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Study on the Impact of the Healthy Cities Pilot Policy on Industrial Structure Upgrading: Quasi-Experimental Evidence from China

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Abstract: The impact and working mechanism of the national Healthy Cities pilot policy on the upgrading of the industrial structure remain foggy. This study takes China's first batch of Healthy Cities under the pilot policy in 2016 as a natural experiment and builds a DID model based on the panel data of 280 prefecture-level cities from 2012 to 2019 to explore the impact of the Healthy Cities pilot policy on the industrial structure, wherein the impact tests and regional heterogeneity analysis are carried out accordingly. It is found through the study that the Healthy Cities pilot policy significantly contributes to industrial structure upgrading, especially for cities in the eastern and central regions. Further research on the impact mechanism shows that the Healthy Cities pilot policy facilitates industrial structure upgrading through technological innovation and green total factor productivity. Supported by the research results, this study argues that it bears great significance on the sustainable development of China's economy as well as the health and well-being of the people to continually carry out the Healthy Cities pilot work and fully explore the mediating mechanism of the multi-faceted pilot policy on the optimization and upgrading of industrial structure, so as to promote the transformation of the health industry in different regions according to respective local conditions.

Keywords: Healthy Cities pilot; industrial structure upgrading; mediating effect; DID model

1. Introduction

Sound and sustainable city development is essential for industrial structure optimization [1]. Especially in the context of the COVID-19 pandemic, a green economic-industrial form derived to facilitate environmental protection, and human well-being is widely sought after. It has been incorporated into the sustainable development goals of countries around the globe and plays an increasingly prominent role in many national and regional policies and practices. Studies point out that social demands and policy changes may significantly affect industrial structure upgrading [2], which has a significant and positive impact on the transformation of economic growth patterns in various countries and even on human well-being.

Industrial structure upgrading is mainly manifested in the rationalization and the advancement of industrial structure [3], in which the former reflects the coordination of various industries and the resource utilization efficiency in an economy, while the latter represents a shift from low value-added labor-intensive industries to high value-added technology-intensive and capital-intensive industries [4]. The upgrading of industrial structure promoted by these two factors demonstrates an industrial evolution from simplicity to complexity. It leads to an economic development model favored by developing countries and is also a core element in understanding the difference in economic development between developed and developing countries [5]. Previous studies show that the

influencing factors of industrial structure upgrading are multi-faceted. Scholars have extensively discussed the relationships between industrial structure upgrading and industrial policy [6–8], environmental regulation [9–12], information technology [13,14], economic development [15,16], urbanization level [17], and infrastructure construction [18]. Some scholars believe that the upgrading of the industrial structure in China is largely driven by its national policies [19]. Although the long-term impacts of relevant policies of developed countries in Europe and the United States are significantly different [20], a consensus has been generally reached by policy practitioners that policy-driven industrial structure upgrading can maximize the potential competitive advantages of different industries, thereby promoting the sustainable and green development of global economies [21–24].

In the 14th Five-Year Plan period (2021–2025), facing the urgent situation of resource shortage and environmental constraints, China has made industrial structure upgrading an important approach to achieve green and sustainable economic development [25]. By learning from past experiences, China determined various factor conditions related to industrial structure upgrading and has formulated ambitious development plans [26,27]. Among them, the release of the policy for the first batch of 38 healthy pilot cities by the Bureau of Disease Control and Prevention of the National Health Commission (National Patriotism and Health Office) in 2016 deserves special attention. It is well-known that the Healthy City Initiative was originally proposed by WHO in the 1980s. Subsequently, it has been practiced in various countries and regions, and governments around the world have put forward visions, plans, and strategies for building a healthy city.

In fact, since China launched its first batch of pilot healthy cities in 2016, after a short but rapid development, the Healthy Cities pilot policy has become an important media to guide local governments to enhance the awareness of green governance, optimize local energy structure, increase resource utilization efficiency, and advocate healthy lifestyles. It is also regarded as an indispensable engine for the transformation and upgrading of regional industrial structure and the realization of green and sustainable economic development. Existing research on building a healthy city mainly focuses on the construction and analysis of theoretical models from the perspectives of influencing path [28], organization and management [29,30], and multi-dimensional comprehensive analysis [31–33]. There are also studies on constructing an evaluation index system for healthy cities, such as the HUMIDES index [34], DFH [35], HIAs [36], etc.

Through a literature review, we believe that the Healthy Cities pilot policy, as an attempt requiring interactions between the central and local governments, is part of a national strategy and a driving factor for industrial development with a higher and more macro dimension. However, there are few studies on the causal relationship between the Healthy Cities pilot policy and industrial structure upgrading, especially in the context of the Healthy China strategy. A series of important questions can thus be raised: **First**, has the pilot policy promoted the upgrading of industrial structure? **Second**, what factors may promote or inhibit the pilot policy in transforming industrial structure? **Third**, is there any regional heterogeneity regarding the impact of the pilot policy on the upgrading of industrial structure? By answering the above questions, it can help us further understand the mechanism of the pilot policy affecting industrial structure upgrading, and it is also of great reference value for both research and practice.

Differently from previous intuitive analyses on the effects of health policies and the results of industrial optimization, this study, starting from cross-disciplinary research covering health economics and management, etc., for the first time, used the panel data of prefecture-level cities in China from 2012 to 2019. Through a difference-in-differences (DID) model and a series of robustness tests, it focused on the effects of the Healthy Cities pilot policy on industrial structure upgrading and its impact mechanism and discussed the issue of industrial supply balance arising therefrom. The main contributions of this study are as follows: First, based on the panel data of 280 cities in China, the study examined the impact of the pilot policy on industrial structure upgrading from a macro perspective, providing valuable and verifiable decision-making references for realizing green and sustainable

economic development and promoting the Healthy China strategy. Second, this study took the pilot policy as a policy shock event. In order to reduce statistical errors, DID was used to accurately measure and evaluate the effectiveness of the policy before and after its implementation, which deeply reveals the influencing path of the pilot policy in industrial structure upgrading and is conducive to the improvement and optimization of subsequent relevant pilot policies. Third, the study took further consideration the different effects of the pilot policy by discussing the relationships between it and industrial structure upgrading in different areas so that the conclusions will fit better with the current economic and industrial development in China.

