially, in 2015, the per capita GDP of Beijing, Tianjin, and Hebei was 106,497 yuan, 107,960 yuan, and 40,255 yuan, respectively, with rankings of 3rd, 2nd, and 19th in the nation. By 2019, their per capita GDP had increased to 164,220 yuan, 90,371 yuan, and 46,348 yuan, respectively. Beijing's per capita GDP surged to 1st place in the nation, while Tianjin and Hebei's rankings dropped to 7th and 26th, respectively, in terms of per capita GDP in the country. This indicates that, despite both being part of China's major regional coordinated development strategies, the economic development disparities among provincial-level administrative units in the Beijing-Tianjin-Hebei region have been widening over time.

Beijing, Tianjin, and Hebei Province are located in the North China Plain, and they are similar in terms of natural resource endowments. However, barriers stemming from administrative divisions and government policies have been the fundamental reasons behind the development disparities observed in the Beijing-Tianjin-Hebei region. The government is the most suitable entity to eliminate these regional development barriers, and government policies aimed at regional coordinated development directly influence the dismantling of these barriers. Government-promulgated regional coordinated development policies serve as driving forces for the transfer of technology and factors of production across regions.

Currently, people have differing views on the economic effects of the Beijing-Tianjin-Hebei integration policy. Some people believe that the overall impact of the Beijing-Tianjin-Hebei integration strategy has been to promote regional economic development, while others hold opposing views, suggesting that the integration process faces obstacles, and disparities continue to widen. This paper argues that economic growth is aimed at enhancing the utility that people can obtain, and regional development is just one dimension of overall development. From the perspective of per capita GDP, the development gap in the Beijing-Tianjin-Hebei region has been widening, and the growth rates of per capita GDP in Tianjin and Hebei are insufficient to maintain their original rankings among provinces and cities nationwide. This may be related to the use of provincial-level panel data by some scholars, which overlooks the variability in policy impacts at the municipal level.

Therefore, this paper uses municipal-level panel data from the Beijing-Tianjin-Hebei region and surrounding provinces and utilizes the PSM-DID method to evaluate the policy effects of Beijing-Tianjin-Hebei coordinated development. Furthermore, we have noticed that the traditional DID (Difference-in-Differences) method assumes that all individuals in the treatment group experience the same treat at the same time. However, in reality, the Beijing-Tianjin-Hebei coordinated development strategy has introduced different policies to different cities and regions. Therefore, it is highly possible that the policy's effects vary across different cities and regions. Based on this, this article also employs the Dynamic DID method to analyze the policy's effects in different years and cities.

The results of this paper are as follows.

(1) Overall, the Beijing-Tianjin-Hebei coordinated development planning policy has a promoting effect on the development of the region. The policy's impact exhibits a lag, meaning that although the policy was introduced in 2015, its effects have become increasingly evident from 2016 onwards (with regression coefficients becoming significant). This effect is particularly pronounced when considering the total GDP, where the policy's impact has been growing (with increasing regression coefficients).

(2) Regarding the results specific to each city, the timing of the policy's impact varies. For instance, in the case of Beijing, the policy's effects became more noticeable from 2016 onwards, while for cities like Qinhuangdao, the policy's impact has remained inconspicuous.

(3) From a spatial perspective, the policy's effects are non-uniform. For cities like Beijing, Shijiazhuang, Baoding, Hengshui, and Langfang, this policy has promoted their economic development. However, for cities like Tangshan, Handan, Zhangjiakou, and Chengde, the implementation of this policy has hindered the growth of per capita GDP and GDP.

(4) Considering the geographical locations of these cities, if Beijing is considered the growth pole of this region, the southern direction mainly exhibits a diffusion effect, while the northern direction primarily demonstrates a polarization effect. Additionally, the closer the distance, the more pronounced the effects observed.

The remaining sections of this paper are organized as follows.Section Two provides a review of the existing

research findings by scholars in the field.Section Three introduces the model design approach and the criteria used for selecting indicators.In Section Four, we calculate the policy effects while controlling for different time fixed effects and by breaking down the analysis into individual cities.To ensure the credibility of the model, Section Five includes counterfactual tests for both the overall model and the city-specific models.Finally, Section Six presents the conclusions drawn from the model and offers insights into the widening development gap in the Beijing-Tianjin-Hebei region, along with policy recommendations.

2 Related Literature

2.1 Review of the Policy Effects on Synergetic Development

Current research on the impact of the Jing-Jin-Ji coordinated development strategy on regional development shows mixed evaluations. Some scholars believe that the Jing-Jin-Ji integration strategy has overall promoted regional economic development. For example, Liu Jiajun (2020) argues that the synergy within Jing-Jin-Ji has been increasing, internal urban disparities have been narrowing, economic connections have been growing stronger, industrial optimization and reform have been deepening, and regional division of labor has been improving. Even if the regional coordination process exhibits a spiral or wave-like pattern of fluctuations, it is considered a normal part of development (Fang Chuanglin, 2017).

However, other scholars hold opposing views. As early as 2014, before the release of the "Outline," Bo Wenguang pointed out several issues in the analysis of Jing-Jin-Ji coordinated development. These issues include the clear hierarchical structure of industrial development among the three areas, difficulty in forming a mutually beneficial interaction, significant disparities in existing regional development, the concentration of resources toward economic centers leading to the stagnation of peripheral areas, and a lack of coordinated governance mechanisms. One major reason for these problems is the competition for resources among the three regions, each acting independently. Additionally, in terms of political status, Beijing is far ahead of Tianjin, with Hebei lagging behind, which has led to a situation where they "serve the central government" at the expense of their own development.

Zhang Saiyin (2019) conducted quantile regression analysis to assess economic development disparities in the Jing-Jin-Ji region. Zhang found that Beijing, Tianjin, and Tangshan are the three fastest-developing entities within Jing-Jin-Ji, with no significant differences in overall economic growth rates. However, it's important to note that Tangshan is just one of many cities in Hebei Province, and this conclusion suggests that many other cities in Hebei have experienced insufficient development.

