The Impact Assessment of the Water Resources Tax Policy of Hebei Province——Based on New Evidence of Synthetic Control Method

Yao Zhang

School of Economic＆Management, Southwest Petroleum University, Chengdu, 610000, China.

Abstract

In this paper, 2014-2017 years' panel data of Hebei province and other provinces that do not implement water resources tax policy are combined with synthetic control method to conduct an empirical analysis to evaluate the impact of water resources tax policy. By using synthetic control method to simulate the water resources tax policy of multiple provinces before implementation, we can objectively evaluate the impact of water resources tax policy on Hebei province. The results show that: the implementation of water tax policy has improved the GDP of Hebei province to a certain extent, and this effect is not obvious at the beginning. After that, the conclusion is still valid after the placebo effect test.

Keywords

Water resources tax;Synthetic control method;Gross Regional Product.

1. Introduction

In order to promote water conservation, protection and rational use, and strengthen water management, on July 1, 2016, the Hebei Provincial Government issued the “Notice on Printing and Implementing the Pilot Implementation Measures for Water Resources Tax Reform in Hebei Province”, thereby making Hebei Province a national The only province that was the first to pilot a water tax. More than a year has passed since the implementation of the water tax policy. In addition to whether the water tax policy improves the water use problem in Hebei, it also focuses on whether the tax policy has an impact on the GDP of Hebei and the degree of impact. In general, the implementation of tax policies will have a certain impact on local and even GDP. This impact may be negative or positive. From the existing research reports, it is not difficult to see that taxation and many GDPs, etc. The main economic indicators have an interactive relationship. For example, Zhang Lunjun[13] studied the mathematical relationship between taxation and economic indicators by establishing a time series model and a ridge regression model between major economic variables such as tax and GDP; Pan Laichi[14] Through the value-added of the state-owned enterprise income tax in 1978-1987, the relationship between tax and GDP in China was studied by eliminating the impact of data anomalies in 1985. The main economic indicators such as taxation and GDP have a positive interaction, and the total amount of taxation is determined by GDP. At the same time, regional economic growth will be affected by taxation. This paper will study the Hebei water resources tax policy from the macro aspect to the total production in Hebei. The impact of the value.

In general, the existing literature has done a detailed study of many existing tax policies. For example, Deng Yuanjun[18] discussed the relationship between Beijing's value-added tax and regional GDP. Liu Ming and Wang Kexi[19] discussed industrial and commercial taxes and The relationship between GDP, Wei Tong[20] explored the relationship between environmental tax and GDP, and the literature on water resources tax research has not been published yet, and the existing literature on GDP research mainly focuses on investment, consumption, There are few literatures on the impact of taxation on the quantitative impact of GDP on the impact of exports and fiscal revenue.

2. The Estimation Method

Since the promulgation and implementation of the water resource tax policy, the quantitative research on this policy has not been published in the academic community. The main obstacles are twofold: First, the traditional policy evaluation method—the multiple difference method has many defects. This evaluation method will treat Hebei Province as The treatment group, other provinces as a reference group in the reform period to compare, but in fact the pilot cities themselves often have a certain degree of specificity, and can not be compared with a simple averaging method; the second is the existing policy assessment method (such as dual The difference model) has great subjective arbitrariness when selecting control groups. Different comparison objects will produce different results. These evaluation methods will greatly reduce the reliability of the results. Choosing a very reasonable and objective control group is a correct evaluation policy. key. This study uses the synthetic control method proposed by Abadie and Gardeazabal [1] to estimate the impact of the water tax policy. It has practical and theoretical significance for the government to observe the impact of the tax policy on Hebei Province. Compared with the traditional policy evaluation method, the synthetic control method solves the problem of the selection of the control group in the policy evaluation. This method linearly combines other cities in China except Hebei to construct an excellent “synthetic control area”, which will “ "Real Hebei" is compared with "Synthetic Hebei". "Synthetic Hebei" is based on data analysis to give the linear combination the optimal weight, which greatly avoids the subjective randomness of the researcher and the endogenous nature of the policy. At present, the "synthetic control method" is widely used in comparative cases. For example, Abadie and Gardeazabal[1] used synthetic control to construct other anti-terrorist areas in Spain into a "counterfactual group" in the Basque region. The impact of the terrorist attacks on the region's economy; Yang Jingguo[3] and others used the synthetic control method to evaluate the economic growth effects brought about by the establishment of special economic zones in China in a counterfactual manner; Liu Jiayan and Fan Ziying[2] chose February 2011 The real estate tax pilot implemented in Chongqing was used as a natural experiment to analyze the impact of real estate tax on housing prices in pilot cities by using synthetic control method. Wang Yanfang and Zhang Jun[4] used the annual pollution days as an indicator of air pollution degree through synthetic control method. Estimated the impact of the 2008 Beijing Olympic Games on Beijing's air quality, in order to study whether the environmental planning policy has a long-term effect on improving air quality; Chen Yuting[5] and others used the 2010-2014 company listed company data, using the synthetic control method to evaluate The impact of high-tech enterprises on foreign direct investment on their research and development efficiency; Zhu Jun[7] to Hubei The integration of higher education administration in Jingzhou City is a case study. The use of synthetic control method and counterfactual state to construct “virtual Jingzhou” analyzes the integration effect; Lu Yajuan[6] adopts the synthetic control method, and divides the control group and the semi-annual report by the listed company. In the synthesis group, whether the stock's rate of return will be affected by the public information is empirically analyzed; Liu Yang, Zhang Bo[10] and others used the synthetic control method to select 39 national poverty-stricken counties in Hebei Province to analyze the contiguous development and poverty alleviation. The implementation effect of the pilot.