In this paper, we first reviewed the research advances both at home and abroad on the relationships between the Healthy Cities pilot policy and industrial structure upgrading and put forward our assumptions. Then we introduced the model construction methods, research data and variables and analyzed and discussed the data results. Finally, in the conclusion section, we emphasized the main findings of the study and suggestions for future research. We focused on the decisive factors determining whether the pilot policy can promote or hinder industrial structure upgrading and their influencing paths.

2. Literature Review and Research Hypothesis

2.1. The Healthy Cities Pilot Policy and Industrial Structure Upgrading

There are few studies on the effects of healthy city construction on industrial structure upgrading. In terms of content, most of the existing literature focuses on the relationships between health and economy [37–40], education [41], demographic structure [42,43], consumption and saving [44], labor productivity [45], etc., and these above topics often involve each other. According to the requirements listed in the Notice of the National Patriotism and Health Office on Implementing the Healthy Cities Pilot Policy, governments of these national pilot cities should take the construction of healthy cities as their development priority. The Notice further defines five elements for healthy city construction, including a healthy environment, healthy society, health services, health culture, and healthy people, and emphasizes the effects of multi-subject coordinated governance at different levels. First of all, the construction of a healthy environment highlights a low-carbon and circular economy. Adjustment and optimization of industrial policies can be used to promote land conservation and intensive use, strengthen environment protection legislation and supervision, and improve the livability of cities. Second, a healthy society and health services clarify the principles of problem-orientation and equality in health promotion. To meet the diversified health demands of urban residents of all classes and ages, the focus of the government-led public health and health services will be on grassroots communities and rural areas, gradually forming inclusive disease prevention and health management system, which means that the health service industry will promote the shift of a large number of labors from the primary and secondary industries to the tertiary industry. Finally, the goals of health culture and healthy people can deeply reflect how well the supply and the demand of the urban health industry match. By improving the availability of urban health services, cultivating and developing the local health consumption market, stimulating health consumption willingness of urban residents, and improving their health consumption level, the goal of healthy urban governance can be achieved.

The new economic form generated by the pilot policy mainly involves the health manufacturing industry and the health service industry. The pilot policy demonstrates various positive effects on the pilot cities. Specifically, first, the pilot policy is conducive to realizing the goals of health governance and environment protection in pilot cities by setting the development goals of a healthy city, preparing development plans, encouraging the expansion of health infrastructure, and actively implementing health education projects. Second, the first batch of pilot cities enjoys preferential policies from both the central and local governments, mainly in tax relief, financial subsidies, talent introduction, and improvement of the quality of public infrastructure. These policies may encourage relevant enterprises to carry out structural adjustment and technological innovation. Third, the pilot

policy has a "halo effect", which can effectively stimulate the local government to make policy commitments and build a healthy model city, then further affect foreign investment and trade and promote economic development. In addition, the gradual implementation of the pilot policy can lead to the prosperity of the health service industry. It will not only offer job opportunities for low-income people but also expand social welfare coverage. In particular, at present, China strongly advocates that health market resources should be concentrated in cities so as to drive healthy economic development and industrial structure upgrading by continuously promoting the modernization and quality of health services. To sum up, this study proposes the following assumption.

H1. *The Healthy Cities pilot policy can effectively promote the transformation and upgrading of the urban industrial structure.*

2.2. The Impact Mechanism of the Healthy Cities Pilot Policy in Promoting Industrial Structure Upgrading

2.2.1. Healthy Cities Pilot Policy Mediated by Technological Innovation and Industrial Structure Upgrading

This study further focuses on the impact mechanism of the Healthy Cities pilot policy on industrial structure upgrading. The improved level of building Healthy Cities is primarily reflected in the local government's emphasis on ecological and environmental issues. Therefore, local governments will strengthen environmental regulations in order to meet the requirements of a healthy environment, during which process technological innovation is regarded by enterprises as an important way to shape the image of an eco-friendly society. According to the "Porter Hypothesis" [46], appropriate environmental regulation will stimulate green technology innovation, which reduces the cost of enterprises caused by environmental regulation, enabling enterprises to obtain greater competitive advantages and potential long-term benefits. Following the innovation compensation effect, most enterprises (especially polluting enterprises), in an attempt to avoid the negative impact of environmental regulations as much as possible, tend to adjust their investment structure and production decisions and adopt green technology innovation to expand the supply of healthy products and services to actively cater to the consumer market. This technological innovation path not only creates economic benefits for enterprises but also expands scale benefits in such areas as business management, human resources, and related supporting technologies.

In addition, technological innovation drives the upgrading of the industrial structure, which has been widely demonstrated by scholars at home and abroad [47,48]. In particular, it has played a vital role in the process of industrial upgrading in western developed countries [49]. Entering the new development stage of the "14th Five-Year Plan", technological innovation has provided an internal driving force for the upgrading of China's industrial structure from one mainly driven by labor to one driven by efficiency [50]. On the one hand, with the replacement of old machinery and equipment, technological innovation will inevitably change the proportion of capital and labor and render the industrial structure more reasonable. On the other hand, according to Maslow's Hierarchy of Needs theory [51], people's yearning for a better life, in the long run, may lead to an upgrade of demand, contributing to a higher-quality resource allocation efficiency among industries and upgrading the industrial structure. It can be said that the Healthy Cities pilot policy has greatly expanded the boundaries of health services for technological innovation and its application scenarios. Guided by the policy, companies are forced to carry out green technology innovations related to health, creating more health demands and stimulating the corresponding supply of health services, which, in turn, drives the rationalization and advancement of the local industrial structure. In summary, this study proposes the following hypotheses.

