Research Article

An Empirical Study on the Measurement of Forestry Total Factor Productivity Based on DEA Malmquist Model

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Based on the forestry total factor productivity of 31 provinces in China from 1997 to 2020, this study uses the DEA Malmquist model to measure its forestry total factor productivity. The results show that the overall development trend of forestry total factor productivity in China is fluctuating and rising, and the main driving force of growth comes from technological change; from other influencing factors, the reduction in human investment, the rationalization of industrial structure and the improvement of the level of scientific, and technological and economic development can also effectively improve the total factor productivity of forestry.

1. Introduction

According to the results of the Ninth National Forest Resources Inventory (2014–2018), China’s forest area is 220 million hectares and the forest coverage rate is 22.96%, realizing the “double growth” of forest area and forest volume in the past 30 years [1]. China’s contribution to the world in forest protection and afforestation has been affirmed by the Food and Agriculture Organization of the United Nations. China’s increasing role in maintaining the global ecological balance is due to the high attention paid by the Chinese government to the construction of ecological civilization. Since the 1980s, China has put forward and implemented a number of ecological plans, including the project of returning farmland to forest, the construction project of farmland shelterbelt system in the Yangtze River and Pearl River basins, and the natural forest resource protection project. After the implementation of the national forest protection project, China has implemented the policy of stopping and limiting cutting in key state-owned forest areas, striving to actively cultivate new economic growth points in forestry ecological development on the basis of protecting natural forest resources. Neoclassical economic growth theory holds that economic growth comes from the growth of factor input and the improvement of total factor productivity (TFP). How to utilize the long-term planning under the current overall layout of ecological civilization and the favorable situation of paying attention to the construction of ecological civilization, and how to provide support and guarantee in terms of policy guidance and management mechanism, give full play to the implementation effect of ecological protection policies such as nature conservation project, further improve the TFP of forestry, optimize the forest ecological industrial structure, and realize the sustainable development of forestry are important in the future development of China’s forest resources.