2.2 A Review of Policy Impact Research Methods

2.2.1 Policy Text Analysis

Policy text analysis is a research method that involves the statistical examination of government policy documents to explore aspects such as the evolution of policies and their areas of focus. This approach combines knowledge from fields like bibliometrics and statistics and can also be used to forecast future policy development trends. In a study conducted by Wei Wei in 2021, this method was employed to analyze policy documents from the Beijing-Tianjin-Hebei (Jing-Jin-Ji) region between March 1, 2014, and February 28, 2019. The analysis revealed that policies in Hebei Province primarily emphasized adjustments in the tertiary industry structure and infrastructure development, while policies in Beijing were particularly focused on the public services sector. Policies in Tianjin Municipality primarily concentrated on the tertiary industry and comprehensive management. Additionally, the study found that policies in the Jing-Jin-Ji region exhibited a characteristic of "top-down promotion" as a core driving force.

2.2.2 Policy Text Analysis

Regression Discontinuity (RD) is a quasi-experimental method that addresses endogeneity issues between variables, accurately reflecting causal relationships between variables. Samples in the Regression Discontinuity design are divided into two groups: the experimental group, which is influenced by a policy, and the control group, which is not affected by the policy. Considering that policy implementation is a binary variable, policy shocks may result in a discontinuity in certain observed values within the treatment group. By comparing the difference in the observed value for the treatment group after policy implementation at both sides of the discontinuity point, treatment effects can be identified. The formula is as follows:

$$\lim_{D \downarrow D_0} E(P|D) - \lim_{D \uparrow D_0} E(P|D) = F_1(x_i) - F_0(x_i) \neq 0 \tag{1}$$

where $F_1(x_i)$ and $F_0(x_i)$ are arbitrary functions, if , it satisfies the hypothesis that the experimental group exceeds the control group.

$$E(D|x_i) = P(D_i = 1|x_i) = F_0(x_0) + [F_1(x_0) - F_0(x_0)]T_i \tag{2}$$

T_i is the treatment effect.

2.2.3 Differences-in-Differences Method

The Differences-in-Differences Method (DID) is the most commonly used approach in academia for evaluating policy effects. It is based on natural experiments and its core is to control for a single variable through multiple differences. Therefore, the control group and treatment group should be as similar as possible in aspects other

than policy implementation, satisfying the hypothesis that they have the same development trend in the absence of intervention. Additionally, considering the basic form of the Differences-in-Differences method as follows:

$$Y_{it} = \beta_0 + \beta_1 \text{treated} \times \text{time} + \beta_2 X_{it} + \lambda_i + \mu_i + \varepsilon_{it} \tag{3}$$

where Y_{it} represents the dependent variable, treated $\times$ time represents the core explanatory variable. Variable treated spatially distinguishes the policy coverage, taking the value 1 if the city implements the policy and 0 if it does not. Variable treated temporally distinguishes the policy implementation, taking the value 1 if the policy is implemented and 0 if it is not yet implemented. Variable X_{it} comprises a series of control variables that affect regional economic development, used to control for other factors that may influence the outcome. To account for spatial heterogeneity and time heterogeneity in city regions, variables λ_i represent unobservable city fixed effects, and variables μ_i represent time fixed effects. Lastly, variable "h" represents random error.

Overall, it is evident that there is still disagreement among scholars regarding the economic effects of the Beijing-Tianjin-Hebei integration policy. Additionally, in terms of selecting measurement indicators, scholars often use aggregate indicators as standards to assess regional development levels. However, it is important to note that economic growth is ultimately aimed at enhancing the utility that people can derive. In this context, regional development is just one dimension, and when considering per capita GDP, the development gap in the Beijing-Tianjin-Hebei region is continuously widening. Furthermore, the growth rates of per capita GDP in Tianjin and Hebei are insufficient to maintain their original rankings among provinces and cities nationwide.

As a result, this paper puts forward the following three hypotheses:

Hypothesis 1: The Beijing-Tianjin-Hebei coordinated policy has varying effects on different cities.

Hypothesis 2: The implementation effects of the Beijing-Tianjin-Hebei coordinated policy exhibit a lag.

From a research method perspective, scholars have approached the Beijing-Tianjin-Hebei policy from both qualitative and quantitative angles. Policy text analysis primarily focuses on qualitative analysis, allowing for the identification of policy emphases and directions, but it cannot provide specific insights into policy effects. On the other hand, regression discontinuity analysis and difference-in-differences analysis are quantitative approaches that treat policy implementation as an external shock. They assess the impact of this shock on the overall economy, focusing on specific policies while often disregarding subsequent policies and overlooking differences in policies applied to different sectors.

3 Data Sources and Model Design

3.1 Research Design

The implementation of the regional coordinated development strategy can be seen as a localized experiment aimed at promoting economic growth within the entire country. Quantitatively assessing the effectiveness of

policy implementation requires precise control of the single variable, whether the policy has been implemented or not. However, regional economic development is influenced by various factors such as resources, environment, finance, foreign investment, and government policies. If we only compare the situation before and after the implementation of a specific policy in a region, we cannot differentiate what factors have led to the economic growth in that region. Therefore, this study employs the Double Difference (DID) model for analysis.

The common assumption in traditional treatment effects models that "treatment effects are homogeneous" does not align with the staircase-like characteristics of the Beijing-Tianjin-Hebei coordinated development plan, which features "one core, two cities, three axes, four zones, and multiple nodes." Considering that comparing policy-implemented areas and non-implemented areas during the same time period overlooks the spatial heterogeneity among different provinces and cities, and solely focusing on regional differences while ignoring time changes neglects the economic development brought about by natural growth in the regional economy. Therefore, this paper will use an individual and time double-fixed double difference approach to establish models for both the overall Beijing-Tianjin-Hebei region and its corresponding cities.

Considering that the Beijing-Tianjin-Hebei integration plan in China covers all cities within Beijing, Tianjin, and Hebei Province, they all belong to the treatment group. Taking into account the differences in development models between northern and southern regions in China, as well as variations in the level of development between eastern and western regions, and given the distinctiveness of Beijing and Tianjin as two direct-administered municipalities compared to other provincial-level administrative regions, this paper employs the Propensity Score Matching-Double Difference model (PSM-DID model) proposed by Heckman et al. Specifically, this involves using the Propensity Score Matching (PSM) method to find control groups from 79 cities in the surrounding regions of the Beijing-Tianjin-Hebei area, which include Liaoning Province, Inner Mongolia Province, Shanxi Province, Henan Province, and Shandong Province, as well as the other two direct-administered municipalities, Shanghai and Chongqing.