H2. *The Healthy Cities pilot policy improves the level of technological innovation, thereby promoting the transformation and upgrading of the urban industrial structure.*

2.2.2. The Healthy Cities Pilot Policy Mediated by Green Total Factor Productivity and Industrial Structure Upgrading

As mentioned above, the Healthy Cities pilot policy focuses on changes in the external environment and residents' lifestyles. However, due to a series of environmental challenges brought about by economic growth and rapid urbanization, energy-intensive industries, in particular, have increased risks for China's aging society [52–55]. In this regard, the improvement of urban green total factor productivity has become an important way to achieve the coordinated development of economic performance and the Healthy Cities pilot policy. Specifically, differently from the traditional GDP-oriented economic development pattern that features high investment, high energy consumption, and high pollution, the Healthy Cities pilot policy focuses more on the collaborative efficiency among ecological and environmental conservation, factor and resource input, and economic growth. Such an intervention policy guided by the concept of green development has effectively reduced the desire of local governments to simply pursue GDP growth and increased internal motivations for enterprises to carry out technological innovation, reduce energy consumption, and optimize labor structure, thereby improving the green total factor productivity.

Moreover, through increasing green total factor productivity, the Healthy Cities pilot policy provides intrinsic incentives for cultivating industrial green demands. On the one hand, this economic development pattern guided by green concepts reduces the proportion of pollution-intensive industries but also optimizes the pattern of technology and knowledge-intensive industries, making the connection between the secondary and tertiary industries increasingly close. On the other hand, the green total factor productivity effect from the Healthy Cities pilot policy promotes the development of the tertiary industry dominated by clean industries, which not only effectively improves the livability of cities but also invokes a higher-level green consumption willingness that better meets national health demands, such as new energy vehicles, healthy food [56], education fairness [57,58], etc. Gradually, this will not only enable the industrial value chain to extend to the higher end but also create better social conditions for local Chinese governments to continually improve the environment, economy, and health care services. Taken together, this study proposes the following hypotheses.

H3: *The Healthy Cities pilot policy improves green total factor productivity, which, in turn, promotes the transformation and upgrading of the urban industrial structure.*

3. Materials and Methods

3.1. Data and Variables

Based on the principles of completeness and availability, this study selects the panel data from 280 cities at the prefecture level and above from 2012 to 2019. The indicators of the core explanatory variables and control variables are all from the *China Urban Statistical Yearbook*, and the statistical yearbooks of various cities and other public databases, wherein the missing values are uniformly replaced by the mean values. The data of the explained variables are compiled according to the "Notice of the National Love and Health Office on Launching the Pilot Work of Healthy Cities" issued by the Bureau of Disease Control and Prevention (National Love and Health Office) under China National Health and Family Planning Commission. All figures and tables should be cited in the main text as Figure 1, Table 1, etc.
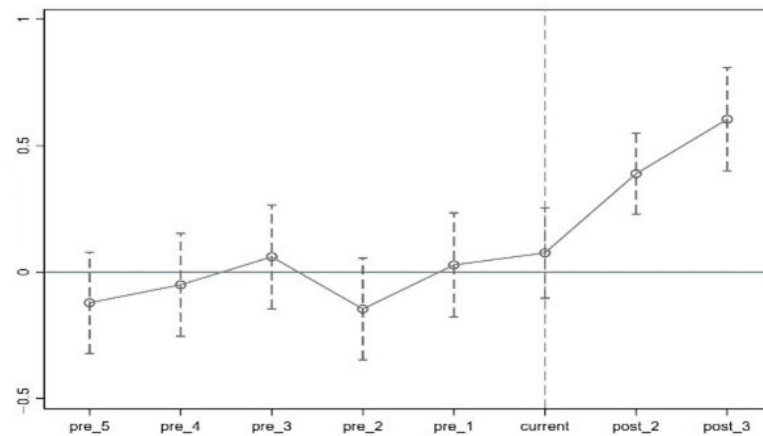
Figure 1. *ais* is the explained parallel trend test.

Table 1. Description of main variables.

Variable Category	Variable Name	Obs	Mean	Std. Dev.
Explained variables	Advanced industrial structure *(ais)*	1496	1.114	0.674
	Rational industrial structure *(theil)*	1496	0.715	0.123
Core explanatory variables	Whether it is in the first batch of Healthy Cities pilots *(D$_{it}$)*	1496	-	-
	Regional economic development level *(lgdp)*	1496	0.500	0.490
	Total level of urbanization *(tlou)*	1496	0.379	0.240
	Human capital development level *(lhc)*	1496	0.058	0.040
Control variables	Level of opening to the outside world *(doo)*	1496	0.022	0.032
	Urban environment level *(uel)*	1496	4.702	6.044
	Level of government issue *(logi)*	1496	0.256	0.302
	Health policy strength *(hps)*	1496	4.88	13.478
Mediating variables	Technological innovation *(pg)*	1496	7116.064	14,422.594
	Green total factor productivity *(SBM)*	1496	0.729	0.588

Explained variables for the industrial structure upgrading. The connotation of industrial structure upgrading involves the progress of the proportional relationship of various industries and the rational allocation of production factors among industries [59] to obtain the "structural effect". Based on this, this research adopts the method commonly used in the academic community, namely, to measure the two indicators of the rationalization of industrial structure and the advancement of industrial structure. The advanced industrial structure (ais) reflects the process of advancing the regional industrial focus from primary industry to secondary and tertiary industries. This study draws on the practice of Gan Chunhui [4] and measures it by the ratio of the output value of the tertiary industry to that of the secondary industry. For the rationalization of the industrial structure (theil), this research adopts the Theil index to measure the rationalization level of the industrial structure of each city. The Theil index, also known as the Theil entropy, is widely used in studies of regional income disparities. This research draws on the methods of Liu Zhe and Liu Chuanming [60] and introduces the Theil index to couple the input of factors of production and structure of output and measure the degree to which the industrial structure deviates from the equilibrium level. The calculation formula is as follows:

$$theil = \sum_{k=1}^{m} \left(\frac{Y_{k,m}}{Y_k} \right) \ln \left[\frac{\frac{Y_{k,m}}{Y_k}}{\frac{L_{k,m}}{L_K}} \right] \tag{1}$$

