

Article

Impact of Forest City Selection on Green Total Factor Productivity in China under the Background of Sustainable Development

Yameng Wang ¹ , Fan Zou ¹, Wenqing Guo ¹, Weinan Lu ² and Yuanjie Deng ^{3,*} 

¹ School of Economics, Qufu Normal University, Rizhao 276800, China; wym2022@qfnu.edu.cn (Y.W.); zof@qfnu.edu.cn (F.Z.); qf2023417429@qfnu.edu.cn (W.G.)

² Rural Economic Research Center, Ministry of Agriculture and Rural Affairs, Beijing 100010, China; luweinan@nwafu.edu.cn

³ School of Economics, Sichuan University of Science and Engineering, Zigong 643000, China

* Correspondence: ecodyj@suse.edu.cn

Abstract: In the critical period of strengthening the construction of ecological civilization, the construction of forest cities has become an important measure to promote urban ecosystem restoration and achieve sustainable development. Based on the mechanism of forest city promoting green development, the construction of a national forest city is regarded as a “quasi-natural experiment”. Using China’s urban panel data from 2005 to 2019, the impact of national forest city construction on urban green total factor productivity was evaluated using Multistage asymptotic double difference. The results show that National Forest Cities with environmental regulation can significantly promote regional green total factor productivity, which is still valid after a series of Robustness tests. Mechanism analysis shows that forest city construction not only affects territorial spatial planning but also forms a linkage with green technology innovation, mutual promotion and mutual promotion to jointly promote the sustainable development goals. This paper argues that building a national forest city is an important measure to achieve China’s sustainable development goals in the new era, but in the process of policy implementation, it is necessary to implement the national forest city selection system according to local conditions.

Keywords: national forest city; sustainable development; green total factor productivity; EBM-GML



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1. Introduction

The concept of “Lucid Water and Lush Mountain are Invaluable Assets” has become a guide to action to lead China on the road to green development. China’s ecological safety and economic and social development of forest resources as a basic, leading, strategic elements, its environmental bearing space has affected the development space of human society [1]. However, with the rapid development of the economy and industrialization, the carrying capacity of China’s forestry resources continues to decline, and the illegal occupation of forest land by various types of construction exceeds 2 million mu per year. Environmental degradation, such as forest destruction and decline, has become a key factor hindering China’s ecological civilization construction and sustainable development [2]. Specifically, China’s industry relies on the traditional high-input, high-consumption, high-pollution mode of production driven by resource factors to rapidly drive economic growth [3]. In many areas, excessive exploitation of forests to produce timber and forest products for short-term economic benefits leads to the reduction of forest resources, the increase of harmful gases and dust over the city, the intensification of soil and water pollution, urban greenhouse and heat island effect, which is not conducive to the green development of the city [4]. However, the current policies on urban ecological environment are still focused on the direct source of pollution, mainly on eliminating environmental pollution itself, such as environmental protection legislation, Enforcement and

other mandatory means; these mean the control of environmental pollution while ignoring the cost of environmental regulation, resulting in strict environmental regulation policy may cause capital outflow, reduce the total factor productivity of the city and other issues, the current urban economy have a negative impact [5]. This series of problems highlights the obstacles to the further development of the city. Therefore, it is urgent for Chinese cities to promote the development mode of resource-saving and ecological environment virtuous circle.

How to realize the sustainable development of the urban economy has become the focus of attention of the government and academia. On the one hand, the government has issued a number of documents to provide guidance for promoting the construction of ecological cities. For example, the Outline of the 13th Five-Year Plan for National Economic and Social Development of the People's Republic of China in 2016 clearly states that the "Development of forest cities, Construction of forest town to consolidate the ecological security barrier" marks that the construction of forest city has been integrated into the national major development strategy, which also provides new specific ideas for promoting urban sustainable development; In 2021, the National Development and Reform Commission issued the "14th Five-Year Plan" for the Development of Circular Economy, which clearly pointed out the path of urban development of circular economy. It is necessary to change the mode of development, which relies too much on increasing material resources consumption, extensive expansion, high energy consumption and high emission industries, improve the current situation of the ecological environment and make urban ecological restoration an important part of sustainable development strategy. The report of the 20th National Congress of the Communist Party of China pointed out that China is in a critical period of strategic transformation from high-speed economic growth to high-quality economic development, and high-quality development is the primary task of comprehensively building a socialist modern country, while green total factor productivity is the most important factor in the development of China. It is an important driving force for achieving high-quality economic development. So, can the national implementation of forest cities effectively promote the growth of urban green total factor productivity? What is the mechanism behind it? The theoretical interpretation and empirical test of such problems undoubtedly have important theoretical and practical significance.

On the other hand, the evaluation of forest city construction effect has aroused extensive discussion in the academic circle, and mainly focuses on the following two aspects. First, it is important to enhance local ecological connotation and enhance environmental carrying capacity [6]. As a kind of living infrastructure, the urban forest has ecological functions such as eliminating atmospheric suspended matter [7], transpiration and cooling [8]. For example, the Jatai Goias area in Brazil has seen an increase in species richness, diversity and stability over the past 13 years following urban greening [9], and the Cook and DuPezi urban forests in Chicago in the United States absorb an average of 2000 tons of CO₂ per day [10]. Yingjie et al. used the panel data of Chinese cities from 2013 to 2017 to study whether national forest cities can improve urban living environment and found that after the construction of forest cities, the total green area such as grassland and forest land increased by 7.5%, the per capita green area such as grassland and forest land increased by 10.9%, the green coverage rate increased by 1.0%, and the PM2.5 decreased by 3% [11]. Second, building a national forest city is not only about China's Environmental protection goals but also about sustainable urban economic development [12]. There is an inseparable relationship between the economy and the environment. This relationship is manifested in that extensive economic development may lead to the intensification of environmental pollution, but the economic transformation development can restrain or reduce environmental pollution [13]. In other words, the economic benefits of urban forests are essentially the economic quantification of ecological benefits and social benefits [14]. The quantification of ecological benefits comes mainly from energy savings from shading, wind protection and fire protection. With the reduction of losses from water and soil conservation and environmental clean-up [15] and the increase of wealth from green space, Cabe Space [16]

used eight urban parks in the UK to examine the relationship between urban forest and property values and found that urban forest has an increase of 7.3%–11.3%. The quantification of social benefits is mainly reflected in the urban forest green space on the regional rent, residents' consumption and industrial development also has a role in promoting. As an important part of public service supply, urban forest enhances urban soft power through its functions of improving environmental quality and beautifying urban landscape. To attract labor inflows and promote the development of tourism, service industry, real estate related, commercial and other tertiary industries [17], especially with the rapid development of high-speed rail and other transportation infrastructure, the comprehensive completion of a well-off society, etc. To a certain extent, the construction of transportation infrastructure breaks the restrictions of time, space, economy and other factors existing in the traditional flow of residents, making the ecological environment gradually become an important factor in residents' employment choices [18], which further strengthens the urban forest as a green infrastructure, making urban forest construction to the economic structure, labor mobility and accumulation of the external impact [19].