Specifically, this paper uses regional GDP to assess the impact of water tax policies, expressed in S_i. Assume that panel data for J+1 provinces and T periods can be collected, Among them, only the province i was subjected to the natural experiment of water tax in the $T_0(1 \le T_0 \le T)$period. The other J provinces belong to the control unit of the province i in the T period, so the degree of change in the S_i value of the water resource tax pilot province can be expressed as:

$$\theta_{it} = Y_{it}^{1} - Y_{it}^{0} \tag{1}$$

1 indicates that the province i is subject to the implementation of the water resource tax pilot policy, and 0 indicates that it has not been implemented by the water resource tax pilot policy. It is easy to

know that when $T \geq T_0$, the Y_{it} value is superscripted to take 1. In addition, Y_{it}^1 indicates the S_i value of the $i \in [1,1+J]$ province incorporated into the water resource tax pilot in the T period. Y_{it}^0 indicates the S_i value of the $i \in [1,1+J]$ province that was not included in the water resource tax pilot during the T period. At the same time, it is assumed that the i-zone is implementing the water resource tax pilot in July 2016, as all provinces were not affected by the water resources pilot policy from January 2014 to June 2016, so $Y_{it}^1 = Y_{it}^0$. The focus of this paper is on the change of S_i value after implementing water resources tax in Hebei Province. Therefore, θ_{it} is the value to be estimated, but in fact, when province i is in $T_0 \leq t \leq T$, only Y_{it}^1 can be observed, and Y_{it}^0 cannot be observed. A reasonable control group was chosen to estimate by a counterfactual approach.

Abadie et al. proposed the following model to estimate the value of Y_{it}^0. The specific model is as follows:

$$Y_{it}^0 = \rho_t + \phi_t Z_i + \gamma_t \mu_i + \varepsilon_{it} \tag{2}$$

Where ρ_t is the time-fixed effect of the S_i value affecting all provinces, Z_i is a covariate of (k × 1), indicating control variables that are not affected by the implementation of the water tax policy and are observable, ϕ_t is a (1 × k) dimension to estimate parameter vector, μ_i is a (p × 1) dimension unobservable fixed effect of province I, γ_t is the (1 × p) dimension of the estimated parameter vector, and ε_{it} is the unobservable temporary disturbance with a mean of 0. Specifically, Z_i can be a set of factors such as disposable income of residents, natural population growth rate, inflation rate, and per capita education years.

In order to obtain the result that the province i was not affected by the water resource tax pilot policy during the $T \geq T_0$ period, In this study, the remaining J provinces that do not implement water resource tax are used as control units, and then the non-parametric method is used to select the weight of each province. Finally, the weighted average J provinces are combined to form a synthetic control group, making it a water resource. a reasonable comparison of the provinces of tax i. For this purpose, we define a (j × 1) dimensional weight vector W = ($W_2,...,W_{j+1}$), Among them, all $w_j \in W$ are in the range of $0 \leq w_j \leq 1$, and there is $\sum_j w_j = 1$

$$\sum_{j=2}^{j+1} W_j Y_{jt} = \rho_t + \phi_t \sum_{j=2}^{j+1} W_j Z_j + \gamma_t \sum_{j=2}^{j+1} W_j \mu_j + \sum_{j=2}^{j+1} W_j \varepsilon_{jt} \tag{3}$$