Considering that there might be a time lag between policy issuance and the actual policy effect, this paper will also separately calculate the policy effects for 1-3 years after policy issuance.

The research approach in this paper is as shown in the following diagram:

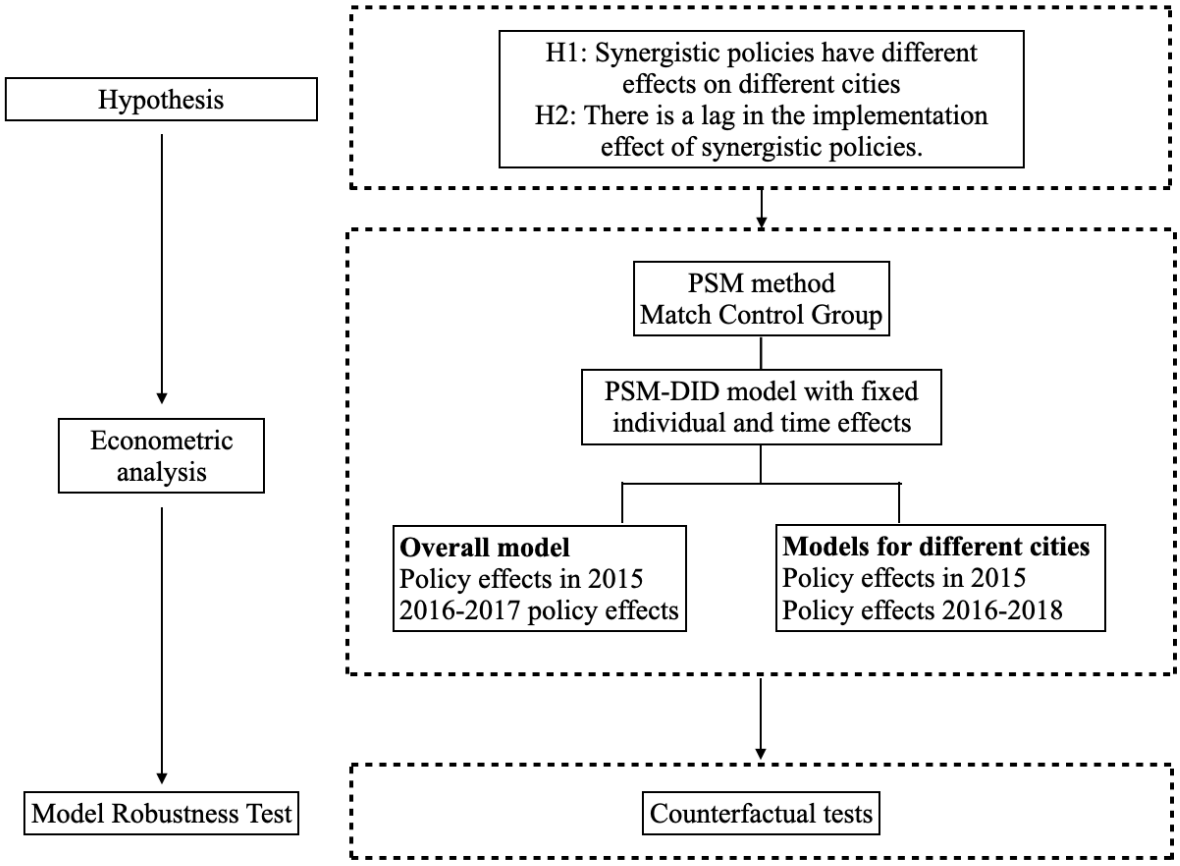

Figure 1: Research Design

3.2 Control Variables and Data Sources

The total GDP of a city can directly reflect the level of regional economic development, and per capita GDP can reflect the standard of living of the people in that region. Therefore, this paper selects the total GDP of the city and the per capita GDP as the dependent variables. The data comes from the statistical bulletins published by various cities over the years. Since economic growth is determined by multiple factors, regional economic integration policies reduce or even eliminate administrative barriers between regions, increase government investment in infrastructure, and provide fiscal support to local enterprises. Therefore, the following control groups need to be considered:

3.2.1 The Degree of Industrial Structure Sophistication

The industrial structure measures the characteristics of the region's industrial structure. The transformation of the industrial structure will cause labor to flow between different sectors, thereby changing labor income. The industrial structure in the Beijing-Tianjin-Hebei region exhibits a clear hierarchical characteristic. Due to the small administrative areas of Beijing and Tianjin, the proportion of the primary industry is extremely low. Meanwhile, Beijing serves as the capital and has shifted many industrial enterprises, showing a significant emphasis on the service sector, entering the post-industrialization stage with a strong presence of the service industry. Tianjin's economic growth is driven by both the secondary and tertiary industries. In contrast, Hebei Province has a relatively low proportion of the tertiary industry, with a higher proportion of the secondary industry, especially in the lower-level raw material supply sectors within the production chain. The heavy industry sector with high pollution and energy consumption is an important source of economic income in Hebei Province. The significant disparity in the industrial structure among the three regions is a crucial reason for the one-way flow of production factors (Bo Wen-Guang and Chen Fei, 2014). However, considering that the Thirteenth Five-Year Plan Outline indicates the need to relieve Beijing of its non-capital functions and relocate certain high-energy-consuming enterprises, logistics bases, and some medical, service, and administrative institutions to other spatial regions, it is important to note that GDP statistics are still based on the original location of the enterprises, and the employees are temporarily dispatched from the original enterprises. Therefore, this paper believes that the changes in the added value of the tertiary industry in the statistical data are mainly caused by endogenous factors of regional development. Moreover, the guidance outline of functional positioning and spatial pattern optimization in the Beijing-Tianjin-Hebei coordinated development strategy emphasizes strengthening the characteristics of its own industrial structure. In the "Fourteenth Five-Year Plan and 2035 Vision Outline" released in 2021, it is explicitly proposed to 'promote the deep integration of the industrial chain and innovation chain in the Beijing-Tianjin-Hebei region.' Therefore, this paper believes that in the short term, the changes in the added value of the tertiary industry in the Beijing-Tianjin-Hebei region due to the coordinated strategy are relatively stable, and the changes in industrial structure sophistication caused by technology and innovation have not been fully implemented in the short term. Hence, it is difficult to reflect.