Reviewing the existing literature [20], some studies focus on the evaluation of ecological functions of forest city construction [21], while few studies on green total factor productivity are based on the sustainable perspective of forest city construction. In view of this, the marginal contribution of this paper may be in two respects: (1) The study of this paper makes up for the shortcomings of the existing literature on the impact of forest cities on urban green total factor productivity in China. On the basis of clarifying that the realization of sustainable urban development must take into account both ecological and economic benefits, Taking the construction of a national forest city as the starting point, this paper expounds on the internal mechanism and practical effect of forest city to promote urban green total factor productivity and provides policy reference for building a socialist modern country in an all-round way. (2) This paper reveals the operating mechanism and social benefits of forest cities in depth and strengthens the depth and breadth of relevant empirical research. Using urban macro data, the ecological and economic benefits of forest city construction are confirmed, and the different effects of forest city-induced factor agglomeration, territorial space planning and green technology innovation characteristics are identified. At the same time, considering the differences in regional conditions, this paper discusses whether forest city construction can significantly promote green total factor productivity in any region, analyzes the policy effects from multiple perspectives, and draws policy enlightenment in order to improve relevant policies.

2. Theoretical Analysis and Research Hypotheses

Theoretical Background and Research Hypotheses

As a specific area to assume ecological functions and maintain ecological security, National Forest City is a location-oriented ecological compensation policy implemented in China, which has the dual significance of realizing ecological environment protection and economic green development [22]. China's forest city policy combines policy guidance with market incentives through urban planning. On the one hand, the government and relevant departments increase the green space coverage rate and forest coverage rate of cities through large-scale greening projects [23]. At the same time, ecological restoration work around and in the suburbs of cities is strengthened to restore ecosystem functions [24]. On the other hand, the central government has increased financial investment and financial support to promote the implementation and implementation of various measures for the construction of forest cities, so as to comprehensively enhance the sustainable development capacity of cities [25]. China has created 219 National Forest Cities since the first national forest city was built in 2004. In addition, the National Greening Commission Office released "2020 State of Land Greening in China" in 2021. The number of national forest cities has reached 441, and the construction of national forest cities has become an irreversible trend in China's urban construction in the new era. Under the current system, the National Forest City implements the form of rewarding advanced evaluation and commendation,

and through holding the China Forest Forum, encourages and affirms the cities that have achieved remarkable achievements in urban forest construction in China and sets up a model for ecological construction for Chinese cities. Specifically, because regional economic development has become an important benchmark for regional progress for a long time, local governments lack the incentive to actively improve the regulation of urban resources and the environment. Keen to pursue the economic benefits of natural resources, and then ignore the ecological benefits, and the national forest city selection with its evaluation mechanism, strengthen the local government to protect ecological resources awareness of the main responsibility, and in the form of a legal system to implement the specific work process.

This paper discusses how national forest city construction influences urban green total factor productivity and analyzes the heterogeneous effects of regional conditions on policy effects from three effects: territorial spatial allocation, green technology innovation and factor agglomeration effect.

(1) The construction of forest cities promotes the improvement of urban green total factor productivity. The national evaluation of forest cities aims to comprehensively promote China's urban "production development, life affluence, ecological good", three coordinated development goals. Its core theme still stresses environmental protection and economic growth in coordinated development. Although the relevant documents of the national forest city selection have not issued clear and specific policies or institutional arrangements, they have given principled provisions on the specific tasks of forest cities as an External Force for Urban Green Transformation [26]. Forest City cultivates a number of forest-based green industries through planning guidance, project support, science and technology promotion and policy support. We will encourage ecological conservation and protection of forest products, such as forest tourism, forest recreation, flower cultivation, and green forest products [27]. The interrelated effects of these industries provide strong support for urban sustainable development and provide continuous impetus for the development of urban green total factor productivity [28]. In addition, urban green infrastructure construction projects not only depend on the natural conditions of the city but are also closely related to the city's own economic situation and resource endowment [29]. Based on this, this paper proposes hypothesis H1.

H1. *National forest cities have a positive impact on the improvement of urban green total factor productivity, and the policy effect of forest cities has regional heterogeneity.*

(2) Analysis of the mechanism of optimizing land space allocation in forest city construction. The construction of a national forest city takes forest vegetation as the main body and expands the urban ecological space by optimizing the land space planning [30]. We should give full play to the unique advantages of forest vegetation in improving urban environmental quality, clearly limit extensive urbanization and industrialization expansion, and emphasize that urbanization should be matched with regional environmental carrying capacity so as to reflect the dual significance of sustainable urban development and improvement of ecological service efficiency. The study shows that urban construction and industrial development rely on the existing resources and environmental load-carrying capacity [31]. However, it strictly limits the expansion of land for construction and the intensity of human activities from the aspect of land use. Environmental protection has a direct external impact on urban industrial planning, which directly shows that the construction of a forest city has an important impact on urban green total factor productivity. Based on this, we propose hypothesis H2.

H2. *National Forest City can influence the productivity of urban green elements through the spatial allocation effect.*

(3) Mechanism analysis of promoting green technology innovation in forest city construction. On the one hand, the environmental quality of the city is an important factor to

consider when residents make migration decisions. The construction of a national forest city directly expands the area of urban green space and improves the soft environment of regional investment [32], influences the migration of residents and the transfer of labor force, and provides the carrier and opportunity for the accumulation of urban human capital and industrial agglomeration. The labor force, considering environmental factors when choosing to flow into the city, may have a relatively better educational background, and the high-quality living environment attracts high-end talents and intellectual capital accumulation [33], which makes the intellectual capital of urban industries accumulate and improve, and promotes the scientific and technological progress of the city. On the other hand, with the continuous improvement of urban green infrastructure, the related consumption in its vicinity will increase, which will stimulate the consumption behavior of residents related to real estate, tourism, catering, accommodation and shopping, and induce the market consumption potential [34]. At the same time, the improvement of transportation infrastructure makes modern high-tech industries remove the constraints of space distance, so that they are more inclined to settle in areas with good environment and high market potential, so as to reduce various environmental costs, which further promotes the progress of green technology in their regions. Based on the above analysis, this paper proposes hypothesis H3.

