Study on the Policy Effect of Beijing-Tianjin Industrial Transfer on the Development of Hebei—Based on Empirical Analysis of Regression Discontinuity

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Abstract. Based on the panel data of Beijing, Tianjin and Hebei from 2004 to 2016 and the obvious changes of the industrial transfer caused by the policy coordinating development of Beijing-Tianjin-Hebei as a national strategy in 2014, this paper makes a regression discontinuity on the exogenous impact of the policy on the development in Hebei. The results show that: Firstly, in 2015, the amount of industrial transfer from Beijing-Tianjin to Hebei has increased nearly three times than that of 2014. Secondly, the contribution rates of the policy to the increase of per capital gross regional product and rural per capita net income are 47.8% and 62.3% respectively. Thirdly, the policy has different effects on different regions, the central and eastern areas of Hebei are the most policy-sensitive which made the Theil of these areas fall by 0.1%.

1. Introduction

In February 2014, General Secretary Xi proposed that the coordinated development of Beijing, Tianjin and Hebei should be raised to the level of national strategy, emphasizing "promoting industrial docking and collaboration, straightening out the industrial chain of the three regions, and forming the mechanism of dislocation development and linkage between upstream and downstream industries among regions" [1]. In April 2015, the Outline of Beijing-Tianjin-Hebei Cooperative Development Planning pointed out that the core of Beijing-Tianjin-Hebei Cooperative Development is to relieve Beijing's non-capital functions, and to take the lead in such key areas as transportation integration, ecological environment protection, industrial upgrading and transfer [2]. Regional economic relations are changing from low investment efficiency to win-win cooperation [3]. Successful industrial transfer can promote the upgrading of undertaking grounding economy, and unsuccessful transfer will bring disadvantages to both [4]. It is the objective demand of Hebei Province to take the initiative to undertake industrial transfer and realize structural adjustment and upgrading.

In 2018, the per capita GDP of Beijing, Tianjin and Hebei were 14.0, 12.1 and 48 million yuan respectively. The amount of Beijing and Tianjin were more than 2.5 times as much as Hebei. For a long time, the problem of uncoordinated and unbalanced economic development of the three places was serious. In 2014, Hebei's economic growth rate dropped from 8.2% in 2013 to the lowest level of 6.5% in nearly 10 years, much lower than the national level of 7.3% in that year. After years of decline, Hebei's economic growth rebounded to 6.8% in 2015, and then remained flat or even surpassed the national economic growth rate for many consecutive years. According to the rebound year of Hebei's economic growth, it is reasonable to speculate that this is related to the coordinated development of Beijing-Tianjin-Hebei becoming into a national strategy. This paper chooses the county statistical data of Hebei
from 2004 to 2016 for 13 years to minimize the unit of analysis; besides, it uses the fuzzy regression discontinuity to eliminate the interference of other factors on the time axis, and pays more attention to the channel of policy influence and the way to narrow the development gap.

2. Theoretical Analysis

2.1. Regression Discontinuity
Regression Discontinuity was first proposed by Donald Campbell [5], a psychologist at Northwest university in the United States. Hahn et al. made theoretical proof for the model estimation of breakpoint regression and proposed the estimation method [6]. Regression discontinuity is the most credible method in quasi-experimental method, which can effectively analyse the causal relationship between variables by using practical constraints [7].

Regression discontinuity defines a critical value of "\(D_0\)", and the parts affected by policy and not affected by policy are defined as "treatment group" and "control group" respectively. By regressing a section of interval samples with approximate random distribution before and after the critical value, we can judge whether the target variables have significant changes according to the regression results. As shown in the following formula:

\[
\lim_{D \downarrow D_0} E(P \mid D) - \lim_{D \uparrow D_0} E(P \mid D) = F_1(x_i) - F_0(x_i) \neq 0
\]

(1)

\(F_1(x_i)\) and \(F_0(x_i)\) are arbitrary functions. If \(F_1(x_i) \geq F_0(x_i)\), it satisfies the hypothesis that the data of treatment group is larger than that of control group, that is, when \(x_1 \geq x_2\), the probability of experimental individuals entering the processing group will increase.

According to the research content of this paper, \(E(D \mid x_i) = P(D_i = 1 \mid x_i) = F_0(x_0) + [F_1(x_0) - F_0(x_0)]T_i\), \(T_i\) is the treatment effect of the experimental individuals.

2.2. Measure Indicators
Industrial transfer is measured by the method proposed by Feng and Yang [8]. The formula is as follows:

\[
IR_{ij} = \frac{(IAV_i / IAV_j - IAV_i / IAV_{j-1}) IAV_j}{IAV_j}
\]

(2)

According to the actual research content of this paper, \(IAV_j\) is used to represent the overall industrial added value of Beijing, Tianjin and Hebei in the period \(j\), and \(IAV_{ij}\) is used to represent the industrial added value of Hebei in the period \(j\). When \(IR_{ij} > 0\), \(IR_{ij}\) is the transfer amount of the local industry; when \(IR_{ij} < 0\), \(|IR_{ij}|\) is the transfer amount of the local industry.