Suppose there is $W^* = (W^*_2,...,W^*_{j+1})$ to satisfy equation (4)(5):

$$\sum_{j=2}^{j+1} W_j^* Y_{j1} = Y_{11}, \quad \sum_{j=2}^{j+1} W_j^* Y_{j2} = Y_{12}, \quad \ldots \tag{4}$$

$$\sum_{j=2}^{j+1} W_j^* Y_{jT0} = Y_{iT0} \text{ 且 } \sum_{j=2}^{j+1} W_j^* Z_j = Z_i \tag{5}$$

Given that $\sum_{n=1}^{T0} \lambda_n' \lambda_n$ is not singular and the number of periods before the natural experiment occurs in the sample, it can be proved that the difference between Y_{it}^0 and $\sum_{j=2}^{j+1} W_j Y_{jt}$ tends to zero, so $\sum_{j=2}^{j+1} W_j Y_{jt}$ can estimate Y_{it}^0, and the experimental unbiased estimate is:

$$\hat{\theta}_{1t} = \pi_{it}^{N} - \sum_{j=2}^{j+1} W_j^* Y_{jt}, t \in \{T_0 + 1, \cdots, T\} \quad (6)$$

From equation (6), it can be obtained that the approximate weight is needed to determine the optimal weight vector W^* when the value of $\hat{\theta}_{1t}$ is obtained. Abadie (2010) uses the distance $\| X_1 - X_0 W \|_V = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$ between X_1 and $X_0 W$ to determine W^*

At the same time, when j∈[2, J+1], $W_j \geq 0$ and $W_2 + W_3 + \cdots + W_j = 1$. X_1 is the characteristic vector of the water resource tax pilot area before the implementation of the water resource tax policy; X_0 is the eigenvector of the non-water resource tax pilot area before the implementation of the water resource tax policy; V is a symmetric semi-positive semi-defined symmetric matrix, and its optimal choice It is to give the variable a reasonable weight and minimize the error. In this paper, the data-driven method is used to obtain V, which makes the synthesis of Hebei's approximate water resources tax policy before the implementation of the regional GDP trajectory. The weighted synthesis of Hebei simulates the assumption that Hebei does not implement water tax, synthesizing Hebei and Hebei data. The difference is the impact of the implementation of the water tax policy on the GDP of Hebei.

3. Data and Empirical Results

3.1 Data and variable description

According to the Notice of the People's Government of Hebei Province on Printing and Implementing the Pilot Implementation Measures for Water Resources Tax Reform in Hebei Province issued by the General Office of the Provincial Government in July 2016, as of December 2017, only Hebei Province was the first pilot province for water resources tax. Taking Hebei Province as the initial sample object, we will focus on the impact of water resources policy on the GDP of Hebei from a macro perspective. Since a province has a special economic zone or a national economic and technological development zone, its policies will be quite different from those of the general provinces. The four municipalities of Shanghai, Beijing, Chongqing and Tianjin are excluded from the sample selection, and the politics of Hong Kong, Macao and Taiwan are also The differences between the economic system and the mainland provinces, and the statistical data collection in Tibet, Guangxi, Inner Mongolia, Ningxia and Xinjiang Autonomous Region are not sufficient, so these regions will not be included in the sample. In the end, we selected 21 provinces other than these regions and Hebei as the synthetic control group for data analysis. The specific provinces include Anhui, Fujian, Gansu, Henan, Guizhou, Heilongjiang, Hubei, Hunan, Jilin, Jiangsu, Jiangxi, Liaoning, Qinghai, Shandong, Shanxi, Shaanxi, Sichuan, Yunnan, Zhejiang, Guangdong and Hainan. Since the water resource tax policy is promoted nationwide in December 2017, as of the end of this study, other provinces that implemented the water resource tax policy in 2018 are too few to support this study. We only choose Hebei as the research object.

According to the research on the influence factors of Yang Jingguo and Zhou Lingling[3] on the growth effect of special economic zones, this paper selects a series of factors affecting the GDP of the region, such as the per capita years of education, the proportion of fixed assets to the population, and the density of roads and railways, as predictive control variables. In this paper, according to the 2014 to 2017 "China Statistical Yearbook", "China Demographic Yearbook" and "China City Statistical Yearbook", the relevant data are compiled.