Therefore, this paper controls the proportion of added value of the tertiary industry to GDP in that year and uses the ratio of the tertiary industry to the secondary industry to reflect the local industrial structure sophistication. The added value of the tertiary industry and the total GDP of each year in this paper are based on the statistical bulletins of the respective cities, and the ratio of the added value of the tertiary industry is calculated based on this data to estimate the local industrial structure. For some areas and years in Liaoning Province and Inner Mongolia that did not directly disclose GDP and added value of the tertiary industry in the current year, the GDP growth rate disclosed in the statistical bulletin is used for calculation."

3.2.2 Foreign Direct Investment

Foreign Direct Investment (FDI) refers to economic activities conducted by foreign enterprises, other economic organizations, or individuals that are approved by the Chinese government to invest and establish productive enterprises within China. FDI brings both technology and capital to regional development, thereby promoting regional economic growth. Given that the Beijing-Tianjin-Hebei coordinated development strategy emphasizes internal cooperation and connections, especially regional economic growth changes resulting from government guidance and investment, this section uses the amount of FDI in foreign-invested enterprises as a control variable reflecting foreign investment conditions. The data in this section mainly come from the statistical bulletins of various cities in 2020 and the "China Urban Statistical Yearbook" from 2011 to 2019. Missing values are supplemented from provincial statistical yearbooks. Since the unit of measurement is "ten thousand US dollars," it is converted to RMB according to the average exchange rate between China and the US for that year. Exchange rate data come from the "China Statistical Yearbook" from 2011 to 2020.

3.2.3 Human Capital

With the development of science and technology, human capital and technological levels have become increasingly important drivers of economic growth. Human capital refers to the knowledge and skills possessed by the labor force, which depend on training and education. The talent development and scientific research capabilities in the Beijing-Tianjin-Hebei region exhibit a hierarchical pattern, with Beijing having the highest capabilities, followed by Tianjin, and then Hebei. The current stage of the regional coordinated development strategy focuses more on innovation and technology transfer, and the quality of labor is not expected to improve significantly in the short term due to the strategy. This is particularly true for Hebei Province, where the quality of labor depends more on the local talent development capabilities. Therefore, this paper needs to control for the human capital variable. Since the data from the sixth national population census have a long time interval and are not representative, this paper measures the annual increase in regional human capital using the number of regular university students in the city, which is sourced mainly from the "China Urban Statistical Yearbook" from 2011 to 2019. Missing values are supplemented using data from the city's statistical bulletins, statistical yearbooks compiled by the city, and statistical yearbooks of the province where the city is located. Permanent resident population data are sourced from the city's statistical bulletins and the statistical yearbooks of the respective provinces.

4 Empirical Results

4.1 Analysis of the Regional Integration Policy Effects Based on the PSM-DID Method

Table 1: Regression Results

Explainary Variable	$\ln pGDP$		$\ln GDP$	
	With Control Variables	Without Control Variables	With Control Variables	Without Control Variables
treated × time	0.0587	0.0671	0.0704**	0.0836**
	(1.85))	(1.60)	(3.72)	(3.73)
seni		-0.0234		-0.2122
		(-0.85)		(-0.79)
STU		0.0000		0.0000
		(1.22)		(-1.16)
pFDI		2.7314**		2.1880**
		(4.24)		(3.63)
c	11.2209**	11.1779**	9.6277**	9.4912**
	(260.85)	(105.94)	(211.87)	(64.59)
N	766	633	771	635
Adjusted R^2	0.9332	0.9452	0.9740	0.9799
F Value	282.58	1747.72	756.99	797.04

*Note: *, ** indicate significant at the 0.10 and 0.05 significance levels, respectively, with t-values in parentheses.*

This paper uses Stata MP 13.0 to process the data, and the results are shown in the table above. From the calculation results, it can be seen that whether using urban GDP as the dependent variable or urban per capita GDP as the dependent variable, the coefficient of the treated*time interaction term is positive, indicating that policy implementation is conducive to increasing regional income when using the logarithm of GDP total as the explanatory variable. However, when using the logarithm of per capita GDP as the explanatory variable, the coefficient is not significant at the 0.05 significance level, whether or not control variables are included. This suggests that the policy's impact on per capita income levels is not significant, possibly because the full effect of the policy takes some time to materialize. To investigate the lagged effects of policy implementation, we continue to utilize the Dynamic Difference-in-Differences (Dynamic DID) method for analysis. The regression

model constructed is as follows:

$$Y_{it} = \beta_0 + \sum_{j=2015}^{2018} \beta_j treated \times time_j + \beta_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{4}$$

In this model, we use $\sum_{j=2015}^{2018} \beta_j treated \times time_j$ instead of $\beta_1 treated \times time$ to explore the policy effect in different years. The results are shown in the following table.

It can be observed that all policy regression coefficients for the year 2015 are not statistically significant, whereas in the subsequent years, 2016 and 2017, these coefficients begin to exhibit significance. Moreover, in the regression equation with lnGDP as the dependent variable, this positive coefficient continues to increase. This indicates that there is a certain lag in the generation of policy effects, requiring some time for these effects to manifest, and policy effects tend to strengthen over time.

The regression coefficients for the year 2018 are all not statistically significant, which may be attributed to the fact that in 2018, there was a significant amount of missing data in many local statistical yearbooks, leading to incomplete data for that year.

4.2 Analysis of the Effects of Regional Integration Policies on Different Cities Based on the PSM-DID Method

The previous analysis of the implementation effects of the Beijing-Tianjin-Hebei coordinated development policy supports the view in academia that the policy promotes regional development. However, it does not fully explain why the per capita income gap in the Beijing-Tianjin-Hebei region continues to widen. Given the significant differences in industrial structure, human capital stock, and other factors among the three regions, the same policy may have different effects on Beijing, Tianjin, and Hebei. In some areas, the impact of the policy promotion may be relatively small, leading these areas to continue along their existing economic development trends. Because Beijing has a more favorable industrial structure compared to Tianjin and Hebei, Beijing has the greatest development potential, while Hebei and Tianjin show relatively weaker development. Therefore, this study suggests that the effectiveness of the Beijing-Tianjin-Hebei coordinated development policy may vary across different regions, and the time it takes for significant impacts to emerge may also differ.