2. Literature Review

Forestry total factor productivity plays a vital role in forestry ecological construction. The existing literature attempts to analyze the forestry total factor productivity in different regions and different periods and then draw the spatial characteristics and policy role of forestry total factor productivity. Table 1 summarizes the sample selection, variable determination, research methods, and main conclusions of relevant literature in recent years.
| Author                          | Time            | Sample                          | Method            | Conclusions                                                                                                                                                                                                 |
|--------------------------------|-----------------|---------------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lai Zuoqing and Zhang Zhonghai (2008) | 2006            | 21 cities in Guangdong Province | DEA               | The overall efficiency of Guangdong is high, and the relative efficiency of the nine cities is the best. The main reason for the low efficiency is that the forestry human resources are in the waste stage Tianjin, Shanxi, Guangdong, and Guizhou have the best three efficiency values of forestry input-output. The forestry land area and government input are not fully utilized, resulting in low forestry efficiency. |
| Li Chunhua et al. (2011)        | 2006            | 31 regions in China             | DEA               | The basic reason for the low output efficiency of some large forestry provinces is the idle labor resources and the low utilization rate of forest resources and capital.                                                                                          |
| Li Wei et al. (2012)            | 2008–2010       | 31 regions in China             | DEA               | The average value of forestry input-output comprehensive efficiency in China is high, and forestry labor input and forestry primary industry output value are important factors affecting efficiency. The average value of forestry input-output comprehensive efficiency in Anhui Province is high, and forestry labor input and forestry primary industry output value are important factors affecting efficiency. |
| Tian Shuying and Xu Wenli (2012) | 1993–2010       | China                           | DEA               | The average value of forestry input-output comprehensive efficiency in Gansu Province is high, and forestry labor force factor is important. The efficiency in Guangdong Province is not high, and the population density in mountainous areas, rural per capita income, and the incidence of forest diseases and insect pests are significant factors. |
| Tian Shuying, Zhang Chen, and Xu Wenli (2013) | 1998–2013   | Anhui Province                  | DEA               | There are obvious regional differences in forestry input-output efficiency among cities and prefectures in Hunan, mainly due to the mismatch between input and output. The average value of forestry input-output comprehensive efficiency in Beijing is high, and the complete amount of forestry fixed assets investment is an important factor affecting the efficiency of Lin Chao, Xie Zhizhong, and Cai Wenying (2016). |
| Mi Feng, Liu Zhidan, Li Zhuowei, and Ji Yingxun (2013) | 1999–2011   | Gansu Province                  | DEA               | The efficiency value of Fujian Province shows an upward trend, and forestry labor input and technological progress are important factors. In most years, Guangxi Province is in a state of inefficiency, and capital investment is an important factor. |
| Yu Mingxia, Zhang Ziqiang, and Gao Lan (2014) | 1992–2012   | Guangdong Province              | DEA Tobit         | The forestry output efficiency of Jiangxi Province has great growth potential, and the investment in forestry infrastructure and the salary of employees are important factors. The overall efficiency of Gansu Province is not ideal. |
| Xiong Xi, Cai GuiGui, Zhang Xuewen, and Zhang Qi (2014) | 2013           | Hunan Province                  | Cluster analysis  | The labor transfer in the eastern region of the Yangtze River economic belt was conducive to the promotion of forestry TFP. China’s forestry total factor productivity was generally stable. |
| Zhang Ying, Yang Guihong, and Li Zhuowei (2016) | 1993–2013   | Beijing                         | DEA               |                                                                                                                                                                                                          |
| Lin Chao, Xie Zhizhong, and Cai Wenying (2016) | 2004–2013   | Fujian Province                 | DEA Malquist      |                                                                                                                                                                                                          |
| Wei Jingnan and Zhang Lizhong (2016) | 2000–2013   | Guangxi Province                | DEA               |                                                                                                                                                                                                          |
| Liao Bing and Jin Zhinong (2014) | 2000–2011   | Jiangxi Province                | DEA Tobit         |                                                                                                                                                                                                          |
| Li Jingxuan, Chen Bingpu, and Yang Lujia (2017) | 1998–2014   | Gansu Province                  | DEA Malquist      |                                                                                                                                                                                                          |
| Xiang Hongling, Chen Zhaojiu, Liao Wennai, Ai Juan, and Zhang Mengling (2021) | 2007–2019 | 11 provinces (cities) in the Yangtze River economic belt. | DEA Malquist/ SEM |                                                                                                                                                                                                          |
| Liu Dong, Wang Xin, and Lu Yuan (2021) | 2006–2018   | China                           | DEA Malquist/ SEM |                                                                                                                                                                                                          |
First, from the perspective of sample data, the analysis periods and objects selected by previous research literature are different. The previous literature often analyzed the total factor production efficiency of forestry in different regions after 1993, and the specific time period is not exactly the same. Li et al. [2] (2011) and Li et al. [3] (2012) analyzed and demonstrated the TFP of forestry in 31 regions in China, but the former selected the cross-sectional data in 2006, while the latter analyzed the efficiency of 31 regions in China from 2008 to 2010. Tian and Xu (2012) [4], different from the former two, calculated the total factor forestry productivity from 1993 to 2010. Although Xu et al. (2015) [5] also studied China’s forestry production efficiency from 1992 to 2011, the object is the nature reserves of China’s forestry system. In addition to the total factor production efficiency of forestry in the seven western provinces studied by Gao (2014) [6] and the action mechanism of labor transfer in 11 provinces (cities) of the Yangtze River Economic Belt studied by Xiang et al. (2021) [7] on forestry TFP, other literature generally determines the research level as the provincial level, and some cover several counties or farmers in the province, such as Lai and Zhang (2008) [8], Tian et al. (2013) [9], Feng et al. (2013) [10], Lin et al. (2016) [11], Yang et al. (2017) [12], and Li et al. (2017) [13].

Second, from the perspective of variable selection, the measurement of forestry total factor productivity mainly determines the output variables and input variables. Most of the existing literature studies choose the total output value of the forestry industry as the output variable. For the investment in forestry production, most literature studies understand it as land, capital, and labor. However, because the data of forest land area are updated only once every five years, the previous literature often chose the completed investment of fixed assets in forestry as the capital investment, and the number of employees in the forestry system at the end of the year as the labor force investment. However, Liao and Jin [14], Liao et al. [15], Xiong et al. [16], Jingnan and Zhang [17], and Zhang et al. [18] chose to replace forest land area with afforestation area as an input variable for calculation.