3.2 Outcome of Practice

Table 1 shows the weights of the provinces in the synthetic control group when analyzing different objects. Specifically, the synthetic Hebei is composed of Anhui, Henan, Liaoning, Qinghai and Shandong. Among them, Liaoning has the largest weight and Anhui has the smallest weight.

Table 1.Control group provinces account for the weight of the target province

Anhui	Fujian	Gansu	Henan	Guizhou	Heilognjian	Hubei
0.014	0	0	0.049	0	0	0
Hunan	Jilin	Jiangsu	Jiangxi	Liaoning	Qinghai	Shandong
0	0	0	0	0.498	0.232	0.207
Shanxi	Sichuan	Yunan	Zhejiang	Guangdong	Hainan	Shanxi
0	0	0	0	0	0	0

Notes: The provinces of the synthetic group are listed in the first row of each table, and the provinces that synthesize Hebei include 1.4% of Anhui, 4.9% of Henan, etc., and all the provinces of the synthetic group have a total sum of 1 and a province with a weight of 0. Represents its weight below 0.1%.

Table 2 shows the comparison of the predictive variables between the provinces of each experimental group and the synthetic control group before the implementation of the water resource tax policy. For Hebei, the per capita disposable income of the residents, the added value of the primary industry as a percentage of GDP, and the investment in fixed assets The difference between the real value and the synthetic value of GDP is very small. It can be seen that the provinces of the synthetic control group and the experimental group have a good fit. This also shows that the synthesis of Hebei in the analysis of regional GDP changes can be a good counter-factual alternative to Hebei's implementation of the water tax policy.

Table 2.Comparison of real and synthetic values of predictors

	Hebei	
	Actual value	Synthetic value
Residents' disposable income (RMB)	11159.27	11027.89
The value added of the primary industry to the proportion of GDP (%)	10.6	9.99
Fixed assets investment as a percentage of GDP (%)	82.9	83.2

The comparison of the GDP of Hebei and synthetic Hebei in the study is shown in Figure 1. The time corresponding to the vertical dotted line indicates the time for the implementation of the water taxation pilot (July 2016). As can be seen from Figure 1, Hebei The fit to the left side of the vertical dashed line is better than that of the synthetic Hebei, so the synthesis of Hebei can well replicate the GDP characteristics of Hebei. After the implementation of the water tax policy, the regional GDP of Hebei and synthetic Hebei began to differ. The gap between the two lines is the impact of the implementation of the water tax on the regional GDP. It can be seen from the comparison chart that Hebei The regional GDP is higher than the regional GDP of synthetic Hebei, and this difference is gradually widened after 2017. It can be seen that after the implementation of the water tax policy, Hebei's regional GDP has increased.

Through experiments, we found that the GDP of Hebei Province and the synthetic Hebei Province produced a difference after the implementation of the water resource tax policy, but whether this difference is due to the impact of the water tax policy, or whether it is caused by other policies or accidental factors, We also need to further validate the experimental results. To this end, the authors draw on the placebo test method used by Abadie and Gardeazabal (2003) in the robustness test. The concept of “placebo” is derived from a randomized, medical trial that is often used to test the efficacy of a newly developed drug. Usually, the researchers divide the experimental volunteers into two groups, a group called the experimental group. Volunteers take the real medicine, a group called the control group, the group of volunteers take a placebo (that is, the use of sugar pills consistent with the taste of the real medicine), in order to avoid the influence of the subjective psychological effects

on the final drug efficacy. The volunteers in both groups were not told what to take, and the researchers used this method to ensure the objective accuracy of the results. The author draws on similar ideas and uses the change of the disposal group to test the accuracy of the experimental results. The basic idea of this kind of inspection method is to select the provinces other than Hebei Province that have not implemented the water resource tax policy to conduct the same analysis as the research method in this paper, and observe the GDP of the province and the synthetic province after the T_0 period. Whether the results are very different, if the experimental results are the same as those in Hebei Province, the synthetic control method used in this study does not accurately verify that the water resource tax has an impact on the GDP of Hebei Province.