In the PSM-DID method used in the previous section, the differences in economic development in different regions were examined over time by comparing before and after policy implementation, using the policy implementation as the dividing line. After the first difference, a series of factors, including policy implementation factors, affected economic development in the policy-covered areas. To control for the impact of other factors on regional economic development, a second difference was conducted using the PSM-DID method, which eliminated the influence of other economic factors on regional economic development through cross-sectional differences between the experimental and control groups. This provided an assessment of the specific impact of policy factors on regional economic development. However, this method does not account for the variability

Table 2: Dynamic DID Regression Results

Variables	$\ln pGDP$		$\ln GDP$	
	With Control Variable	**Without Control Variable**	**With Control Variable**	**Without Control Variable**
$treated \times time_{2015}$	-0.1607	0.0119	0.0172	0.0294
	(-0.65)	(0.50)	(0.63)	(1.16)
$treated \times time_{2016}$	0.1928*	0.2443**	0.0728**	0.1079**
	(1.80)	(2.32)	(2.65)	(3.99)
$treated \times time_{2017}$	0.0511	0.0669*	0.1534**	0.1392**
	(1.20)	(1.88)	(4.16)	(4.78)
$treated \times time_{2018}$	-0.0792	-0.0082	-0.0104	0.0197
	(-0.89)	(-0.18)	(-0.14)	(0.46)
$SENI$	-0.0223		-0.0204	
	(-0.87)		(-0.80)	
STU	0.0000		0.0000	
	(1.30)		(1.20)	
$pFDI$	2.6565**		2.2041**	
	(4.11)		(3.64)	
c	11.1088**	11.2247**	9.5088**	9.6399**
	(87.02)	(227.87)	(66.06)	(197.30)
N	634	767	636	772
R^2	0.9473	0.9359	0.9803	0.9745
F Value	1294.50	255.71	919.52	1019.42

in the policy's impact on different areas. Therefore, we will treat each city as the experimental group, match samples obtained using the PSM method as the control group, and perform regression using the Dynamic DID method respectively. The regression results for$\ln pGDP$ and $\ln GDP$ as dependent variables are shown in table 3 and table 4.

We can observe that the policy indeed has different effects when implemented in different cities. This difference can be seen in two aspects: firstly, when the policy began to take effect, and secondly, the nature of the impact it had when it did take effect. In other words, did the policy promote economic development or hinder it? To what extent did it influence economic growth?

For cities like Beijing, Shijiazhuang, Baoding, Hengshui, and Langfang, this policy has promoted their economic development. This is evident in both per capita GDP and total GDP tables. This is especially true for Beijing, and as time has passed, this promoting effect has become increasingly pronounced. Furthermore, we can see from the increasing coefficients that the policy's positive impact on the economy has been growing.

However, for cities such as Tangshan, Handan, Zhangjiakou, and Chengde, the implementation of this policy has negative impact on the growth of per capita GDP and total GDP. This is especially the case for Tangshan, where the regression coefficients over the years have consistently been significantly negative.

If we combine the geographical locations of these cities, we can further uncover more details about the effectiveness of policy implementation. On the graph, areas represented in red and blue indicate the first category of cities (where the policy promotes economic development) and the second category of cities (where the policy hinders economic development), respectively. The gray areas represent regions where the regression coefficients have both positive and negative values, indicating uncertainty in the policy's impact on economic development, requiring continued observation over the next few years. Light-colored areas denote regions where the policy's effect on either GDP or per capita GDP is not significant, but it has a significant impact on the other.

Table 3: Regression coefficients in front of $treated * time_{year}$ obtained using Dynamic DID method for different cities (Explained Variable $\ln pGDP$)

City	With Control Variables				Without Control Variables			
	2015	**2016**	**2017**	**2018**	**2015**	**2016**	**2017**	**2018**
Beijing	0.0160	0.1235**	0.2569**	0.2570**	-0.0192	0.0927	0.1243**	0.2297**
	(0.72)	(4.93)	(5.19)	(6.89)	(-0.33)	(1.52)	(2.03)	(3.67)
Tianjin	-0.2194	-0.0529	0.1465**	-0.2281**	0.0602	0.1316**	0.1090**	-0.2840**
	(-1.67)	(-1.57)	(4.74)	(-5.76)	(1.30)	(2.71)	(2.22)	(-5.60)
Shijiazhuang	-0.0016	0.0682**	0.0996**	omitted	0.0348**	0.1204**	0.1425**	0.0085
	(-0.12)	(3.71)	(3.69)	-	(2.44)	(5.82)	(6.46)	(0.34)
Tangshan	-0.1056**	-0.0813**	-0.1048**	-0.2516**	-0.0694**	-0.0261	-0.0608**	-0.1831**
	(-4.60)	(-3.01)	(-3.11)	(-6.49)	(-2.70)	(-0.88)	(-1.98)	(-5.53)
Handan	-0.0956**	-0.0500	-0.0101	omitted	-0.0631**	0.0046	0.0316	-0.0957**
	(-3.54)	(-1.63)	(-0.28)	-	(-2.13)	(0.14)	(0.93)	(-2.64)
Xingtai	-0.0374	0.0433	0.0579	-0.0036	0.0015	0.1177**	0.1146**	0.0733**
	(-0.72)	(0.79)	(0.97)	(-0.06)	(0.06)	(4.09)	(3,85)	(2.28)
Zhangjiakou	-0.0693**	-0.0042	0.0542*	omitted	-0.0304**	0.0493**	0.0515**	-0.0276
	(-3.67)	(-0.17)	(1.94)	-	(-2.09)	(2.36)	(2.32)	(-1.09)
Baoding	0.0696**	1.4975**	0.0716**	omitted	0.0529**	1.5128**	0.0656**	0.0599*
	(4.55)	(73.21)	(2.57)	-	(2.28)	(54.80)	(2.29)	(1.92)
Qinhuangdao	0.0621	0.1236	-0.0674	omitted	0.1088	0.1847**	-0.0284	-0.0181
	(0.72)	(1.42)	(-0.75)	-	(1.51)	(2.51)	(-0.38)	(-0.24)
Chengde	-0.1850	0.4011	-0.2144	-0.2965	-0.1006	0.5005**	-0.1488*	-0.2011**
	(-2.43)	(5.18)	(-2.70)	(-3.64)	(-1.26)	(6.17)	(-1.83)	(-2.44)
Cangzhou	-0.0088	0.0371	0.0164	omitted	0.0223	0.0865**	0.0507**	-0.0115
	(-0.45)	(1.57)	(0.53)	-	(1.31)	(3.81)	(2.12)	(-0.43)
Hengshui	0.0364**	0.1756**	0.2180**	omitted	0.0268	0.1827**	0.2121**	0.1495**
	(2.28)	(8.33)	(7.78)	-	(1.08)	(6.31)	(7.08)	(4.62)
Langfang	0.1232**	0.2043**	0.1963**	omitted	0.1398**	0.2271**	0.2146**	0.2013**
	(6.40)	(9.21)	(6.70)	-	(8.67)	(10.30)	(9.20)	(7.62)