Third, from the perspective of research methods, most studies use the DEA model calculation method to evaluate forestry total factor productivity. For example, in 1978, Professor A. Charnes, a famous American operational research scientist, puts forward the DEA efficiency evaluation method, and then, it is gradually developed by researchers to form a common research model for non-parametric analysis. The main purpose of the DEA model calculation method is to evaluate whether the decision-making unit with more input and output is technically effective [19]. Although the DEA calculation method can evaluate forestry efficiency, its deficiency is that it is unable to find the reasons for the effectiveness or ineffectiveness of efficiency. Therefore, Yu et al. [20], Liao Bing (2014), and Liao Wenmei et al. (2014) chose the tobit model to further investigate the effective or ineffective factors affecting efficiency. In addition to the above methods, Xiong Xi et al. (2014) adopted the cluster analysis method, Gao Jing (2014) adopted the set pair analysis method to evaluate the total factor productivity of forestry, and Liu [21] et al. (2021) used DEA Malmquist index to calculate provincial forestry TFP.

Throughout the previous research on forestry total factor productivity, domestic scholars have explored the productivity of the whole country or a region and generally use various types of DEA models for calculation and research. In view of the different effects of different forestry resource endowment regions on forestry technological progress, the research on the next step of forestry total factor productivity should focus on its influencing factors, such as the impact of technological progress on forestry total factor productivity. Based on the Malmquist analysis, this study calculates the total factor productivity of forestry from 1997 to 2020 and introduces other variables to analyze how it affects the TFP of forestry and to provide policy reference for ecological management. The public special governance of sustainable development of ecological forestry and the establishment, implementation, and implementation and effect evaluation of public supply service projects need to make scientific calculations on ecological forestry, sustainable development of forestry, externality of input, and uncertainty of output, so as to clarify the strict research boundary and provide a scientific and rational analysis framework for further research.

3. Measurement and Analysis of Total Factor Productivity

3.1. Method Selection and Model Setting. In the past, the commonly used methods to measure total factor productivity were the production function method, stochastic frontier analysis (SFA), and data envelopment analysis (DEA). By analyzing different inputs and outputs of the system, the maximum possible output of the system is looked for [22]. In the calculation of total factor productivity, the more mature method is DEA. In this study, the Malmquist index DEA model reflecting the dynamic change of total factor productivity is selected to analyze the forestry total factor productivity of 31 provinces in China. DEA model is divided into $C^2R$ mode and $BC^2$ models. Charnes, Cooper, and Rhodes put forward the $C^2R$ model and assumed that the return to scale of the decision-making unit did not change; the $BC^2$ model relaxes the assumptions and decomposes the overall efficiency into scale efficiency and pure technical efficiency [23]. In this study, the TFP of forestry is calculated by the DEA model. The specific use is the $BC^2$ model considering scale income. The model set in this study is as follows:

At present, there are n DMUs, and each DMU has m inputs and s outputs. Suppose a total of j DMUs, each DMU is represented by $DMU_{j}$. The input and output variables are expressed $X_{ij}, Y_{ij}$ in the following:

$$X_{j} = (x_{1j}, x_{2j}, \ldots, x_{mj})^T,$$

where $X_{ij} > 0$ indicates the input quantity; $i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$. 
(2)
\[ Y_j = \left( y_{1j}, y_{2j}, \ldots, y_{sj} \right)^T, \]

where \( y_{rj} > 0 \) indicates the output quantity; \( r = 1, 2, \ldots, s \).

Then, the BC\(^2\)-DEA model that evaluates the status of the \( j \) DMU as effective is as follows:

\[
\min \theta = V_D, \quad \sum_{j=1}^{n} \lambda_j x_j + \theta^* = \theta x_0, \\
\sum_{j=1}^{n} \lambda_j x_j - \theta^* = Y_0, \\
\sum_{j=1}^{n} \lambda_j = 1, \\
S^* \geq 0, S^\theta \geq 0, \lambda_j \geq 0, j = 1, 2, \ldots, n.
\]

In the above formula, \( \lambda_j \) is unit combination coefficient; \( \theta \) represents the judgment standard of the relative effectiveness of DMU, i.e., comprehensive efficiency; \( V_D, X_0, \) and \( Y_0 \) are constant terms; and \( s^* \) and \( s^\theta \) are expressed as a relaxation variable \( [8]\)\(^{107} \). If \( \theta = 1 \), then the evaluation decision-making unit \( j \) is weak DEA effective; if \( \theta = 1, s^* = 0, \) and \( s^\theta = 0 \), then DMU\( j \) is DEA valid; if \( \theta < 1 \), then DMU\( j \) is DEA invalid \([8, 9]\).