In addition, industrial restructuring has an impact on the income of local residents, and there is a more promotive effect on the income of urban residents [9]. Therefore, this paper uses three indicators including per capita GDP (PGDP), Theil and urban per capita disposable income (UPDI) to measure the effect of industrial transfer.

2.3. Data Analysis
According to the calculation method of industrial transfer measurement [8], the industrial transfer volume of Beijing and Tianjin is calculated. Fig. 1 is a fitting chart of Hebei's volume of industrial transfer from 2004 to 2017. It can be seen that there are two breakpoints in 2006 and 2014.
3. Study Design

3.1. Model Building

From Figure 1, we know that there is a breakpoint in figure of volume of industrial transfer in 2014. The variable of whether Hebei undertakes industrial transfer from Beijing-Tianjin affected by policy is \( D_i \). “\( D_i=1 \)” indicates that industrial transfer is affected, and “\( D_i=0 \)” indicates that it is not affected by this factor. In addition, this paper introduces the index of ”industrialization level” as the control variable. In this paper, year is used as the tool variable, so the data of 13 years from 2004 to 2016 are selected as the research sample. The data before and after 2014 are used as the control group and the treatment group respectively. The method of two-stage least squares (TSLS) [7] is used to estimate \( T_i \) by introducing the tool variable, and the following models are established:

\[
Y = \alpha_0 + \alpha_1D + \alpha_2IR + \alpha_3\ln\text{Ind} + \gamma + \mu + \epsilon \\
Y = \alpha_0 + \alpha_1D + \alpha_2IR + \alpha_3\ln\text{Ind} + (\beta_1IR + \beta_2\ln\text{Ind})D + \gamma + \mu + \epsilon
\]

In order to avoid the problem of heteroscedasticity, the qualified variables are analysed in the form of natural logarithm; \( Y \) is the explanatory variable, including the natural logarithm of per capita GDP, Theil and the natural logarithm of urban per capita disposable income, InUPDI; IR is the explanatory variable, the amount of industrial transfer; InInd is the control variable, the level of industrialization, which is calculated by the ratio of the added value of secondary industry to GDP multiplied by 100. However, logarithm shows that \( \gamma \) represents time-fixed effect and \( \mu \) represents individual-fixed effect; \( D \) is a fictitious variable, and the value before the coordinated development of Beijing, Tianjin and Hebei is 0, the value after it is 1.

3.2. Sources of Data and Variable Processing

The data in this paper are obtained from the National Bureau of Statistics, Hebei economic yearbook and the Urban economic yearbook of Hebei.

According to the research of Wang and Ouyang [10], considering the research problems in this paper, the Theil formula to measure the regional development level gap is as follows:

\[
\text{Theil} = \sum_{i=1}^{n} \frac{GDP_i}{GDP} \ln \frac{PGDP_i}{PGDP}
\]

\( GDP_i \) and \( GDP \) respectively express GDP of region \( i \) and all-region, and \( PGDP_i \) and \( PGDP \) express per capita GDP of region \( i \) and all-region respectively.

4. Empirical Results

4.1. Fuzzy Regression Discontinuity

Figure 1. Fitting figure of volume of industrial transfer of Beijing-Tianjin in sample period
In this paper, the year ("ye2014") is used as a tool variable to measure policy impact, and the polynomial of time difference from 2014 (K) is simulated by regression (Table 1). The results show that the effect of industrial transfer under the policy is significant; at the same time, the implementation of the policy enhances the income of urban residents in Hebei, and consolidates this effect through industrial transfer; in reducing the development gap and alleviating the imbalance of development, the policy effect is not significant. In addition, the result of adding the term of K-square shows that increasing the degree of a polynomial does not improve the significance of the model and variables, so the degree of the time difference polynomial selected in this paper is 1.

| Interpreted variable (first-order term) | Interpreted variable (quadratic term) |
|----------------------------------------|----------------------------------------|
| lnPGDP                                 | lnPGDP                                 |
| lnUPDI                                 | lnUPDI                                 |
| Theil                                  | Theil                                  |
| Constant                               | Constant                               |
| lnInd                                  | lnInd                                  |
| K                                      | K                                      |
| K-squared                              | K-squared                              |
| Intercept                              | Intercept                              |
| Adjusted R²                            | Adjusted R²                            |

Table 1. Fuzzy Regression Discontinuity.

Note: The results in Table 1 processed by TSLS using years as tool variables. K and K-square are the linear term and quadratic term respectively. *** , ***, * indicate that the results are significant under the degree of confidence of 1%, 5% and 10% respectively. The data in parentheses are the standard deviation of the estimated parameters. The policy refers to the national strategy of coordinated development of Beijing-Tianjin-Hebei.