H3. *The national forest city can influence the urban green total factor productivity rate through the green technology innovation effect.*

(4) Mechanism analysis of promoting factor flow in forest city construction. By referring to relevant studies [35], we can conclude that the decision of individual labor flow is mainly based on the expected utility brought by alternative cities. This paper puts the ecological benefits of forest cities in China into the expected utility theory and constructs a theoretical analysis framework of factor mobility in national forest city construction. The theoretical framework is as follows. For any two different cities j and k , the expected utility of choosing the two cities for the representative individual i is $E[U_{ij}]$ and $E[U_{ik}]$ respectively, if $E[U_{ij}] \geq E[U_{ik}]$ it will choose to move to city j , and if not, they will choose city k . Generally speaking, the expected level of disposable income is the most important factor that affects the utility level of workers after they enter the city, but workers cannot know the actual income situation after the inflow. It can only be judged in advance based on the fluctuation of expected average wages ω , and forest city construction can affect the health cost [36] and labor productivity [37] of the inflow by improving the urban environmental quality and affecting the real income of the inflow from two main aspects [38]. Therefore, assuming that the health cost to the city j is c_j and the urban environmental quality level is $e_j \in [0, 1]$ (the closer e_j is to 1, the higher the degree of forest city construction) when the urban wage ω is determined, the average disposable income of workers should be $\omega - (1 - e_j)c_j$. According to the rational person hypothesis, the article assumes that the laborers can anticipate the future long-term disposable income development information from the current urban ecological construction and can obtain the long-term disposable income $y \sim N[\omega - (1 - e_j)c_j, (1 - e_j)\sigma^2]$ of laborers, where σ^2 is a constant. Assuming the individual worker is risk aversion, the risk aversion coefficient $\alpha = -\frac{d^2U/dy^2}{dU/dy}$. The analytical solution for the risk aversion coefficient is $U(y) = -\frac{C_1}{\alpha} \exp(-\alpha y) + c_2$, and under the control of other city information z , the conditional expectation function is as follows:

$$E(U_{ij}|e_j, \omega, z) = -C \exp \left\{ -\alpha [\omega - (1 - e_j)c_j] + \frac{1}{2} \alpha^2 (1 - e_j) \sigma^2 \right\} \quad (1)$$

After controlling the wage level of each alternative city, ω is a constant:

$$E(U_{ij}|e_j, \omega, z) = -C \exp \left\{ \alpha (1 - e_j) c_j + \frac{1}{2} \alpha^2 (1 - e_j) \sigma^2 \right\} \quad (2)$$

Equation (2), The first derivative of ecological health level e_j is obtained:

$$\frac{\partial E(U_{ij}|e_j, \omega, z)}{\partial e_j} = C \exp[\alpha(1 - e_j)c_j + \frac{1}{2}\alpha^2(1 - e_j)\sigma^2](\alpha c_j + \frac{1}{2}\alpha^2\sigma^2) \quad (3)$$

Among them, $c > 0, \alpha > 0, e_j \in [0, 1]$ can obtain $\frac{\partial E(U_{ij}|e_j, \omega, z)}{\partial e_j} > 0$. Its economic meaning is that the improvement of the urban ecological environment is conducive to improving the effectiveness of individual labor. Through the above analysis of the theoretical framework of individual labor mobility decision-making, we can conclude that when other conditions remain unchanged, the improvement of the urban ecological environment will help improve the effectiveness of workers choosing to live in forest cities after the construction of forest cities. Based on this, this paper proposes hypothesis H4.

H4. *The national forest city can affect the urban green total factor productivity rate through the factor flow effect.*

3. Materials and Methods

3.1. Study Area and Data Source

To examine the impact of national forest city construction on green total factor productivity, this paper constructed a panel dataset covering economic and social, ecological environment and geographic information of 280 cities for a total of 15 years from 2005 to 2019. Specific sources of data are as follows.

(1) China Forest City data. In 2004, the State Forestry and Grassland Administration of China initiated the creation of the “National Forest City” activity and held the first China Urban Forest Forum in the same year, naming Guiyang City as the first national forest city, which kicked off the prelude to the construction of China’s forest city. As of January 2024, the number of national forest cities in China has increased to 219 (<https://www.stats.gov.cn>, accessed on 15 December 2023). This paper is organized according to the “Guiding Opinions on Focusing on the Construction of Forest Cities” and “National Forest City Development Plan” issued by the State Forestry and Grassland Administration of China. Due to the lack of economic and social data of some cities, there are 164 national forest cities in the sample in this paper;

(2) Economic and social development data. Urban economic and social data mainly come from the “Statistical Yearbook of Regional Economy in China” and “Statistical Yearbook of Urban China” (<https://www.stats.gov.cn>), including per capita regional GDP, end-of-year permanent resident population, fixed asset investment, government public revenue and expenditure, rural residents’ disposable income, financial institutions’ various loans, industrial output value, R&D spending, and urban road passenger transportation volume indicators. Missing values are supplemented based on each city’s statistical yearbook;

(3) Ecological environment data. Urban ecological environment data mainly come from the China Urban Statistical Yearbook, including energy input of the whole society, urban green area, industrial wastewater discharge, industrial sulfur dioxide discharge and industrial smoke and dust discharge.

3.2. Description of Variables

(1) Explained variable: Green total factor productivity. Traditional DEA, SFA and Malmquist index are the main methods to measure GTFP in academia. However, both traditional DEA, SFA and Malmquist index methods are difficult to deal with in the case that input and output variables have radial and non-radial characteristics at the same time. In view of this, this paper refers to the research of Lan fang C. et al. and Kaoru T. et al. [39]

and uses the EBM-GML method to measure the urban green total factor productivity. The specific model is as follows:

$$\psi = \min \frac{\varepsilon - \omega_x \sum_{u=1}^m \frac{\omega_u^- s_u^-}{x_{uh}}}{\varphi + \omega_{yG} \sum_{j=1}^n \frac{\omega_j^+ s_j^+}{y_{Gjh}} + \omega_{yB} \sum_{z=1}^l \frac{\omega_z^- s_z^-}{y_{Bzh}}} \quad (4)$$

$$s.t. \begin{cases} X\delta + s_u^- = \varepsilon x_{uh}, u = 1, 2, \dots, m \\ Y_G\delta + s_j^+ = \varphi y_{Gjh}, j = 1, 2, \dots, n \\ Y_B\delta + s_z^- = \varphi y_{Bzh}, z = 1, 2, \dots, l \\ \delta \geq 0, s_u^-, s_j^+, s_z^- \geq 0 \end{cases}$$

In the formula, X , Y_G , and Y_B respectively represent m inputs, the n expected outputs and the l unexpected outputs; H is the number of decision-making units; ψ ($0 \leq \psi \leq 1$) is the optimal efficiency value; ω_u^- , ω_j^+ , ω_z^- and s_u^- , s_j^+ , s_z^- represent the weights and slack variables of the u th input, j th output, and z th undesirable output, respectively; ω ($0 \leq \omega \leq 1$) is an important parameter combining radial efficiency value ε and non-radial relaxation variables.

Combined with technical efficiency ψ , the GML index is constructed as follows:

$$G^{t,t+1}(x^t, y^t, b^t; x^{t+1}, y^{t+1}, b^{t+1}) = \frac{\psi^{G,t+1}(x^{t+1}, y^{t+1}, b^{t+1})}{\psi^{G,t}(x^t, y^t, b^t)} \quad (5)$$

In this formula, $\psi^{G,t}$ and $\psi^{G,t+1}$ represents the global efficiency value of phase t and $t + 1$, respectively, and G represents the green total factor productivity index. Taking 2005 as the base period and accumulating the results of subsequent years, we can obtain the green total factor productivity Gy_{it} of each city.