Without setting the form of the production function, combining the Malmquist index with the DEA method can avoid strong theoretical constraints. Malmquist index decomposition method mainly refers to that the change of total factor production efficiency (TFP) can be decomposed into technical progress (Tech), pure technical efficiency (Pech), and scale efficiency (Sech). At the same time, pure technical efficiency and scale efficiency will jointly reflect the change of technical efficiency (Effch). The change of effch measures the "catch-up effect" of units at the possible boundary of production. Scale efficiency measures the "growth effect" of units moving along the production frontier \([24]\). This study calculates the Malmquist index of the development and change of forestry total factor productivity, and taking \( t \) period as the base period, the formula is as follows:

\[
\text{MALM}_{Vt}^{t+1}(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_t^{x+1}(x^t, y^t)}{D_t^{x}(x^t, y^t)} \times \left[ \frac{D_t^{y+1}(x^{t+1}, y^{t+1})}{D_t^{y}(x^{t+1}, y^{t+1})} \right] \times \left[ \frac{D_t^{x+1}(x^{t+1}, y^{t+1})}{D_t^{x}(x^{t+1}, y^{t+1})} \right] \times \left[ \frac{D_t^{y+1}(x^{t+1}, y^{t+1})}{D_t^{y}(x^{t+1}, y^{t+1})} \right] = \text{PECH}_{Vt}^{t+1} \times \text{SECH}_{Vt}^{t+1} \times \text{TECHCH}_{Vt}^{t+1} = \text{EFFCH}_{Vt}^{t+1} \times \text{TECHCH}_{Vt}^{t+1}.
\]

In the above formula, Malm is the TFP of forestry from \( t \) to \( t + 1 \), PECH is the pure technical efficiency change index from \( t \) to \( t + 1 \), SECH is the scale efficiency change index from \( t \) to \( t + 1 \), TECHCH is the technical progress change index from \( t \) to \( t + 1 \), and EFFCH is the technical efficiency change index from \( t \) to \( t + 1 \). \( x^t \) and \( x^{t+1} \) are the input vectors of units from \( t \) to \( t + 1 \), \( y^t \) and \( y^{t+1} \), respectively, and the input vectors of units from \( t \) to \( t + 1 \), \( D_t^x(x^t, y^t) \), and \( D_t^{x+1}(x^{t+1}, y^{t+1}) \) are distance functions based on \( T \) and \( T + 1 \) period technology, respectively. The subscript \( v \) in the above formula is the variable return to scale assumption, and \( C \) is the constant return to scale assumption. If the Malmquist index is greater than 1, the total factor productivity has improved; if the Malmquist index is less than 1 in the calculation results, the development of forestry total factor productivity is backward; in the calculation results, if PECH, SECH, EFFCH, and TECHCH are greater than 1, respectively, the pure technical efficiency, scale efficiency, technical efficiency, and technological progress promote the improvement of total factor productivity; on the contrary, they inhibit the progress of total factor productivity.

### 3.2. Index Selection.

The success of using the DEA model to calculate and analyze depends on the selection of factor input index and output index. As far as forestry total factor productivity is concerned, the input index is all kinds of production factors that can promote the sustainable and stable development of forest ecological construction. According to the production function formula of western economics, the three elements of land, capital, and manpower are considered in turn. The input index of land factor selection is forestry land area; the investment index for the selection of capital elements is the completed investment of forestry fixed assets; the input index of human factor selection is the number of employees in the forestry system at the end of the year \([6]\)\(^{113} \).