Among them, $Y_{k,m}/Y_k$ represents the proportion of the output value of the *m*-th industry in region *k* to the GDP of the region, and $L_{k,m}/L_k$ stands for the proportion of the employment of the *m*-th industry in region k to the total employment in the region. Further, this indicator clearly shows the changing trend in the industry and the degree to which the industrial structure deviates from the equilibrium level. If the Theil index is 0, it means that the industrial structure is in equilibrium and the industrial structure stands as more reasonable. If the Theil index is not 0, it indicates that the industrial structure deviates from the equilibrium level, which marks an unreasonable industrial structure.

Core explanatory variables for the first batch of Healthy Cities pilot policy. This study uses dummy variables to assign values to whether cities were approved and when they were approved for the Healthy Cities pilot policy. During the sample period, cities that have been approved as Healthy Cities pilots are assigned a value of 1 for all years starting from the year of approval, and cities that have not been approved as Healthy Cities pilots are assigned a uniform value of 0. The dummy variable for time is set to 0 before the policy implementation and 1 after the policy takes effect. Therefore, the interaction term produced by multiplying the two dummy variables is used as the core explanatory variable "did" in this study.

Mediating variables. As mentioned in the theories above, the Healthy Cities pilot policy may have an impact on the upgrading of the industrial structure through technological innovation and green total factor productivity. Therein, this study uses the level of technological innovation and green total factor productivity as mediating variables. Among them, the level of technological innovation is measured by the number of patents granted in the cities in that year. For green total factor productivity, this study, under the global DEA framework, adopts the Bootstrap super-efficiency SBM model [61] based on undesired output and selects industrial wastewater discharge, industrial SO_2 discharge, and industrial soot discharge to measure the pollution indicators as a result of economic activities.

Control variables. According to the practice of previous research, this research selects seven control variables, including social environment factors, human capital factors, and government intervention factors, which are closely related to the upgrading of industrial structure, including:

(1)   Regional economic development level (*lgdp*), measured by regional per capita GDP;
(2)   Total level of urbanization (*tlou*), measured by the ratio (%) of urban population to total population at the end of the year;
(3)   Level of human capital (*lhc*), measured by the ratio (%) of teachers to students in general colleges and universities;
(4)   Degree of opening to the outside world (*doo*), measured by the ratio (%) of actual FDI to GDP;
(5)   Urban environment level (*uel*), measured by per capita park green space (hectare/ 10,000 people);
(6)   Level of government issue (*logi*), measured by the proportion (%) of government fiscal expenditure in regional GDP;
(7)   Health Policy Strength (*hps*), using the frequency of health policy promulgated by prefecture-level cities in China over the years as the indicator of policy strength of the Healthy Cities pilot.

3.2. Descriptive Statistics

The descriptive statistics of the main variables are shown in Table 1, which reports descriptive statistics for the full sample for the entire period (cities data from 2012–2019).

3.3. Model Design and Construction

The impact of the Healthy Cities pilot policy on industrial structure upgrading (advancement of industrial structure and rationalization of industrial structure) is affected by both the time effect and the cities' own special effect. In this regard, this study uses a DID model to separate the time effect and the urban space effect in order to explore the

impact mechanism of the Healthy Cities pilot policy on industrial structure upgrading. Subsequently, the benchmark regression model of this study is set as follows:

$$ais_{it} = \alpha_0 + \alpha_1 treat_i \times time_t + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{2}$$

$$theil_{it} = \alpha_0 + \alpha_1 treat_i \times time_t + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{3}$$

In the formulas, *i* refers to the cities, t stands for the year, ais_{it} and $theil_{it}$ denote the industrial structure advancement index and rationalization index of region *i* in the *t*-th year, respectively, $lgdp_{it}$ refers to the regional economic development level of region *i* in the *t*-th year, $tlou_{it}$ stands for the urbanization level of region i in the *t*-th year, lhc_{it} indicates the human capital development level of region *i* in the *t*-th year, doo_{it} indicates the level of opening to the outside world in region *i* in the *t*-th year, uel_{it} indicates the urban environment level of region *i* in the *t*-th year, $logi_{it}$ means the government fiscal expenditure of region *i* in the *t*-th year, and hps_{it} represents the health policy intensity of region *i* in the *t*-th year. α_0, β_0, φ_0, δ_0, γ_0, λ_0, and η_0 are constant terms, μ_i refers to individual effects, and e_{it} represents random error terms.

In order to further test how the Healthy Cities pilot policy affects industrial structure upgrading, two mediating variables, namely technological innovation (*pg*) and green total factor productivity (*SBM*) are introduced based on the above model. The study sets the mediating effect model as follows:

$$pg_{it} = \beta_0 + \beta_1 treat_i \times time_t + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{4}$$

$$SBM_{it} = \varphi_0 + \varphi_1 treat_i \times time_t + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{5}$$

$$ais_{it} = \delta_0 + \delta_1 treat_i \times time_t + \delta_2 pg_{it} + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{6}$$

$$ais_{it} = \gamma_0 + \gamma_1 treat_i \times time_t + \gamma_2 SBM_{it} + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{7}$$

$$theil_{it} = \lambda_0 + \lambda_1 treat_i \times time_t + \lambda_2 pg_{it} + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{8}$$

$$theil_{it} = \eta_0 + \eta_1 treat_i \times time_t + \eta_2 SBM_{it} + \sum control_{it} + \mu_i + \varepsilon_t + e_{it} \tag{9}$$

4. Analysis and Results

4.1. Parallel Trend Test

The DID benchmark regression model constructed above shows the results, on average, of the impact of the Healthy Cities pilot policy on the upgrading of the industrial structure. In fact, the Healthy Cities pilot policy is affected by factors such as implementation intensity, supporting measures, and adjustment of production factors. The performance also varies at different stages. On the one hand, the Healthy Cities pilot policy normally experiences a period of weakness, and the policy strength may be time-sensitive. On the other hand, the parallel trend assumption is applied before studying the causation between the Health Cities pilot policy and industrial structure upgrading; namely, the trend of industrial structure upgrading of the treatment group and the control group should show a similar trajectory before the Healthy Cities pilot policy experts its impact.