Table 4: Regression coefficients in front of $treated * time_{year}$ obtained using Dynamic DID method for different cities (Explained Variable $\ln GDP$)

City	With Control Variables				Without Control Variables			
	2015	**2016**	**2017**	**2018**	**2015**	**2016**	**2017**	**2018**
Beijing	0.0957**	0.1975**	0.2824**	0.3293**	0.0367	0.1461**	0.1779**	0.2612**
	(2.85)	(6.61)	(6.27)	(8.56)	(0.53)	(2.10)	(2.51)	(3.71)
Tianjin*	0.0903**	0.2690**	-0.1300**	-0.2281**	0.1485**	0.2271**	0.2080**	-0.2037**
	(2.59)	(2.08)	(6.05)	(-2.62)	(3.84)	(5.87)	(5.05)	(-5.04)
Shijiazhuang	0.0474*	0.1146**	0.1709**	omitted	0.0630**	0.1490**	0.1795**	0.0355
	(1.91)	(5.24)	(4.96)	-	(3.04)	(7.19)	(7.17)	(1,50)
Tangshan	-0.0771**	-0.0639**	0.0270	-0.1982**	-0.0573**	-0.0243	0.0395	-0.1646**
	(-3.07)	(-2.80)	(0.77)	(-6.02)	(-2.31)	(-0.98)	(1.39)	(-6.02)
Handan	-0.0613**	-0.0231	0.0445	omitted	-0.0443	0.0151	0.0536*	-0.0896**
	(-2.12)	(-0.85)	(1.19)	-	(-1.53)	(0.52)	(1.66)	(-2.87)
Xingtai	-0.0259	0.0444	0.1577**	0.0179	0.0055	0.1081**	0.1871**	0.0643**
	(-0.47)	(0.79)	(2.50)	(0.29)	(0.21)	(4.17)	(6.35)	(2.27)
Zhangjiakou	-0.0458*	0.1268	0.0815**	omitted	-0.0199	0.0494**	0.0565**	-0.0395*
	(-1.81)	(0.53)	(2.59)	-	(-0.94)	(2.34)	(2.23)	(-1.64)
Baoding	0.0249	0.0291	0.0498	omitted	0.0252**	0.0614**	0.0428	-0.0906**
	(0.79)	(0.96)	(1.26)	-	(0.94)	(2.28)	(1.41)	(-3.09)
Qinhuangdao	-0.0505	0.0032	0.1075**	omitted	-0.0435	0.0255	0.0871**	0.0859**
	(-1.39)	(0.09)	(2.39)	-	(-1.35)	(0.79)	(2.47)	(2.50)
Chengde	-0.0436	0.-0.0062	-0.1063**	-0.0894*	0.0194	0.0729**	0.1392**	-0.0331
	(-0.97)	(-0.14)	(2.13)	(-1.82)	(0.91)	(3.41)	(5.44)	(-1.36)
Cangzhou	0.0001	0.0668**	0.1212**	omitted	0.0144	0.1012**	0.1228**	0.0015
	(0.04)	(3.15)	(3.55)	-	(0.69)	(4.83)	(4.87)	(0.06)
Hengshui	0.0722**	0.2029**	0.2690**	omitted	0.0476	0.1950**	0.2317**	0.1535**
	(2.51)	(7.49)	(7.29)	-	(1.34)	(5.49)	(6.07)	(4.11)
Langfang	0.1915**	0.275**	0.3053**	omitted	0.2011**	0.2912**	0.2980**	0.2903**
	(7.39)	(12.47)	(9.02)	-	(9.47)	(13.71)	(11.69)	(12.01)

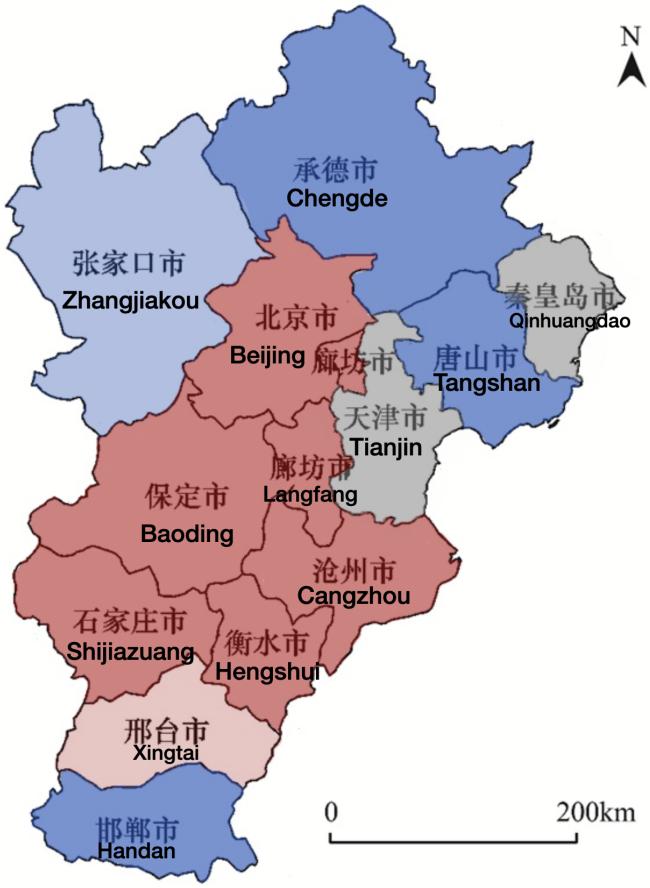

Figure 2: Policy Impact

We can find two key patterns:

Firstly, centered around Beijing, cities who are closer to Beijing experience a more significant impact from the policy, whereas cities farther from Beijing exhibit less noticeable effects, whether these effects are promoting or hindering economic development.

Secondly, cities situated to the south of Beijing primarily experience a promoting effect, while cities to the north of Beijing mainly encounter a restraining effect.