According to the principles of economics, after the input of production factors, the output of general industries will be considered from three aspects: economic benefits, ecological benefits, and social benefits. The most intuitive embodiment of the economic benefits of forestry is the total output value of the forestry industry. The total output value of the forestry industry selected in this study includes the output value of the primary industry, secondary industry, and tertiary industry. This output index represents the output of economic benefits. In addition, the afforestation area and forest tending area are selected as the second and third indicators of economic benefits. The afforestation area and forest tending area are the technical and economic indicators reflecting the forest tree coverage in an area. The afforestation area selected in this study is the afforestation area with a survival rate of 85%. The ecological benefits of forestry are expressed by forest coverage and the occurrence and control rate of forestry pests. Forest coverage is an important indicator reflecting the actual level of forest resources, and its...
value comes from the ratio of forest area to total land area; the occurrence and control rate of forest pests are an important index to reflect the level of forest ecological environment protection. The social benefits of forestry are expressed by the number and area of forest parks. Forest park refers to the forest that forms a landscape system or can be used for a short-term free vacation after construction. It has many functions such as construction and convalescence. Therefore, the number and area of forest parks are used to reflect social benefits. All the sample data used are from China forestry statistical yearbook and China forestry yearbook (Table 2).

### Table 2: Index selection of forestry total factor productivity.

| Type               | Category          | Factor index                                      | Type            | Category         | Factor index                                      |
|--------------------|-------------------|--------------------------------------------------|-----------------|------------------|--------------------------------------------------|
| Output indicators  | Economic benefits | Total output value of forestry industry          | Input indicators | Capital          | Completed investment in forestry fixed assets     |
|                    |                   | Afforestation area                               |                 |                  |                                                  |
|                    |                   | Forest tending area                               |                 |                  |                                                  |
|                    |                   | Forest coverage                                  |                 |                  |                                                  |
|                    | Ecological benefits| Occurrence and control rate of forestry pests    |                 |                  | Human resources                                   |
|                    |                   | Number of forest parks                            |                 |                  | Number of employees in forestry system units in end of the year |
|                    | Social benefits   | Forest park area                                 |                 |                  |                                                  |

### Table 3: Index and decomposition of average total factor productivity of forestry in 31 provinces in China from 1997 to 2020.

| Region            | Technical efficiency | Technical progress | Pure technical efficiency | Scale efficiency | Total factor productivity |
|-------------------|----------------------|--------------------|---------------------------|------------------|---------------------------|
| Shanxi            | 1.016                | 1.079              | 1.009                     | 1.005            | 1.093                     |
| Inner Mongolia    | 1.048                | 1.017              | 1.000                     | 1.056            | 1.062                     |
| Jilin             | 1.000                | 1.008              | 1.000                     | 1.000            | 1.008                     |
| Heilongjiang      | 1.059                | 0.953              | 1.000                     | 1.059            | 1.009                     |
| Henan             | 0.998                | 0.978              | 1.000                     | 0.998            | 0.979                     |
| Hubei             | 1.016                | 1.017              | 0.999                     | 1.019            | 1.035                     |
| Hainan            | 1.000                | 1.135              | 1.000                     | 1.000            | 1.135                     |
| Chongqing         | 1.000                | 1.088              | 1.000                     | 1.000            | 1.088                     |
| Sichuan           | 1.079                | 1.051              | 1.006                     | 1.079            | 1.136                     |
| Guizhou           | 1.016                | 1.029              | 1.015                     | 1.012            | 1.047                     |
| Yunnan            | 1.027                | 1.015              | 1.006                     | 1.027            | 1.013                     |
| Tibet             | 1.000                | 1.006              | 1.000                     | 1.000            | 1.006                     |
| Shanxi            | 0.983                | 0.983              | 0.996                     | 0.985            | 0.958                     |
| Gansu             | 1.015                | 0.999              | 0.995                     | 1.026            | 1.009                     |
| Qinghai           | 0.998                | 1.017              | 1.000                     | 0.998            | 1.013                     |
| Ningxia           | 1.018                | 1.021              | 0.999                     | 1.019            | 1.047                     |
| Xinjiang          | 1.010                | 1.042              | 1.005                     | 1.009            | 1.053                     |
| Beijing           | 0.996                | 1.049              | 1.000                     | 0.994            | 1.043                     |
| Tianjin           | 1.000                | 1.021              | 1.000                     | 1.000            | 1.021                     |
| Hebei             | 1.001                | 1.046              | 1.000                     | 1.001            | 1.046                     |
| Liaoning          | 1.007                | 1.007              | 1.004                     | 0.999            | 1.005                     |
| Shanghai          | 1.000                | 1.048              | 1.000                     | 1.000            | 1.048                     |
| Jiangsu           | 1.001                | 1.108              | 1.000                     | 1.001            | 1.109                     |
| Zhejiang          | 1.000                | 1.167              | 1.000                     | 1.000            | 1.167                     |
| Anhui             | 1.013                | 0.946              | 1.001                     | 1.009            | 0.957                     |
| Fujian            | 1.009                | 1.079              | 1.000                     | 1.009            | 1.088                     |
| Jiangxi           | 0.999                | 1.004              | 1.000                     | 0.999            | 0.999                     |
| Shandong          | 1.000                | 1.041              | 1.000                     | 1.000            | 1.041                     |
| Hunan             | 1.051                | 1.005              | 1.008                     | 1.034            | 1.059                     |
| Guangdong         | 1.031                | 1.117              | 1.002                     | 1.029            | 1.143                     |
| Guangxi           | 1.035                | 1.045              | 1.005                     | 1.039            | 1.069                     |
| National average  | 1.013                | 1.036              | 1.002                     | 1.013            | 1.047                     |