According to the EBM-GML method, this paper constructs an index system including capital, labor force and energy input, as well as urban expected output and non-expected output. The GTFP measurement index system is shown in Table 1. Among them, the fixed asset investment, urban land of construction and scientific expenditure are used. Labor input is measured by the number of employees per unit and the number of industrial enterprises above the designated size at the end of the year. Energy input should choose the total amount of water supply, gas supply and electricity consumption. The expected output is measured by actual GDP, per capita total social consumption, urban afforestation and greening area. The expected output is measured by wastewater discharge, SO₂ discharge and dust production. The data are also standardized.

(2) Core variable interpretation: This paper regards the national forest city selection as an exogenous policy impact and explores the policy effect of national forest city construction on green total factor productivity in the two dimensions of prefecture-level city-year. The regions that actually won the title of national forest city were the treatment group, and the regions that did not win the title of national forest city were the control group. The virtual variables of whether each region was awarded the title of National Forest City were compiled by hand according to the official website of the Forestry and Grassland Bureau. It is worth noting that the National Forest City Evaluation Index is a series of evaluation indicators for urban forest ecosystem construction announced by the State Forestry Administration in 2007. The first batch of national forest city selection was in 2004; this form of difference may affect the effectiveness of the quasi-natural experiment, so the empirical analysis of the national forest city before the release of the evaluation index;

(3) Control variables. In addition to ecological policies, urban green total factor productivity is also affected by many factors, such as social economy and basic factor endowment, which need to be controlled. Based on the existing literature [40], this paper selects the following control variables: urban population density, urban financial deepening level, urban industrial structure, urban economic development level, local government intervention

level, regional science and technology expenditure level, and regional highway transportation level. The main variable meanings and descriptive statistics are shown in Table 2.

Table 1. GTFP measurement index system.

Types of Indicators	Definition of Indicators	Average Value	Standard Deviation
Labor input	Number of employees per unit at year-end	0.1535	0.0888
	Number of industrial enterprises above designated size	0.1608	0.0819
Capital investment	Investment in fixed assets	0.1217	0.0544
	Acreage of land for construction	0.1407	0.0667
	Science expenditure	0.1125	0.0481
Energy input	Total water supply	0.1409	0.0811
	Total gas supply	0.1212	0.0650
	Electricity consumption in society	0.1597	0.0943
Expected output	Real gross domestic product	0.1456	0.0710
	Total social consumption per capita	0.1423	0.0685
	Urban afforestation and greening area	0.1431	0.0904
Undesired output	Industrial wastewater discharge	0.1651	0.0852
	Industrial sulfur dioxide emissions	0.1670	0.0731
	Industrial smoke and dust emissions	0.1053	0.0205

Table 2. Main variables meaning and descriptive statistics.

Variable Classification and Name		Variable Meaning	Number of Observations	Average Value	Standard Deviation
Explained variable	Urban green total factor productivity	The Green Development Level of Cities Calculated According to the Index System	4200	0.718	0.078
Core explanatory variables	Construction of forest city	Forest City Selection System Virtual Variables	4200	0.203	0.402
	Effect of land spatial allocation	Proportion of total area of urban ecological space to land area	4200	1.209	4.225
Mediating variables	Rationalization of industrial structure	Output Structure and Employment Structure of the Three Major Industries	4186	27.605	21.030
	Green technology innovation	Total Urban Green Patent Applications	4200	374.277	1299.732
Control variable	Urban financial deepening level	Balance of loans of financial institutions/GDP at year-end	4200	0.876	0.550
	Degree of government intervention	Local public finance general budget expenditure/GDP	4200	0.174	0.094
	Urban population density	Average annual population/land area (in logarithms)	4145	5.758	0.904
	Urban economic development level	GDP per capita (in logarithms)	4200	10.345	0.758
	Urban industrial structure	Gross Secondary Industry/GDP	4200	47.564	10.819
	Regional road transport level	Ratio of Annual Road Freight Volume to Year-end Population	4200	25.638	55.334
	Regional science and technology expenditure level	Proportion of S & T expenditure to local government expenditure	4200	0.013	0.014

3.3. Model Setting

Examine the impact of national forest city construction on regional green total factor productivity, if only by comparing the differences in urban green total factor productivity before and after the national forest city construction. The accuracy of the conclusions will be reduced because there are other factors that affect the development of urban green total factor productivity before and after the construction of National Forest Cities, which may include other ecological policies. Therefore, in order to increase the credibility of the evaluation results, the Multistage asymptotic double difference method is used in this paper. Based on the urban panel data of China from 2005 to 2019, the national forest city construction is regarded as a quasi-natural experiment, and the multi-period DID model is used to evaluate the policy effect of forest city construction. The article constructs the following benchmark regression equation:

$$y_{it} = \beta_0 + \beta_1 \text{Forestcity}_{it} + \sum \beta_x \text{Control}_{it} + u_i + \lambda_t + \varepsilon_{it} \quad (6)$$

Among them, y_{it} is the explanatory variable, which refers to the green total factor productivity; subscripts i and t represent city i and year t , respectively; Forestcity was used to distinguish the control group from the treatment group; T is used to identify the year of implementation of the policy, before the year of implementation of the policy $T = 0$, followed by $T = 1$; Forestcity is the core explanatory variable to measure whether a region is selected as a national forest city; Control represents a set of control variables; u_i is a fixed effect at the city level, which is used to control factors that do not change over time at the city level, such as geographical location; λ_t is a fixed effect of the year, controlling the characteristics of the time level that does not change with regional changes, such as trade shocks, macroeconomic situations, etc.; ε_{it} is the error term; β_1 is the policy implementation effect coefficient. This paper focuses on the coefficient β_1 . If β_1 is greater than 0, it indicates that China's forest city policy has a positive impact on the improvement of urban green total factor productivity.

In addition, the Multistage asymptotic double difference method needs to satisfy the parallel trend assumption. That is, before the construction of the national forest city, the environmental effects of the treatment group and the control group change trend is basically the same. Event Study Approach (ESA) can not only carefully observe the dynamic effect and persistence of the policy impact but also make a parallel trend assumption so as to accurately judge whether there is a significant difference between the national forest urban treatment group and the control group. Therefore, based on the event analysis method, the parallel trend hypothesis is tested, and the policy dynamic effect is analyzed. Drawing on the existing research, the benchmark regression is extended to:

$$y_{it} = \beta_0 + \sum_{-1}^{-5} \beta_j B_{it}^{-j} + \sum_0^6 \beta_k B_{it}^k + \sum \beta_x \text{Control}_{it} + u_i + \lambda_t + \varepsilon_{it} \quad (7)$$

In this paper, we set 2019 as the year of policy occurrence, that is, Year 0, and calculate the relative policy year of forest cities in each country. B_{it}^{-j} indicates the year j before the city selected the national forest city, A_{it}^k indicates the year k after the city selected the national forest city, and the other variables are the same as the benchmark model. In addition, in order to explore the mechanism through which the construction of national forest cities affects urban green total factor productivity, the article constructs the following intermediary effect model:

$$\begin{cases} y_{it} = \beta_0 + \beta_1 \text{Forestcity}_{it} + \sum \beta_x \text{Control}_{it} + u_i + \lambda_t + \varepsilon_{it} \\ M_{it} = \beta_0 + \beta_1 \text{Forestcity}_{it} + \sum \beta_x \text{Control}_{it} + u_i + \lambda_t + \varepsilon_{it} \end{cases} \quad (8)$$

Among them, y_{it} is the explained variable, which refers to the urban green total factor productivity; M represents the mediating variable. If the regional policy implementation

coefficient β_1 is significant, it can show that the national forest city construction can affect the urban green total factor productivity through the intermediary variable.