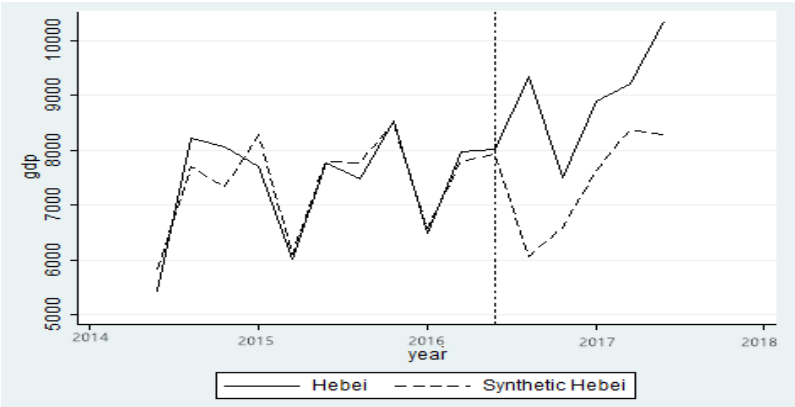

Fig.1 Comparison of GDP between Hebei and Hebei

The author selected Liaoning and Anhui provinces as the test objects for the following reasons: Liaoning Province has the largest weight in the target provinces, indicating that Liaoning Province and Hebei Province are the most similar among various conditions, while Anhui Province is the target province. The weight is the smallest, indicating that Anhui Province and Hebei Province have the largest deviation among various conditions. The two provinces occupy the most similar and most different extreme characteristics, and have good representativeness for the author verification test results. Figures 2 and 3 show the results of the placebo test in Liaoning Province and Anhui Province respectively. The results show that there is no significant difference between the actual provinces and the synthetic provinces before and after the implementation of the water resource tax policy. The development trend of the two is basically the same, which provides strong evidence for our experimental resul。ts that the water resource tax policy has an impact on the GDP of Hebei.

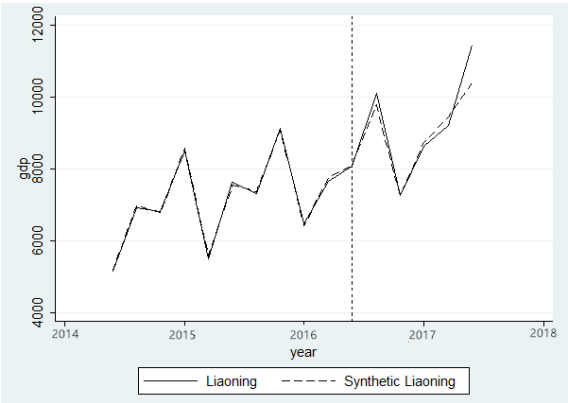

Fig.2 Comparison of GDP and production in Liaoning and synthetic Liaoning

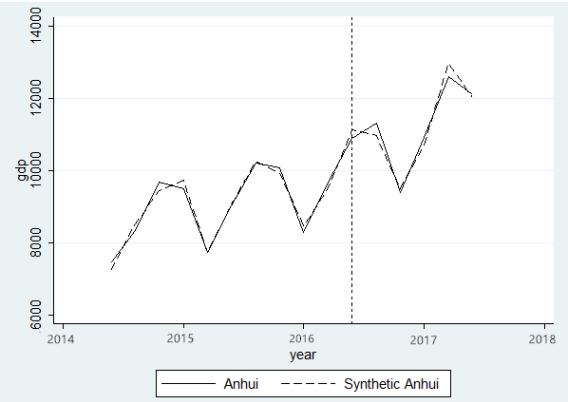

Fig.3 Comparison of total production value of Anhui and synthetic Anhui regions

4. The Research Conclusio

An important direction of economic growth and macro-public finance theory is the impact of government fiscal policy on economic growth. A large number of existing studies have shown that the impact of government fiscal policy on economic growth depends largely on fiscal expenditure structure and tax structure[11]. The definition of regional GDP refers to the final result of production activities of all resident units in the region in a certain period of time[12]. Taxation, as an important means of regulation of macroeconomics, is inextricably linked with regional GDP (2003), Hebei Province The GDP has shown an upward trend and this trend is even more pronounced after the implementation of the water tax. From the above analysis, it is not difficult to see that Hebei Province's water resource tax policy has increased the GDP of Hebei Province to a certain extent. By analyzing the impact of Hebei water resources tax on the province, it is beneficial for the government to assess the water resource tax from various aspects, and it is of practical and theoretical significance for the government to continue to promote the water resource tax and the state to promote water resources tax to other provinces in the country.

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