3.3. Empirical Results and Efficiency Analysis. Using the above indicators and formulas, through the software DEAP 2.1, the Malmquist index of forestry TFP of 31 provinces in China from 1997 to 2021 is measured and calculated. Table 3 shows that the annual mean value of the dynamic change of its efficiency.

From Table 3, we can see that from 1997 to 2018, the highest growth rate of forestry efficiency was Zhejiang, reaching 16.1%; Shaanxi is the lowest, which is −5.2%, and the lack of technological progress is the main reason for the low growth rate of forestry total factor production efficiency. The average growth rate of forestry total factor production
efficiency in China is about 4.3%, the average annual growth rate of technological change is about 3.4%, and the average annual growth rate of technological efficiency is about 1.2%. It can be seen that technological change is the main driving force of forestry TFP. At the same time, it is found that among the 31 provinces in China, the TFP of forestry in Heilongjiang, Henan, Shaanxi, and Anhui is a negative growth rate. There are two situations for provinces with a negative growth rate. One is Heilongjiang and Anhui, where the technical efficiency index is greater than 1 and the technical progress index is less than 1. Although the technical efficiency is improved year by year, the production curve of forest ecological public goods in this area is low, resulting in the decrease of forestry TFP year by year. The second situation is that in Henan and Shaanxi, the technical efficiency index and technical progress index are less than 1. The chief reason for the decrease of its growth rate is the negative growth of scale efficiency. Therefore, on the premise of improving technological progress, Henan and Shaanxi should strengthen the development and utilization of existing forestry scientific management technology, combined with the scale return of local forest resources, correspondingly increase or reduce their investment to improve the scale efficiency, so as to improve the forestry technical efficiency, and improve the forestry total factor productivity [25]. Meanwhile, as shown in Table 3, the TFP of forestry in the eastern region is generally excellent. The main reason is that the eastern region has stronger economic strength than the western region, the higher degree of opening to the outside world, superior economic environment, and high level of scientific and technological management; although the western region is rich in forestry resources, fixed investment, many employees, and large forest land area, the scientific and technological levels are relatively low, so the TFP of forestry is relatively low.