Based on the two reasons above, this study examines the parallel trends of the Healthy Cities pilot policy. Figures 1 and 2 report the regression coefficients of the Healthy Cities pilot policy on industrial structure upgrading under the 95% confidence interval, and the results of the two are basically consistent. This means that before the implementation of the Healthy Cities pilot policy, there was no significant difference between the experimental and control groups, satisfying the parallel trend hypothesis. After the first batch of Healthy Cities pilots was identified, the promotion effect of the policy on the advancement of industrial structure (*ais*) and rationalization of the industrial structure (*theil*) began to appear in the current period of policy implementation, but the effect was not apparent

then. In the second period, however, the positive effect was particularly significant. This may be related to changes in the degree to which relevant individuals understand and respond to the policy throughout the process of implementation and time for integrating innovative resources. It suggests that the promotion effect of the Healthy Cities pilot policy on upgrading industrial structure is gradually increasing, but it also reflects the time lag of the pilot policy: it takes time for the policy to have a significant effect.
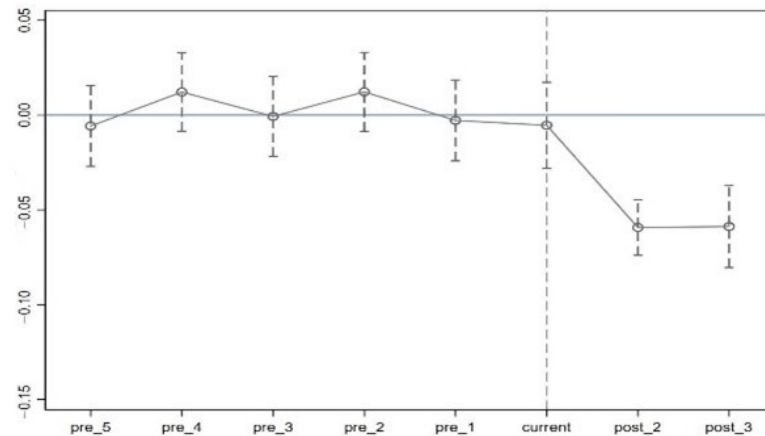

Figure 2. *theil* is the explained parallel trend test.

4.2. Benchmark Regression

First, the panel model is examined by the Hausman test. The results show that the null hypothesis is rejected, so the fixed effect model is used for regression analysis. The regression results are shown in Table 2. From Model (2) in Table 2, it can be seen that whether it is a Healthy Cities pilot or not has a significantly positive influence coefficient on the advanced industrial structure; the influence coefficient is 0.197, which is pretty prominent at the significance level of 1%, indicating that the Healthy Cities pilot policy has a positive effect on the advanced industrial structure. The healthy development of cities is based on the process of urban industrial transformation and the resulting regional and social changes. The implementation of the Healthy Cities pilot policy can promote the local industrial structure to transit from the primary and secondary industries to the tertiary industry, thereby optimizing the industrial mix. It can be seen from Model (4) that whether it is a Healthy Cities pilot or not has a significant negative impact on the rational industrial structure, and the influence coefficient is −0.041, which means much at the significance level of 1% (it should be noted that the rationalization of the industrial structure in this study is a negative indicator). The results show that the Healthy Cities pilot policy can effectively restrain the industrial structure from deviating from the equilibrium level and facilitate a rational industrial structure. Overall, the benchmark regression results support Hypothesis H1, and the Healthy Cities pilot policy has significantly promoted an advanced and rational industrial structure, boosting the transformation and upgrading of the industrial structure.

Table 2. The regression results of the Healthy Cities pilot policy on the upgrading of the industrial structure.

Variables	*ais*		*theil*	
	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**
Whether it is in the first batch of pilot Healthy Cities *(D$_{it}$)*	0.401 ***	0.197 ***	−0.068 ***	−0.041 ***
	(5.81)	(3.21)	(−5.06)	(−5.45)
Regional economic development level *(lgdp)*		−1.185 ***		0.525 ***
		(−13.21)		(47.60)
Total level of urbanization *(tlou)*		1.192 ***		−0.254 ***
		(5.95)		(−10.32)
Human capital development level *(lhc)*		1.310 ***		−0.518 ***
		(4.57)		(−14.72)
Level of opening to the outside world *(doo)*		0.126		−0.035
		(0.31)		(−0.70)
Urban environment level *(uel)*		0.047 ***		−0.005 ***
		(6.18)		(−4.80)
Level of government issue *(logi)*		0.201 ***		−0.046 ***
		(5.36)		(−10.02)
Health policy strength *(hps)*		0.047 ***		−0.019 ***
		(14.77)		(−48.42)
Constant	1.094 ***	0.660 ***	0.719 ***	0.709 ***
	(103.15)	(8.16)	(347.38)	(71.28)
Observations	1496	1496	1496	1496
R-squared	0.027	0.294	0.021	0.717
Time fixed effects	Yes	Yes	Yes	Yes
Spatial fixed effects	Yes	Yes	Yes	Yes
Within R^2	0.027	0.294	0.021	0.717

Note: *** represent the significance levels of 1%, and the standard deviation of the regression coefficient is in brackets.