4. Results

4.1. Benchmark Regression

The baseline regression results are shown in Table 3. The estimated coefficients of the core explanatory variables are significantly positive, regardless of whether the year and city are fixed and whether or not controlling a series of variables of urban socio-economic and natural characteristics. The construction of a national forest city can have a significant positive impact on urban green total factor productivity. Specifically, there is no control period effect and individual effect in column (1), and the results show that there is a significant positive causal relationship between the establishment of National Forest Cities and urban green total factor productivity at the significance level of 1%, that is, policies will significantly promote urban green construction. Columns (2) and (3) controlled the period effect, individual effect and control variable, respectively. Column (4) controls the individual effect and the period effect of the city level and adds the control variable; the empirical conclusion is still consistent with the results of the other columns. Among them, after adding the control variable in column (2), the estimated value of the coefficient is stable at about 5.1%. This result may be biased due to the policy effect is difficult to avoid due to individual heterogeneity and economic fluctuations from the annual macro level. After the addition of the period and individual effects, the estimates of column (3) and column (4) coefficients are stable at about 1.6%, which is credible and consistent with the empirical results of the robustness test. In summary, regardless of whether the year and city are fixed and regardless of controlling for a range of urban socio-economic and physical characteristics variables, The estimated coefficients of the core explanatory variables discussed in this paper are significantly positive, that is, the construction of National Forest Cities has a significant positive impact on urban green total factor productivity. It is verified that the national forest city can promote the improvement of urban green total factor productivity.

Table 3. Benchmark regression results.

Variable	Explained Variable: Green Total Factor Productivity			
	(1)	(2)	(3)	(4)
did	0.071 *** (0.003)	0.051 *** (0.003)	0.016 *** (0.002)	0.016 *** (0.002)
cons	0.705 *** (0.001)	0.612 *** (0.008)	0.716 *** (0.001)	0.694 *** (0.013)
R ²	0.131	0.227	0.776	0.780
Control variable	No	Yes	No	Yes
City fixed	No	No	Yes	Yes
Fixed year	No	No	Yes	Yes
Number of observations	4200	4200	4200	4200

Note: The values of *** indicates significant at the 1% level. The values of t are shown in brackets and are the same in the following tables. Among them, the first column is no added control variable, time fixed effect and region fixed effect. The second column is the addition of control variables, but there is no fixed time effect and regional effect. In the third column, no control variables are added, but time effect and region effect are fixed. The fourth column adds control variables and fixes time and region effects.

4.2. Parallel Trend Tests and Policy Dynamics

The previous paper draws the average effect of national forest city construction on urban green total factor productivity, but it does not reveal the dynamic effects of the policy. To this end, the paper will further make a parallel trend test and dynamic analysis of policy effects. The results of parallel trend test are shown in Figure 1. The results of the parallel trend test show that before the construction of national forest cities, the

virtual variables relative to the year of policy implementation were not significant and fluctuated around 0. This indicates that there is no significant difference in urban green total factor productivity between the pre-treatment group and the control group, which satisfies the hypothesis of parallel trend. However, after the construction of a forest city, the regression coefficient is significantly positive and shows a continuous upward trend, indicating that the construction of a national forest city will continue to drive regional urban green total factor productivity and thus promote sustainable urban development. From the dynamic effect change, for urban green total factor productivity, the estimated coefficient before the establishment of the national forest city gradually presents a certain positive benefit, but it is not significant, which indicates that the impact of national forest city construction on green total factor production has an expected effect. The possible reason is that local governments can respond in advance according to the policy direction. After the establishment of a national forest city, the average treatment effect on green total factor productivity is significantly positive and shows a dynamic upward trend. It shows that the positive promotion of national forest city construction to urban green total factor productivity exists as a continuous trend in time.

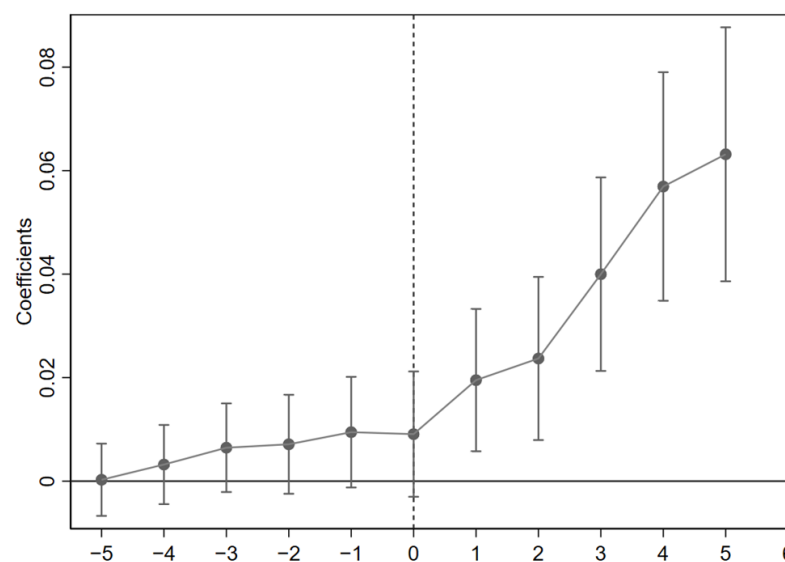


Figure 1. Parallel trend test. Note: The dashed lines in the chart indicate the period when the policy was implemented.

4.3. Placebo Test

In this paper, the placebo test of baseline regression is conducted using a counterfactual framework. Specifically, this paper adopts the treatment method of a non-parametric replacement test to conduct random sampling of all prefecture-level cities and policy times without repetition. Since there are 163 prefecture-level cities belonging to national forest cities, 163 prefecture-level municipalities where national forest cities are located were randomly selected as the treatment group. Then, we randomly selected 2009 as the establishment time of a forest city from 2005 to 2019 and constructed a random experiment on the two levels of city and implementation time. To enhance the explanatory power of the placebo test, the above random process was repeated 500 times, resulting in a kernel density distribution of the estimated coefficients for 500 random policy shocks. If the estimated coefficients are no longer significant under random treatment and are distributed around 0, it means that the benchmark regression results are robust. The results of the placebo test are shown in Figure 2. As shown in the figure, the baseline regression coefficient is outside the 99% confidence interval of the placebo test estimate, and the placebo test estimate is a normal distribution with a mean of 0, indicating that the baseline result in this paper

is not affected by other unobservable factors. Therefore, the placebo test verified the real effectiveness of the national forest city construction policy effect.