Thirdly, Tianjin, as the second municipality directly governed by the central government in the Beijing-Tianjin-Hebei region, experiences an ambiguous impact on its economic development due to the policy. During the years 2015-2017, there was a noticeable positive promoting effect, but in 2018, this effect shifted to a significant negative restraining impact. However, attributing the 2018 result solely to data issues is unreasonable. The objective fact that Tianjin's national GDP ranking has been declining year by year indicates that its

economic performance is not as robust as initially perceived.

Fourthly, we also take particular note of the cities Tangshan and Handan. They share a common characteristic, which is that their pillar industries are centered around heavy industries such as steel and coal. Between 2000 and 2010, they both exhibited high energy consumption and high pollution in their production, especially atmospheric pollution, having negative externalities. Since that Beijing is the capital of China, it becomes especially important to undertake special measures to combat atmospheric pollution. This mind is reflected in the Beijing-Tianjin-Hebei coordinated development plan. To pursue a sustainable and environmentally friendly development path in the future, the closure of some low-capacity small factories is necessary. However, this will constrain the economic development of these two cities in the short term.

5 Stability Test Based on Counterfactual Hypothesis

5.1 Counterfactual Test for the Overall Model

There are many factors affecting regional economic development, and even though the PSM-DID model controls for the effect of policy implementation, the Beijing-Tianjin-Hebei region may have implemented policies other than the Beijing-Tianjin-Hebei coordinated development plan in the same year. Moreover, there may be other unconsidered factors, which could raise doubts about the credibility of the policy measures of the Beijing-Tianjin-Hebei coordinated development plan in promoting economic growth. Therefore, it is necessary to conduct a counterfactual parallel trends test for the policy. We assume that the policy was implemented 1 year and 2 years earlier, creating new interaction terms $treated \times time$ (2014) and $treated \times time$ (2013), respectively, and adjusting the time fixed effects to be 2014 and 2013, before conducting the regression again. We observe whether the coefficient of $treated \times time$ remains significant and positive under these assumptions. If the coefficient of the interaction term is not significant in these hypothetical cases, it indicates that the regional integration policy has a promoting effect on local economic development. By advancing the policy implementation time by 1 year and 2 years, the results are shown in Table 4. It can be observed that with the advancement of time, the significance of the explanation for economic growth by the interaction term continuously decreases. Whether controlling for variables or not, the explanatory effect of the interaction term on per capita GDP is not significant. However, the interaction term still has a significant explanatory effect on total GDP growth. This may be related to the background of Beijing-Tianjin-Tangshan integration that has been in place before the issuance of the 2015 "Plan."

5.2 Counterfactual Test for Models of Different Cities

Table 5 shows the coefficients in front of the DID term obtained from separate regressions for different cities in the corresponding years.

Table 6: Regression coefficients in front of $treated * time_{year}$ obtained using Dynamic DID method for different cities

City	**Without Control Variables**		**With Control Variables**	
	2014	**2013**	**2014**	**2013**
Beijing	0.1636	0.1231	0.1034	0.0736
	(2.37)	(1.84)	(1.78)	(1.36)
Tianjin	-0.0742	-0.0673	-0.0272	-0.0232
	(-1.03)	(-1.07)	(-0.47)	(-0.47)
Shijiazhuang	0.0347	0.0285	0.0425	0.0305
	(1.14)	(1.04)	(1.59)	(1.21)
Tangshan	-0.1153**	-0.1157**	-0.1393**	-0.1348**
	(-4.28)	(-4.53)	(-3.77)	(-3.86)
Handan	-0.851**	-0.1037**	-0.0757*	-0.0972**
	(-2.74)	(-4.57)	(-2.46)	(-4.84)
Xingtai	0.0534	0.0047	0.0756	0.0065
	(1.37)	(0.14)	(1.21)	(0.13)
Zhangjiakou	-0.0119	-0.0221	-0.223	-0.0332
	(-0.56)	(-1.13)	(-0.73)	(-1.21)
Baoding	0.3147	0.2571	0.4123	0.3075
	(1.34)	(1.25)	(1.23)	(1.09)
Qinhuangdao	0.1757**	0.1305*	0.2036*	0.1312
	(2.67)	(2.02)	(2.42)	(1.55)
Chengde	-0.1257	-0.1785	-0.0894	-0.1450
	(-0.90)	(-1.27)	(-0.63)	(-1.03)
Cangzhou	0.0058	-0.0189	0.0032	-0.0263
	(0.22)	(-0.86)	(0.13)	(-1.24)
Hengshui	0.1339**	0.0964*	0.1116*	0.0655
	(3.47)	(2.40)	(2.20)	(1.31)
Langfang	0.1731**	0.1618**	0.1541**	0.1427**
	(4.78)	(4.37)	(4.07)	(3.79)

Similarly, when considering the situation of individual policy implementation cities separately and advancing the policy implementation time by 1 year and 2 years, as shown in Table 5, except for Tangshan, Handan, and the cases of Langfang and Hengshui when not controlling for variables, the regression coefficients of the policy variables are no longer significant. In some cases where significance remains, it may be due to certain preparatory measures taken before the publication of the coordinated development policy documents. Therefore, it can be generally considered that the estimated double difference model in this study is robust, but the models for Tangshan, Handan, Langfang, and Hengshui are not stable, which may be related to the earlier mentioned background of the Beijing-Tianjin-Tangshan coordinated development.

6 Conclusion and Policy Recommendations

6.1 Conclusion

Based on the analysis above, the following conclusions can be drawn:

Conclusion 1: Policy Effects Exhibit Lag.

Overall, the Beijing-Tianjin-Hebei coordinated development planning policy has a promoting effect on the development of the region. The policy's impact exhibits a lag, meaning that although the policy was introduced in 2015, its effects have become increasingly evident from 2016 onwards (with regression coefficients becoming significant). This effect is particularly pronounced when considering the total GDP, where the policy's impact has been growing (with increasing regression coefficients).

The length of the lag also varies for different cities. For instance, in the case of Beijing, the policy's effects became more noticeable from 2016 onwards, while for cities like Qinhuangdao, the policy's impact has remained inconspicuous.

Conclusion 2: The policy has different impacts on different cities and that impact is centred around Beijing. The size of the impact on other cities is affected by their distance from Beijing, with the closer they are to Beijing, the greater the impact, and the further they are from Beijing, the less the impact.