4.3. Robustness Test

4.3.1. PSM-DID Inspection

In order to reduce the possible systematic differences between pilot cities and non-pilot cities, this study refers to the research of Shi Daqian [62] and employs PSM-DID for a robustness test. The matching steps are as follows: perform logit regression on covariates such as control variables through dummy variables between groups to obtain propensity scores, and the cities with the closest scores go into the matching control group for the cities implementing the Healthy Cities pilot policy. The method of propensity score matching can minimize the differences between groups in the industrial structure of different cities.

Table 3 reports the propensity score matching results. It is clear that the t value of the covariate after matching is not significant; that is, there is no significant difference between the experimental group and the control group, nor is there a significant difference between cities after matching. At the same time, the absolute value of the standard deviation after matching is less than 10% except for *uel*, indicating that the matching process is effective.

Table 3. Propensity score matching results.

	t **Value after Matching**	**Matched *p*-Value**	**Standard Deviation (%)**
lgdp	0.55	0.585	8.4
tlou	−0.73	0.468	−9.8
lhc	−0.19	0.847	−1.5
doo	0.38	0.701	5.2
uel	−0.84	0.401	−14.7
logi	−0.50	0.615	−3.3
hps	0.49	0.623	7.7
N	139	139	1496

On the basis of satisfying the above assumptions, PSM-DID analysis is performed, and the regression results are shown in Table 4. There is no significant difference between *ais* and *theil* between the experimental group and the control group after using the "Kernel core matching". The DID test results of the Healthy Cities pilot policy on the advanced industrial structure are significantly positive, and the test results on the rational industrial structure are significantly negative, and both are significant at the 1% significance level; that is, the Healthy Cities pilot policy has promoted advanced industrial structure, which is basically consistent with the basic regression results, indicating that the estimated results of this study are robust.

Table 4. PSM-DID regression results.

Variables	*ais*	*theil*
	Model (1)	**Model (2)**
Whether it is in the first batch of healthy pilot cities (D_{it})	0.197 ***	−0.041 ***
	(3.20)	(−5.44)
Constant	0.660 ***	0.709 ***
	(8.15)	(71.24)
Observations	1495	1495
R-squared	0.294	0.717
time fixed effects	Yes	Yes
Spatial fixed effects	Yes	Yes
Within R^2	0.294	0.717

Note: *** represent the significance levels of 1%, and the standard deviation of the regression coefficient is in brackets.

4.3.2. Placebo Test

In order to further verify that the upgrading of the industrial structure is not affected by other unobservable factors, this study draws on the practice of the existing literature [63] to conduct a placebo test. The Healthy Cities pilot policy is randomly assigned to each city, and the newly generated experimental groups and control groups are randomly sampled 500 times using the benchmark regression model to ensure that the impact of the Healthy Cities pilot policy on D_{it} would not be disturbed by other factors. Figures 3 and 4 show the distribution of core density after randomization. According to Figures 3 and 4, it can be seen that the actual estimated parameters are different from the coefficient estimates obtained in the placebo test, which confirms that the advanced industrial structure due to the Healthy Cities pilot policy is not caused by other accidental factors or noises, signifying that the benchmark regression results of this study are robust.
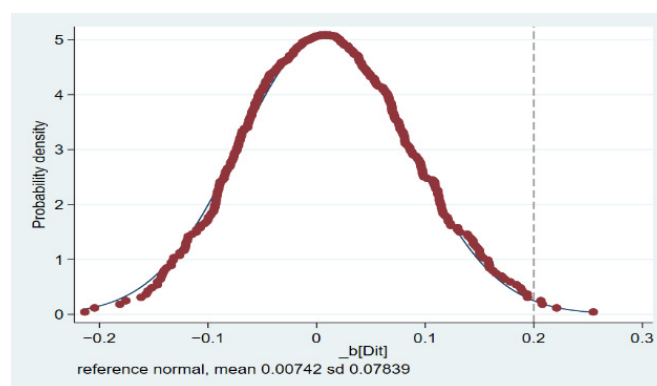

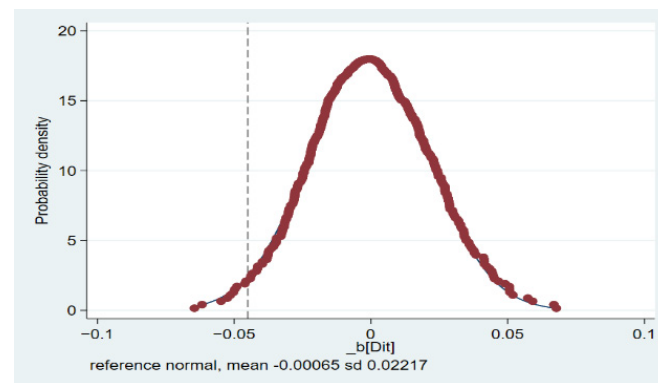**Figure 3.** *ais* is the placebo test of the explained variables.

Figure 4. *theil* is the placebo test of the explained variables.

4.4. Analysis of Influence Mechanism

4.4.1. Technological Innovation

This section examines the mediating effect of technological innovation. It can be seen from Model (1) in Table 5 that, under the premise of controlling other variables, the total effect of the Healthy Cities pilot policy on the advanced industrial structure is 0.197, which is significant at the significance level of 1%; Model (2) reveals that the total effect of the Healthy Cities pilot policy on technological innovation is 0.234, which is significant at the significance level of 5%; Model (3) analyzes the joint effect of the Healthy Cities pilot policy and technological innovation on the advanced industrial structure, and the results show that the coefficient of the Healthy Cities pilot policy is 0.071, which is significant at the 5% significance level. In addition, the coefficient of technological innovation is significantly 0.538 (indirect effect), with a significance level of 1%; that is, the Healthy Cities pilot policy brings technological innovation, thereby promoting the advanced development of the industrial structure.

Table 5. Analysis of the influence mechanism based on technological innovation.