4.2. Test of Interregional Difference

According to the geographical distribution, economic basis and the degree of connection with Beijing and Tianjin, prefecture-level cities in Hebei are divided into four areas to study: north of Hebei (Zhangjiakou, Chengde), eastern coastal areas (Qinhuangdao, Tangshan, Cangzhou), central areas of Hebei (Langfang, Baoding, Shijiazhuang) and south of Hebei (Hengshui, Xingtai, Handan) (Table 2). The results show that the central areas and coastal areas are more sensitive to policy implementation: Tangshan and Cangzhou are the main industrial cities in Hebei Province, while Langfang and Shijiazhuang are relatively developed in the tertiary industry, but the secondary industry is still the foundation for development. In recent years, Tangshan, Cangzhou and Langfang have undertaken a large number of heavy chemical industry, equipment manufacturing industry and electronic information industry from Beijing and Tianjin, such as some large energy enterprises which promote the development of central areas and coastal areas. North and south of Hebei are weakly affected by industrial transfer policies: the two cities in northern Hebei are located in the districts which are sources of wind and water of Beijing-Tianjin areas, and belong to the ecological conservation zone in the coordinated development of Beijing-Tianjin-Hebei. Their industrial foundation is weak and their development is limited, and their traditional industries are poor in carrying capacity. The upgrading of
industrialization level also fails to alleviate the imbalance of development in southern Hebei because of the development gap among the three cities in southern Hebei, and possessing the Handan Steel and other heavy industrial enterprises makes Handan, a resource-based city, is comparable to Tangshan and Cangzhou, which are close to Beijing and Tianjin, but the economic strength of Xingtai and Hengshui is relatively weak.

Table 2. Test of Interregional Difference (Theil).

| Interpreted variable (Theil) | Northern areas | Eastern coastal areas | Central areas | Southern areas |
|-----------------------------|----------------|-----------------------|---------------|---------------|
| IR                          | 0.0004**       | 0.001                 | 0.001         | 0.001         |
| (0.000)                     | (0.000)        | (0.000)               | (0.001)       |
| lnInd                       | -0.144*        | -0.346**              | -1.207*       | 0.447**       |
| (0.207)                     | (0.138)        | (0.620)               | (0.180)       |
| D × IR                      | -0.001         | -0.001*               | -0.001*       | -0.001        |
| (0.009)                     | (0.000)        | (0.000)               | (0.000)       |
| D × lnInd                   | -0.005         | -0.299                | -0.039        | -0.717        |
| (0.005)                     | (0.167)        | (0.006)               | (0.762)       |
| Constant                    | 0.662          | 2.022*                | 4.749         | -1.484*       |
| (0.503)                     | (1.931)        | (2.440)               | (0.651)       |
| F-statistic                 | 38.001         | 51.685                | 40.073        | 34.892        |
| Prob(F-statistic)           | 0.000          | 0.000                 | 0.000         | 0.000         |
| R-squared                   | 0.913          | 0.978                 | 0.900         | 0.953         |
| Adjusted R²                 | 0.889          | 0.960                 | 0.811         | 0.926         |

5. Conclusion and Suggestion

5.1. Conclusions

The main conclusions of this paper include: Firstly, the industrial transfer to Hebei from Beijing and Tianjin has increased significantly after 2014, from 288.63 in 2014 to 827.97 in 2015; the coordinated development of Beijing, Tianjin and Hebei has increased to 827.97 in 2015. Secondly, the industrial transfer after the national strategy has promoted the economic growth of Hebei and the urban per capita disposable income significantly; after the implementation of the policy, it has promoted the growth of economic development and urban per capita disposable income in Hebei which contribution rates are 47.8% and 62.3% respectively. Thirdly, due to individual differences between the prefecture-level cities, the current industrial transfer from Beijing-Tianjin has different effects on promoting balanced development in different areas of Hebei Province, and the policy benefit is not easy to show in the short term because of the policy lag. Fourthly, the coastal areas of central and Eastern Hebei are most sensitive to the policy impact, and due to the coordinated development between Beijing, Tianjin and Hebei changing into the national strategy and by the way of industry transfer, the Theil index of the two regions has decreased by 0.1% respectively, and the unbalanced development of the two regions was alleviated.

5.2. Suggestions

Based on the conclusion, the suggestions following are put forward: Firstly, Beijing-Tianjin industrial transfer plays a significant role in promoting the economic development of Hebei Province, which shows that the planning effect of the government is tremendous, and the government should continue to make efforts to strengthen cooperation between the industrial transfer sites and the grounding undertakings. Secondly, industrial chain should also be constructed according to local conditions, in order to weaken the polar and marginal phenomena in economic development of some areas in Beijing-Tianjin-Hebei.
region, which are far from Beijing-Tianjin. More attention should be paid to the perfection of the industrial chain. Thirdly, when further deepening industrial docking, resource endowment and industrial chain correlation should be considered as the key to industrial undertaking. For example, northern Hebei, located in the poverty-stricken belt around Beijing and Tianjin, is not suitable for undertaking heavy industry. As an ecological function area, the construction of ecological civilization should be guaranteed, while the pension industry and leisure entertainment industry should be introduced and developed appropriately. Finally, the structures of three industries of some cities in Hebei Province indicate that they have begun to develop in the post-industrial era. Although there is a big gap between them, the government can still attach importance to theirs transitional role in undertaking the industry, so that the industry of Beijing and Tianjin can be transferred smoothly according to the natural gradient, and gradually alleviate the "dual structure" gaps of the development of Beijing, Tianjin and Hebei.

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