For cities like Beijing, Shijiazhuang, Baoding, Hengshui, and Langfang, this policy has promoted their economic development. However, for cities like Tangshan, Handan, Zhangjiakou, and Chengde, the implementation of this policy has hindered the growth of per capita GDP and GDP. Considering the geographical locations of these cities, if Beijing is considered the growth pole of this region, the southern direction mainly exhibits a diffusion effect, while the northern direction primarily demonstrates a polarization effect. Additionally, the closer the distance, the more pronounced the effects observed.

6.2 Reflections on the Widening Development Gap in the Beijing-Tianjin-Hebei Region and Countermeasures

From the analysis above, we can observe that the development in various cities within the Beijing-Tianjin-Hebei region is uneven. Even though they are all part of the same regional economic development plan, the policy has different strategic implications for the economic development of different areas, leading to varied outcomes. A significant conclusion drawn from past perspectives has been that the natural development of an economy is largely constrained by natural resources. However, for the resource-endowed Beijing-Tianjin-Hebei region, this explanation seems less convincing. So, what factors contribute to the existing development disparities in the Beijing-Tianjin-Hebei region, and can they be changed? If change is possible, to what extent can we improve these factors? Here is some discussion on these issues.

From the perspective of economic growth theory, the GDP generated by a region over a certain period is determined by both the production function and the inputs of production factors. The production function reflects the utilization capacity of production factors and is related to factors such as the human capital stock, technological innovation capacity, and technology introduction in that region, which determine the quality of regional economic growth. Meanwhile, the inputs of production factors primarily include capital and labor inputs, which represent the endowment of factors in the region and determine the scale of production. Investment in a region depends on the marginal returns on capital and the opportunity cost of capital use, where a better investment environment in a region leads to higher expected marginal returns on capital and is more likely to attract investment. The investment environment of a region is mainly created and maintained by the government through the issuance of preferential investment policies and the construction of essential infrastructure. Additionally, the sufficiency and quality of labor resources in a region depend on policy factors such as social security policies and the household registration system, the cost-effectiveness of living in a particular region, and the regional development prospects. Regional development prospects are closely related to government macroeconomic policies, regional industrial structures, and the profitability of regional enterprises.

Taking this perspective into consideration, looking back at the course of Beijing-Tianjin-Hebei coordinated development, academia has conducted numerous studies in various fields regarding integration directions.

In terms of social security, public services, and labor factor mobility, Zhang Guohua (2020) argued that as China's economy shifts from an investment-driven model to an innovation-driven one, the impact of labor mobility on industry and capital flows will become increasingly significant. Labor mobility depends on regional public environments, service facilities, and other factors. Policies promoting the integration of transportation and the settlement of medical insurance across regions in the Beijing-Tianjin-Hebei area have promoted the mobility of labor factors. However, the cooperation in terms of public services and social security linked to household registration remains lacking in the region. Since Beijing has tightened its control over population numbers since 2016, a segmentation trend has emerged in the labor force market, weakening the trend of labor market integration within the Beijing-Tianjin-Hebei area. However, some scholars argue that the population outflow from Beijing will create development opportunities for Hebei Province, particularly as the transfer

of Beijing's productive service industries to Hebei may provide economic development opportunities (Zhang Mingzhi, 2020). The setback in labor market integration may be related to differences in talent cultivation and retention capabilities among the regions, as well as disparities in innovation capabilities and economic vitality.

Regarding technological innovation capabilities, universities are the main drivers of technological innovation. Beijing boasts numerous high-quality universities, research institutes, and then Tianjin, while Hebei lags behind. There are significant disparities in innovation capabilities among cities in the Beijing-Tianjin-Hebei region, and inter-provincial technological diffusion and resource flow still face barriers. Beijing exhibits a "leapfrog" pattern of technological diffusion, contributing little to the technological innovation of pillar industries in adjacent Tianjin and Hebei provinces (Sun Yukang, 2017). This has led to significant regional disparities in high-tech industries within the Beijing-Tianjin-Hebei region, and there exists a moderate imbalance in development among different industries (Fan Decheng, 2017) (Zhang Pengfei, 2020). This can be explained by the "core-periphery theory," where higher-level innovation cities exhibit a stronger "siphoning effect" on talent and resources from surrounding areas. Innovative achievements continually reinforce the central status of such cities, especially considering the weak connectivity among cities in the Beijing-Tianjin-Hebei region and insufficient policies and incentives in Hebei Province to attract technological talent, thereby resulting in a "core-periphery" situation in technological innovation.

Regarding industrial agglomeration and upgrading, the Beijing-Tianjin-Hebei region has witnessed a trend of lagging development in the primary and secondary industries, with the tertiary industry developing ahead. Additionally, Beijing's industrial upgrading trend is notably superior to that of Tianjin and Hebei (He Gang et al., 2020). Beijing serves as the primary core, followed by Tianjin, and the current situation shows that the agglomeration effect of the core is greater than the trickle-down effect to the periphery. Research by Yan Dongbin (2020) shows that the Beijing-Tianjin-Hebei city cluster lacks spatial and functional integration effects, and spatial economic policies are more concentrated in smaller cities within the city cluster. Moreover, there is no economic complementarity resulting from spatial and functional integration of cities within the city cluster. Furthermore, environmental protection requirements in the Beijing-Tianjin-Hebei integration have hindered the economic development of some cities in Hebei Province, particularly those with heavy-polluting and energy-intensive industries such as steel and coal. This can explain the lack of significant positive effects of regional development policies on cities like Tangshan, and in some cases, the effects may even be negative.

Therefore, the reason for the widening development gap among cities in the Beijing-Tianjin-Hebei region under the context of regional integration is that the degree of regional integration is not sufficiently comprehensive. There are still certain barriers in areas such as the transfer of innovation achievements, connections between upstream and downstream industries, industrial structure upgrading, infrastructure development, public services related to household registration, and the mobility of factor resources. This paper suggests that the government should take the lead in breaking down administrative barriers. The focus should be on facilitating the flow of education resources and innovation achievements, strengthening the interconnection of industrial structures, promoting industrial structure upgrading, and ensuring deeper integration of public services. These measures will help narrow the development disparities within the Beijing-Tianjin-Hebei region and promote

synergistic and interconnected development in the area.

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