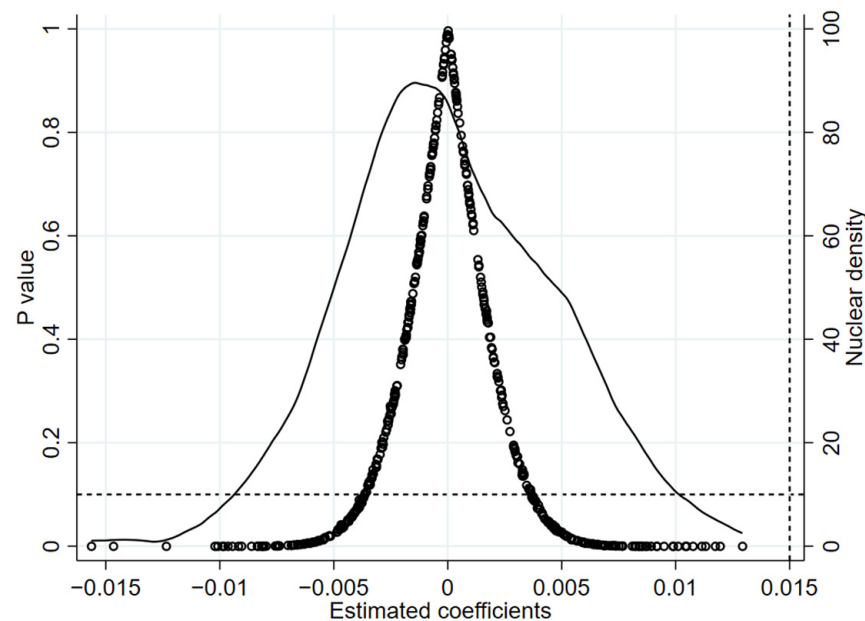


Figure 2. Placebo test of urban green total factor productivity. Note: The X-axis is the estimated coefficients generated randomly 500 times, the empty circle is the p -value of the estimated coefficients, and the left vertical line is the estimated coefficient of the actual policy. The horizontal dotted line indicates a p value of 0.1. The vertical dotted line represents the coefficients in the fourth column of the baseline regression table.

4.4. Robustness Test

Benchmark regression preliminarily verifies that national forest cities are conducive to promoting urban green total factor productivity. In order to ensure the stability and reliability of the estimation results, the robustness test is carried out.

4.4.1. PSM-DID Estimation

Considering that the designation of national forest cities is not completely random but is based on a comprehensive assessment by development and reform departments at all levels based on territorial spatial planning, it is easy to find endogenous problems caused by sample selection bias when selecting regions where location conditions, resource endowments, external environment and economic development are dominant. Propensity Score Matching can solve the sample selection problem under the condition of a non-random experiment. In order to alleviate the sample selection bias and reduce the estimation bias of the Multistage Double Difference Method, the propensity score matching double difference method is further used to evaluate the effect of establishing a national forest city to realize urban green total factor productivity. Use logistic regression to predict the probability that each city will be classified as a forest city using the control variables in baseline regression. Then, the k -nearest neighbor matching method in calipers was used to match the samples of a forest city to ensure that there was no significant systematic difference between the treatment group and the control group before the policy impact of the forest city, and then the matched samples were used for re-evaluation. The estimated results of PSM-DID are shown in Table 4. The estimation results show that the policy effect of the national forest city remains robust.

Table 4. Robustness Test: PSM-DID.

Variable	Explained Variable: Green Total Factor Productivity	
	(1)	(2)
did	0.013 *** (0.003)	0.012 *** (0.003)
cons	0.709 *** (0.001)	0.677 *** (0.015)
R ²	0.768	0.773
Control variable	No	Yes
City fixed	No	Yes
Fixed year	No	Yes
Number of observations	2953	2953

Note: The values of *** indicates significant at the 1% level. Among them, the first column is no added control variable, time fixed effect and region fixed effect. The second column represents adding control variables and fixing time and area effects.

4.4.2. The Exclusion of Other Competing Hypotheses

After the establishment of the National Forest City, the central government also implemented a number of ecological policies to improve the environment at the same time. For example, in 2010, the National Development and Reform Commission issued the “Notice on the Pilot Work of Low-Carbon Provinces and Low-Carbon Cities”. The “Notice on the Pilot Work of National Smart Cities” issued by the state in 2012 may also affect the green total factor productivity of National Forest Cities and interfere with the policy effect of identifying national forest cities. In order to exclude the above policy interference, based on the benchmark model, this paper introduces the national smart city selection dummy variable and low-carbon city pilot dummy variable. The estimated results are shown in Table 5. The measurement results show that the coefficient of core explanatory variables is always significant and positive, and the policy effect of the national forest city remains stable.

Table 5. Results of the robustness test, excluding other policy interference.

Variable	Explained Variable: Green Total Factor Productivity	
	Excluding Low Carbon Cities	Excluding Smart Cities
did	0.007 *** (0.002)	0.007 *** (0.002)
cons	0.735 *** (0.012)	0.733 *** (0.012)
R ²	0.768	0.773
Control variable	Yes	Yes
City fixed	Yes	Yes
Fixed year	Yes	Yes
Number of observations	4200	4200

Note: The values of *** indicates significant at the 1% level.

4.4.3. Control the Prior Effect

In the benchmark regression, this paper chooses the year of national forest city selection as the policy time point, but local governments may actively play their regulatory role to promote urban green development in the year before the selection; that is, there may be an ex ante effect. Therefore, this paper sets the policy time point to the year before the selection to control the ex-ante effect, and the conclusion remains stable. The estimated results are shown in Table 6.

Table 6. Robustness tests: controlling for ex ante effects.

Variable	Explained Variable: Green Total Factor Productivity
did	0.010 *** (0.003)
cons	0.734 *** (0.012)
R ²	0.810
Control variable	Yes
City fixed	Yes
Fixed year	Yes
Number of observations	4200

Note: The values of *** indicates significant at the 1% level.

4.4.4. Delete Some Samples

The establishment of national forest cities may be affected by geographical location, endowment characteristics, environmental carrying capacity, spatial development pattern and so on. Beijing, Tianjin, Guangzhou, Chongqing, Shenzhen and other cities, because of their own geographical conditions and ecological characteristics, there may be systematic differences between other cities. Therefore, the samples of Beijing, Tianjin, Guangzhou, Chongqing, Shenzhen and other cities are excluded, and the samples of other prefecture-level cities are retained for re-estimation. The estimated results are shown in the first column of Table 7.

Table 7. Robustness test: removing some samples.

Variable	Explained Variable: Green Total Factor Productivity		
	Delete Some Cities	Excluding Cities in 2022 and 2024	Shrink Tail
did	0.011 *** (0.002)	0.010 *** (0.003)	0.027 *** (0.004)
cons	0.744 *** (0.011)	0.741 *** (0.012)	0.714 *** (0.013)
R ²	0.798	0.812	0.841
Control variable	Yes	Yes	Yes
City fixed	Yes	Yes	Yes
Fixed year	Yes	Yes	Yes
Number of observations	4035	3975	3713

Note: The values of *** indicates significant at the 1% level.