4. Conclusions and Suggestion

This study calculates and analyzes the Malmquist index of forestry TFP in 31 provinces in China from 1997 to 2018 through the DEA Malmquist model. The results show that China’s forestry TFP generally shows a fluctuating upward trend. Due to the imbalance of economic, social development, and resource endowment in each province of China, the Malmquist index of forestry total factor productivity in each province is obviously regional and different. The growth rate of forestry TFP in Zhejiang is the highest and that in Shaanxi is the lowest. Technological change is the main driving force of forestry TFP growth. To improve forestry total factor productivity, we must strengthen the use of existing technologies. The conclusion of this study has strong policy significance: improving the total factor productivity of China’s forestry and strengthening the sustainable input and efficient output of ecological forestry are one of the important public finance action plans of the country and region to deal with climate change, promoting high-quality development, and responding to people’s yearning for a better life. It aims to further promote the construction of ecological civilization, realize that all people share the achievements of forestry ecological civilization construction, promote the harmonious coexistence between man and nature, and provide a public governance framework conducive to consolidating the ecological material foundation and standardizing people’s environmentally friendly behavior. Strengthening the construction of ecological engineering will play an important role in promoting the construction of ecological civilization and ensuring national ecological security. Among them, natural forest is an important carrier in the strategic pattern of ecological security in China. It has important strategic significance for regulating the water cycle and local climate, maintaining national ecological security, and ensuring national wood resources. Over the past two decades since the implementation of the nature conservation project, 275 million mu of public welfare forest construction and 100 million mu of young and middle-aged forest tending have been completed, enabling 1.932 billion mu of natural forest to recuperate. In the future, we need to continue to increase the central financial support and consolidate the achievements made in the supply of forest and the construction and development of forestry ecology. Although this will cause the central and local governments to face greater financial pressure in short term, its economic benefits will be gradually reflected in the longer term. Especially in terms of the economic and social development of the province where the nature conservation project is implemented, the nature conservation project has brought long-term and sustainable improvement in ecology and society; on the whole, the nature conservation project is an important means to implement the “five-in-one” overall layout and realize the revitalization and development of forest areas. Based on the above analysis conclusions, to effectively promote the forestry total factor productivity, promote the supply of forest ecological products, and ensure sustainable development, the following countermeasures and suggestions are put forward:

First, accelerate the adjustment of industrial structure and vigorously develop the secondary and tertiary industries. The optimization of industrial structure is mainly to update the old ideas, change ideas, based on the reality of forest resources, and actively study and develop ecological products with the concept of green environmental protection. Meanwhile, we should develop digital economic means, develop Internet plus forestry ecological products by using network media such as graphic, video, and live broadcast, and develop the “mountain forest farm” with the characteristics of high ecological diversity in shallow mountainous areas, enrich the supply of forest ecological products and enhance the efficiency of ecological product development and utilization.

Second, investment is increased in scientific research and a good job is done in talent accumulation and training. Simply increasing the number of forestry employees will not help to improve the TFP. Only by improving the management level, increasing the investment in research, and increasing the investment in high-level and high-quality human resources can we effectively improve the total output value of the forestry industry. For example, forestry science
technology research adapts to the significant complexity and diversity of forestry production, actively responds to new challenges such as climate change and pest control, increases the investment of scientific research, and strives to promote the level of science and technology. In terms of forestry production, the historical opportunity of the implementation of the “nature conservation project” is seized to help forestry workers realize the transformation from "loggers" to "forest rangers." Concurrently, to meet the needs of forest production and development, industrial workers who master modern forestry scientific and technological knowledge and are familiar with modern scientific and technological equipment and skills are cultivated. In terms of comprehensive forestry management, managers who are not only familiar with traditional wood production, forest management, and protection are cultivated, but also the development of new technologies and new business forms is actively explored.

Third, investment in fixed assets is increased and the level of management is improved. The development of ecological construction needs to break through the restrictions of infrastructure, enlarge the investment in fixed assets, and promote the management level of fixed assets. The first is to enlarge the investment in ecotourism infrastructure construction, optimize the tourism environment and supporting facilities, and create conditions for forest tourism and the utilization of green ecological resources. The second is to update the processing equipment of forestry products, make full use of rich understory resources, cooperate with the development of the tourism industry, and develop forest characteristic products such as arts and crafts and green food. Simultaneously, the technical level of management is promoted, the information technology level of management is improved, per capita management and protection area are expanded, and work efficiency is improved by using technical means such as satellite remote sensing detection and UAV cruise.

Fourth, forest ecological protection is strengthened and forest coverage is improved. Comprehensively, the implementation experience of the natural forest protection project is summarized, the implementation scope of the natural forest protection project, strengthen management, protection, and law enforcement is appropriately expanded, and effective measures are taken to protect natural forests. The management of artificial forest closure is strengthened, the canopy density of forest land is improved, biodiversity is improved, and the transformation of degraded forest stands is strengthened. Forest resources are strictly managed according to laws and regulations, the forest land not managed by forestry departments are brought into the statistical management of forest resources, the supervision of forest land is strengthened, and it is ensured that the area of forest land only increases but not decreases.

Data Availability
The data used to support the findings of this study are included within the article.

Conflicts of Interest
The author declares that there are no conflicts of interest regarding the publication of this paper.

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