Variables	*ais* Model (1)	*lnpg* Model (2)	*ais* Model (3)	*theil* Model (4)	*lnpg* Model (5)	*theil* Model (6)
D_{it}	0.197 *** (3.21)	0.234 ** (2.36)	0.071 ** (2.37)	−0.041 *** (−5.45)	0.234 ** (2.36)	−0.027 *** (−6.08)
pg			0.538 *** (62.02)			−0.062 *** (−49.07)
Constant	0.660 *** (8.16)	2.688 *** (20.51)	−0.787 *** (−17.15)	0.709 *** (71.28)	2.688 *** (20.51)	0.875 *** (131.14)
Observations	1496	1496	1496	1496	1496	1496
R−squared	0.294	0.317	0.831	0.717	0.317	0.906
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Urban spatial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.294	0.317	0.831	0.717	0.317	0.906

Note: *** and ** represent the significance levels of 1% and 5%, respectively, and the standard deviation of the regression coefficient is in brackets.

It is clear from Model (4) that the total effect of the Healthy Cities pilot policy on the rational industrial structure is −0.041, which is significant at the significance level of 1%. Model (6) analyzes the combined influence of the Healthy Cities pilot policy and technological innovation on the rationalization of the industrial structure. The results show that the coefficient of the Healthy Cities pilot policy is −0.027 (direct effect), which is significant at the 1% significance level; at the same time, the coefficient of technological innovation is −0.062 (indirect effect), which is significant at the 1% significance level. Further, a Sobel test is performed. The Z value of the Sobel test of the mediating path

with the advanced industrial structure as the explained variable is 3.2095, which is greater than the critical value of 1.96 at the significance level of 5%, proving that the test result is significant. Similarly, the Z value of the Sobel test of the mediating path with the rational industrial structure as the explained variable is 5.4128, exceeding the critical value of 1.96 at the 5% significance level, which proves that the test result is significant. This means that the mediating effect of the Healthy Cities pilot policy affecting the advancement and rationalization of the industrial structure through technological innovation exists; that is, hypothesis H2 is verified.

4.4.2. Green Total Factor Productivity

This section examines the mediating effect of green total factor productivity. From Model (1) in Table 6, it is clear that under the premise of controlling other variables, the total effect of the Healthy Cities pilot policy on the advanced industrial structure is 0.197, which is significant at the significance level of 1%; it can be seen from Model (2) that the effect of the Healthy Cities pilot policy on green total factor productivity is 0.074, which is significant at the 10% significance level; Model (3) shows that the coefficient of the Healthy Cities pilot policy is significantly 0.122 (direct effect) at a significance level of 1%, while the green total factor productivity coefficient is 1.011 (indirect effect), which is significant at the 1% significance level.

Table 6. Analysis of impact mechanism based on green total factor productivity.

	ais	*SBM*	*ais*	*theil*	*SBM*	*theil*
Variables	**Model (1)**	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
D_{it}	0.197 ***	0.074 *	0.122 ***	−0.041 ***	0.074 *	−0.032 ***
	(3.21)	(1.79)	(2.73)	(−5.45)	(1.79)	(−5.60)
SBM			1.011 ***			−0.117 ***
			(32.66)			(−29.23)
Constant	0.660 ***	0.512 ***	0.142 **	0.709 ***	0.512 ***	0.769 ***
	(8.16)	(9.35)	(2.33)	(71.28)	(9.35)	(97.51)
Observations	1496	1496	1496	1496	1496	1496
R-squared	0.294	0.198	0.625	0.717	0.198	0.835
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Urban spatial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.294	0.0832	0.365	0.717	0.0832	0.741

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%, respectively, and the standard deviation of the regression coefficient is in brackets. This also applies to the other tables.

In addition, when other variables are all controlled, it can be seen from Model (4) in Table 6 that the impact of the Healthy Cities pilot policy on the rationalization of the industrial structure is −0.041, which is significant at the significance level of 1%; Model (6) demonstrates that the influence coefficient of a rational industrial structure is −0.032 (direct effect) with a significance level of 1%, and the influence coefficient of green total factor productivity on the rational industrial structure is −0.117 (indirect effect), which is significant at the 1% significance level. Due to the weak statistical significance condition on the mediating path, a further Sobel test is needed according to the method of Wen Zhonglin and Ye Baojuan [64].

The Z value of the Sobel test of the mediating path with an advanced industrial structure as the explained variable is 3.1984, which is greater than the critical value of 1.96 at the 5% significance level, proving that the test result is significant. The Z value of the Sobel test of the mediating path with rational industrial structure as the explained variable stands at 5.3539, greater than the critical value of 1.96 at the significance level of 5%, which proves that the test result is significant and indicates that SBM has a mediating effect between the core explanatory variables and the explained variables. This means that the Healthy Cities pilot policy can promote the transformation and upgrading of the

industrial structure by promoting the improvement of green total factor productivity; that is, hypothesis H3 is verified.

5. Regional Heterogeneity Analysis

Based on per capita economic development level, we divide the provinces and cities into three regions: the eastern region, the central region, and the western region. It is clear from Table 7 that the impact of the Healthy Cities pilot policy on the advanced industrial structure in different regions is not the same. Specifically, the Healthy Cities pilot policy has driven the upgrading of the industrial structure in the eastern and central regions but not in the western region. Further, the impact of the Healthy Cities pilot policy on the upgrading of the industrial structure in the eastern region turns out higher than that in the central region. This may be due to the fact that the eastern region boasts greater comprehensive strength, while its efficient resource allocation boosts the green production efficiency of enterprises in turn and provides impetuses for the upgrading of the industrial structure, thus forming a higher level of urban industrial health. As an important hub, the central region has steadily improved the transformation efficiency of better industrial health but compared with the more developed cities in the east, its basic conditions, such as public resources, social resources, and human resources, need to be further improved. In addition, due to the limited degree of opening to the outside world in the western region, the development of the industrial health system is relatively backward, which, to a certain extent, hinders the improvement of the technological innovation level and green total factor productivity of enterprises, thereby leading to the slow upgrading of the industrial structure.