Excluding the national water saving in cities in 2022 and 2024, in benchmark regression, we use the sample period to 2019, a setting that effectively treats national forest cities in 2020 and 2024 as a control group, which may underestimate the policy effects of national forest cities given the ex ante effects. Therefore, this paper excludes the national forest cities selected in 2020 and 2024, and the relevant conclusions remain robust. The estimated results are shown in the second column of Table 7.

Because of the great disparity of environmental levels among cities in China, the green TFP of some areas is outlier than that of the whole population, which may affect the accuracy of regression analysis. Therefore, the article on the cities of green TFP 1% shrinkage tail processing, that is, outliers are in accordance with the distance of the maximum value or minimum value of 1% to replace. The estimated results are shown in the third column of Table 7.

4.5. Analysis of Policy Mechanisms

The above regression results confirm that the establishment of a national forest city can significantly improve urban green total factor productivity, but what is the impact mechanism of national forest city policies on urban green total factor productivity? Therefore, combined with the previous theoretical analysis, this paper introduces three variables: land spatial allocation, factor agglomeration and green technological innovation to build an intermediary effect model, and discusses the mechanism of the impact of national forest city construction on urban green total factor productivity.

(1) Distribution of land space. Territorial space can be divided into production space, living space and ecological space. Among them, ecological space is the space whose main function is to provide ecological products or ecological services, including green space, water ecological space and other ecological space. In this paper, the proportion of ecological space is used to represent the change of land use allocation, that is, the proportion of the sum of forest land, grassland, water area and other ecological space in the land area;

(2) Green technology innovation. The improvement of the green technology innovation ability of enterprises can promote the lean manufacturing of advanced green products, improve the quality of industrial green development, and effectively promote the improvement of green total factor productivity. This paper uses the number of green patent applications and grants to measure green technology innovation;

(3) The elements flow. By virtue of economies of scale and knowledge spillovers, the agglomeration of population factors can promote the upgrading of urban industrial structure, release the green growth potential, significantly reduce the cost of environmental governance, and promote the growth of green total factor productivity. Based on the data from the China Urban Statistical Yearbook, this paper calculates the per capita road passenger transport volume and population flow of cities over the years and then acts as a proxy for regional factor circulation;

The estimated results are shown in Table 8, and it can be seen that the national forest city policy has a significant positive impact on the spatial allocation of land; that is, the national forest city construction helps to expand the ecological space of the covered areas. Detailed study of the reasons since the start of forest city construction, mainly to promote the forest trees as the main body of urban green ecological space construction, positive environmental policies to improve the urban green space coverage, and then restore the integrity of urban ecosystems, diversity and sustainability. The hypothesis H2 is basically verified.

Table 8. Transmission mechanism test of a national forest city.

Variable	Territorial Spatial Planning	Green Technology Innovation	Factor Mobility
did	0.108 ** (0.054)	55.670 *** (4.921)	0.168 *** (0.061)
cons	1.398 *** (0.278)	174.582 *** (27.333)	7.312 *** (0.499)
R ²	0.107	0.879	0.193
Control variable	Yes	Yes	Yes
City fixed	Yes	Yes	Yes
Fixed year	Yes	Yes	Yes
Number of observations	4200	4200	4145

Note: The values of ** and *** are significant at 5% and 1% levels, respectively.

Observation column (2) shows that the construction of national forest cities has a significant positive impact on green technology innovation. In other words, the construction of national forest cities will promote new regional green industries, new products and

the use of renewable energy sources, eliminate old equipment in enterprises, introduce low-carbon environmental protection equipment and use greener low-carbon energy so as to promote green total factor productivity of enterprises. At the same time, the coefficient of national forest city construction on green technology innovation ability passed a 1% significance test, and hypothesis H3 was tested.

Observation column (3) shows that the coefficient value of factor flow is 0.168, and it is significant at the level of 1%; that is, the establishment of national forest cities helps to promote the inflow of labor factors. It shows that the national forest city construction can indirectly increase the urban green all-element productivity through the factor agglomeration effect; hypothesis H4 is proved.

In summary, the construction of a national forest city can promote the improvement of urban green total factor productivity through the spatial allocation effect of land, green technology innovation effect, and factor agglomeration effect.

4.6. Analysis of Heterogeneity

Heterogeneity analysis will be carried out from the following two perspectives: one is the difference in geographical location, which divides the country into six geographical divisions; The second is the difference in the energy consumption structure of transportation infrastructure represented by whether or not high-speed rail is opened.

4.6.1. Differentiating between Different Geographic Spatial Locations

According to the difference in ecological environment endowment conditions and sensitivity in different geographical areas, the whole country is divided into six geographical areas. The six geographical regions are Northeast China, North China, Northwest China, Southwest China, Middle and Lower Reaches of the Yangtze River and Southeast Coastal Region. Northeast China, North China and Northwest China belong to the North and Southwest China, Middle and Lower Reaches of the Yangtze River, and Southeast Coastal Region belong to the South. The regression results are shown in Table 9. The results of heterogeneity analysis based on different geospatial regions are reported.

Table 9. Heterogeneity analysis: regional differences based on geographical position.

Variable	Northeast Region	North China	Northwest Territories	Southeast Coastal Areas	Southwest Region	Middle and Lower Reaches of Yangtze River
did	0.016 * (0.009)	−0.001 (0.004)	0.020 *** (0.006)	0.004 (0.005)	0.003 (0.005)	−0.005 (0.004)
cons	0.676 *** (0.035)	0.535 *** (0.029)	0.653 *** (0.023)	0.798 *** (0.032)	0.549 *** (0.031)	0.747 *** (0.146)
R ²	0.779	0.884	0.855	0.798	0.857	0.870
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
City fixed	Yes	Yes	Yes	Yes	Yes	Yes
Fixed year	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	510	855	525	855	465	990

Note: The values of * and *** are significant at 10% and 1% levels, respectively.

The construction of National Forest Cities in the northeast, southeast coastal areas, northwest and southwest has a positive effect on urban green total factor productivity, but the establishment of forest cities in southwest and southeast coastal areas has no significant effect. In the central region of North China and the middle and lower reaches of the Yangtze River, the performance is different; the two-forest city construction not only the green total factor productivity increase is not obvious; the possible reason is that as the economic center of national development, the role of environmental regulation in national forest

cities is not significant. After comparison, it is found that the construction of national forest cities in the northeast and northwest of China has the strongest promotion effect on urban green total factor production.

4.6.2. Distinguish between Cities and Open High-Speed Rail Differences

Considering that the construction of transport infrastructure such as high-speed rail can promote the mobility of factors of production among regions to a certain extent, it is important for urban green total factor productivity improvement. Using the National Railway Administration's list of cities with high-speed rail from 2005 to 2019, this paper divides the panel data in the study into cities with high-speed rail and cities without high-speed rail. The empirical results are shown in Table 10. The results show that the establishment of national forest cities contributes to the improvement of urban green total factor productivity, regardless of whether the region has high-speed rail access or not, and this effect is more evident in cities with high-speed rail access. The possible reasons lie in the high accessibility between cities in the regions where the high-speed railway is opened, the consumption cost of consumers across regions is low, the passenger flow of service industry has increased significantly, and the proportion of service industry has also expanded, which imperceptibly promotes the upgrading of industrial structure and the greening of cities; Moreover, with the increase of urban road density, traffic congestion will be greatly improved, and the increase of vehicle moving speed will reduce energy consumption and exhaust emissions, which is conducive to urban pollution reduction. In such areas to build national forest cities, the impact of government power on green total factor productivity is weak; on the contrary, promoting national forest city construction in areas without high-speed rail can make up for the lack of local environmental rules.