Table 7. Regional heterogeneity analysis.

	ais			*theil*		
Variables	**Model (1)**	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
$D_{it} \times$ west	0.002 (0.02)			−0.019 (−1.51)		
$D_{it} \times$ c.midd		0.252 ** (2.09)			−0.038 *** (−2.60)	
$D_{it} \times$ c.east			0.262 ** (2.48)			−0.058 *** (−4.56)
Constant	0.599 *** (3.23)	0.666 *** (4.36)	0.733 *** (6.51)	0.703 *** (30.43)	0.716 *** (38.03)	0.703 *** (51.52)
Observations	482	484	530	482	484	530
R-squared	0.360	0.281	0.301	0.702	0.713	0.756
Number of cities_id	90	89	101	280	280	280
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Urban spatial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.360	0.281	0.301	0.702	0.713	0.756

Note: The interaction terms refer to the Healthy Cities pilot policy and the three regions of the eastern, central, and western regions. These items are marked with "×". *** and ** represent the significance levels of 1% and 5%, respectively, and the standard deviation of the regression coefficient is in brackets.

6. Conclusions and Policy Recommendations

Urban industrial structure upgrading has always been one of the hot topics in the field of economic research. Although the existing research has affirmed the positive effects of many policies on the upgrading of the industrial structure, research on the combination of and interaction between the Healthy Cities pilot policy and industrial structure upgrading is relatively rare. From the list of the first batch of national Healthy Cities pilots announced in 2016, this study took 38 cities as the experimental group to conduct quasi-natural experiments. The DID model empirically tests the impact of the Healthy Cities pilot policy on the industrial structure upgrading and its working mechanism. The research

conclusions are as follows. First, the Healthy Cities pilot policy has significantly improved the advancement and rationalization of the urban industrial structure, indicating that the Healthy Cities initiative has a positive effect on the upgrading of the industrial structure. This result still holds after a series of robustness tests. Second, we conduct further tests on the mechanism of technological innovation and green total factor productivity as mediating variables and find that the Healthy Cities pilot policy can achieve the transformation and upgrading of the industrial structure through technological innovation and green total factor productivity. Last, the geographical location of cities has a heterogeneous influence on the Healthy Cities pilot policy's impact on the upgrading of the industrial structure. Specifically, the Healthy Cities pilot policy exerts a significant impact on the industrial structure upgrading of cities in the eastern and central regions but has no significant impact on that in the western region. Based on the research conclusions above, this research puts forward the following suggestions for China to continuously promote the Healthy Cities strategy and the promulgation of related supporting policies.

First, the pilot policy should be taken as an important channel in continuously and unswervingly advancing the Healthy Cities initiative. As a complicated systematic project, its pilot policy highlights a low-carbon orientation and circular economy to a certain extent and encourages local governments to continue to promote the concept of green economic development. In the future, an intelligent health-care service platform should be built on the basis of the expanding infrastructure for comprehensive health. In order to further develop the Healthy Cities initiative, it is important to fully use digital and information technologies, widely integrate knowledge, talents, capital, technologies and other factors, and promote exchanges and interactions among these factors. Meanwhile, widely promoting the achievements and experience of the Healthy Cities pilot policy and expanding its scope year by year will not only help improve the willingness of local governments to build a healthy society and provide health services but also continue to create a healthy atmosphere and shaping healthy consumption scenarios. It will also improve the health awareness of all the people nationwide and accelerate achieving the national strategic goal of "Healthy China".

Second, the industrial structure upgrading mediated by technological innovation and improved green efficiency should be fully leveraged. The research results show that an extremely important part of achieving the overall goal of building Healthy Cities is to improve the level of technological innovation and green total factor productivity of enterprises. At this stage, China's Healthy Cities pilot policy functions as an "external pressure", with its incentive and restraint mechanisms prompting enterprises to innovate in technology and improve green total factor productivity. Therefore, the Healthy Cities initiative in China must adhere to a development strategy combining "market-dominated decision" and "government regulation". On the one hand, it is necessary to emphasize the industrial aggregation effect of urban green development and improve the enterprises' level of R&D investment and the efficiency of industrial resource allocation. On the other hand, it is imperative to ensure that maximized corporate profits will be gradually realized in the process of building Healthy Cities. Through a series of innovation incentives, including continuous and targeted policy guidance, tax relief, and financial support, the strategy should cut production costs, encourage enterprises to arouse willingness and active behavior for green consumption, and reduce consumers' perceived risks and consumption burden due to lack of knowledge of environmental pollution, green products and services, as well as healthy lifestyles [65], which will be beneficial for unleashing the potential of healthy consumption and further enhance the impetus for industrial development.

Third, it is vital to advance the upgrading of the urban industrial structure at different stages of development according to local conditions. China has a vast territory. In terms of regional characteristics, the eastern, central, and western regions see de facto gaps in the economic development foundations and a divergent distribution of resource endowments. Therefore, it is necessary to optimize the differentiated paths of industrial structure upgrading on the basis of comprehensive consideration of relevant factors. Meanwhile, scale-wise,

for cities in the eastern region, large cities, and cities with high administrative levels that have developed well, it is necessary to continue to give full play to their economies of scale, use innovative technologies to accurately identify the needs of the end consumer market, optimize the mechanism for policy coordination, data sharing and industrial linkage, and allow industrial structure upgrading to play the "leading" role in high-quality economic development. The central and western regions should pay more attention to the investment in health-care infrastructure construction projects and bring in more technical talents with diversified supporting policies. Specifically, the western regions should make full use of regional natural resource endowments to cultivate new pillar industries and improve the supervision system and mechanism. It is also necessary for these regions to find the best experimental reference from the various stages and links of the eastern Healthy Cities pilots as soon as possible, which matches their own regional characteristics and can be applied and practiced easily. Through these efforts, the western regions can accelerate their industrial restructuring through economic growth.

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