Table 10. Heterogeneity analysis: differences between cities with or without high-speed rail.

Variable	Opening High-Speed Rail Cities	Cities without High-Speed Rail
did	0.007 *** (0.002)	0.017 *** (0.004)
cons	0.787 *** (0.014)	0.687 *** (0.015)
R ²	0.796	0.863
Control variable	Yes	Yes
City fixed	Yes	Yes
Fixed year	Yes	Yes
Number of observations	3555	645

Note: The values of *** are significant at 1% levels.

5. Discussion

This paper attempts to deepen the ecological and economic effects of China's forest city construction from qualitative analysis to quantitative analysis and evaluate the comprehensive effect of China's urban forest construction on urban green total factor productivity so as to comprehensively understand the positive role of China's urban forest construction in promoting ecological civilization construction and socially sustainable development.

Firstly, this paper uses the multi-phase difference-in-difference (DID) model to find that the construction of forest cities in China can bring positive effects on the improvement of urban total factor productivity. Compared with previous studies, such as the environmental synergistic effect of cooling and air purification in China's forest cities, the relationship between ecological civilization construction in forest cities and residents' green lifestyle [41], and the carbon reduction capability of urban parks [42], more emphasis is placed on the analysis of environmental benefits brought by forest cities. On the basis of previous studies focusing on the ecological benefits of forest cities, our research further incorporated urban capital, energy input and economic output into the urban green total factor productivity

index system, indicating that forest cities can not only improve the urban ecological environment but also enhance urban economic output. This research is also consistent with the concept of coordinated development of the economy and environment advocated by the concept of green development [43].

Secondly, the mechanism analysis of this paper shows that the implementation of China's forest city policy has a positive impact on the growth of urban green total factor productivity, mainly through increasing the urban ecological space area, attracting the concentration of labor resources and promoting the progress of green technology. This research result is consistent with previous studies on the change of green total factor productivity in Chinese cities under resource and environmental constraints [44], indicating that forest city, as an environmental regulation policy [45], not only directly affects the urban ecological space area, but also influences the green technology innovation of enterprises in the city to improve the green total factor productivity of the city [46]. However, this paper also found some new influence mechanisms, for example, the positive ecological benefits generated by forest cities can improve the living environment of urban residents, thus attracting high-quality talents, which has not been deeply discussed in previous studies.

Finally, this paper analyzes the impact of forest city construction in different regions on urban green total factor productivity from the perspective of geographical location differences and regional accessibility differences caused by whether a city has opened high-speed rail. The results show that the forest city construction in an area with better ecological environment endowment conditions has a greater effect on the improvement of urban green total factor productivity, which is particularly obvious in northwest China. This is consistent with the results of many related studies at home and abroad, which further verify that the construction of a forest city is related to both natural [and human factors [47].

Although this paper has carried out an in-depth and detailed discussion on the role of forest cities in China on urban green total factor productivity and its impact path and reached some useful conclusions, limited by personal ability and data availability, the research still needs to be further supplemented and improved in the following aspects. On the one hand, only through the establishment of urban green total factor productivity indicators, ignoring the ecological restoration function of forest cities, the study on the ecological environment effect of national forest cities needs to be further strengthened. On the other hand, China has long been subject to the urban-rural dual system, how forest resources flow in urban and rural areas, and whether forest city construction promotes the coordinated development of rural green transformation are also worthy of attention.

6. Conclusions

The establishment of the forest city is a major reform and innovation of the central government in the process of urbanization, with the goal of urban ecological restoration and promoting urban green development. This paper uses the DID model to study whether the national forest city construction can promote urban green total factor productivity and whether there is regional heterogeneity and further study its mechanism. The results show that after the implementation of China's forest city policy, the urban green TFP is 1.6% higher than that of the control group on average, and the policy mainly promotes the improvement of urban green TFP through territorial spatial planning, green technology innovation and factor agglomeration effect. The conclusion of this paper is very policy-oriented. It is not only a reference and inspiration for the policy-making of constructing ecological progress cities but also an empirical basis for the choice of urbanization development mode in China. In the implementation of specific policies, the following points should be noted:

(1) The local government should not only evaluate the effect of urban forests from economic benefit but also pay more attention to the effect of urban forests on public welfare, such as the environment and health. Urban forest, as a public service product mainly provided by the government, requires governments at all levels to invest a lot of manpower

and physical and financial resources, but unlike transportation, energy and telecommunications infrastructure, which directly increases productive capacity and thus promotes rapid economic growth, are more easily neglected in the context of government budget constraints. At the same time, due to the idea that local governments have attached importance to economic and social development for a long time, the construction of ecological civilization in China is still in the initial stage on the whole, and the construction of urban forests is the main driving force of ecological civilization construction is in a weak position both in theory and practice. The practice and theoretical research of “Lucid Water and Lush Mountain are Invaluable Assets” need to be carried out continuously for a long time. The central government should attach importance to the synergistic effect of forest city policy for regional economic and ecological development and give greater support to urban forest construction through ecological compensation, transfer payment and other means;

(2) There are obvious regional differences in the promotion of green total factor productivity by National Forest Cities, and the construction of National Forest Cities should be designed according to the characteristics of regional heterogeneity. From the perspective of different regions, the promotion effect of national forest city construction on urban green total factor productivity growth is mainly in the northern region, while the inhibition effect is different in the southern regions, which may be related to the fact that the southern region has its own resource endowment conditions. The effect of the policy is not obvious in these areas with better environments and economic resources, which shows that the government should consider the resources and social development conditions of various regions and take corresponding policies and measures according to local conditions when implementing the forest city policy;

(3) Compared to areas without forest cities, the national forest cities effectively promote the growth of urban green total factor productivity, which mainly shows the increase of urban green space, the concentration of resources and the progress of green technology. Therefore, local governments should actively promote the scope of policies in urban construction. Johnson and Johnson should further enhance the efficiency of implementing ecological policies. On the one hand, local governments should guide the flow of production factors such as capital and labor to composite industries and industries with high ecological and economic benefits through market-oriented mechanisms so as to promote the optimization and adjustment of factor allocation and efficiency improvement [48]; on the other hand, local governments should guide the withdrawal of traditional backward production capacity with high emission, high energy consumption and low efficiency through a combination of environmental regulations and industrial policies [49]. For those industries or enterprises with high emission levels that still have development potential or market demand, they should actively guide them to introduce advanced environmental protection equipment, improve production processes and adopt green production technologies. At the same time, enterprises that have achieved green technology innovation should accelerate the popularization and application of their green technology innovation achievements in urban industries and other fields.

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