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Analysis of Influencing Factors of Industrial Green Total Factor Productivity in Henan Province

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Abstract

This paper takes the industrial status of 18 cities in Henan Province as the research object, and uses the DEA-Malmquist method to measure the industrial green total factor productivity (GTFP) index of Henan Province from 2013 to 2017. And based on this, using the Balanced Panel model regression analysis: Industrial fixed capital investment, energy industry investment, foreign investment dependence, energy conservation protection and protection expenditures, and industrial R&D expenditure in total R&D expenditure are positively correlated with industrial GTFP. Finally, based on the analysis results, we will make recommendations on the future ecological civilization construction in Henan Province, promote economic development, rational use of foreign capital, develop green economy, improve scientific and technological innovation capability, and adjust and optimize energy structure.

Keywords

Green total factor productivity; DEA-Malmquist model; Influencing factor; Industrial transformation; Green development concept.

1. RESEARCH BACKGROUND AND SIGNIFICANCE

1.1. Research Background

With the continuous progress of the economy and society, ecological protection and resource conservation have become one of the hottest topics today. At the Nineteenth National Congress, General Secretary Xi Jinping proposed that it is necessary to establish and promote the ecological concept of "green water and green mountains are golden mountains and silver mountains". The harmonious development of nature will ultimately realize the green development strategy. In order to achieve the goal of a strong nation, enriching the people and the organic integration of ecological and environmental protection, improving the quality of economic growth and achieving green economic development have become an inevitable choice for our country in the future. Therefore, economic growth must pay attention to "quality, efficiency, fairness, and the continuity of development", and must not ignore resource conservation and environmental protection, and blindly pursue economic growth while ignoring quality.

In recent years, rapid industrial development in Henan Province, central and western industrial economic aggregate ranked first, the national 5 position, generally enter the later stages of industrialization. Although the rapid development of Henan's industry has greatly improved Henan's economic strength and the people's living standards, it is at the cost of huge energy consumption and serious environmental pollution. "Severe environmental pollution, low economic cycle, low production efficiency" and other issues, Henan's industrial economic growth has extremely obvious semi-extensive characteristics.

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The grim status quo warns us that the main task at present is to accelerate the transformation of economic development mode in order to achieve the goal of a win-win situation for economic growth, energy conservation and environmental protection. Therefore, the key problem that Henan Province urgently needs to solve at present and in the future is how to promote the green and sustainable development of Henan's industrial economy. To achieve sustained and stable growth of the industrial economy, it is necessary to realize the green and intensive development of the industrial industry from the technical level, and to transform the extensive development model based on factor input from the structural point of view. Looking at the development process of economic theory and comparing the practices of other countries and regions horizontally, we can find that economic growth can rely on increasing factor input and improving total factor productivity. Increasing total factor productivity is even more important to promote the sustainable development of our country's economy. Driving force. In summary, the application of the concept of green sustainability can be achieved by improving green total factor productivity.

1.2. Research Purpose and Significance

1.2.1. Research purpose

The purposes is to verify that Henan's industrial green total productivity is related to the two factors of industrial pollution emissions and energy consumption, and to find the development trend of green total factor productivity under environmental constraints. Therefore, this paper uses the DEA - Malmquist model method, taking sulfur emissions and general industrial solid waste generation in the industrial production process as undesired output, industrial added value as expected output, and industrial labor, capital, and industrial energy consumption as undesired output. The input factors are included in the industrial green total factor productivity measurement model to measure the industrial total factor productivity and industrial green total factor productivity of 18 prefecture-level administrative units in Henan Province. At the same time, the analysis results are decomposed and analyzed to find the growth of TFP and GTFP Driving force. Through comparison, it is concluded that the change trend of Henan Province's green total factor productivity in recent years is also conducive to clarifying the development path we should adhere to in the future.

1.2.2. Research Significance

Firstly, to sort out the existing measurement methods of Henan Province's green total factor productivity, and increase the research on the measurement methods. Through analysis, this paper found a simple method, that is, to use the DEA-Malmquist model to measure the industrial green total factor productivity of Henan Province, and decompose the TFP into the technical efficiency index (Effch) and the technological progress index (Techch), and the technical efficiency index is further divided into Pure technical efficiency index and scale efficiency index. This paper briefly combs the existing methods of measuring total factor productivity and green total factor productivity, and reviews and summarizes various methods, which is of great significance for future theoretical analysis and empirical research. On the other hand, it also analyzes the influencing factors that promote the growth of green total factor productivity in Henan Province. Through the Balanced Panel model, this paper considers the energy environment constraints and decomposes the sources of industrial total factor productivity growth of 18 prefecture-level administrative units in Henan Province into industrial fixed capital investment, energy industry investment, foreign capital dependence, and energy conservation protection. Intensity and industrial R& D expenditure share in total R&D expenditure. Existing research on Henan Province's industry tends to ignore energy and environmental constraints, so this article analyzes the sources of growth more comprehensively and effectively.

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The practical significance is beneficial to the future industrial progress of Henan Province and improving the quality of industrial production. Based on GTFP 's specific analysis, it provides suggestions for the government to formulate future development strategies. In the third part of this article, we systematically compared the effects of various influencing factors in promoting Henan's industrial green total factor productivity, including industrial fixed capital investment, energy industry investment, foreign capital dependence, energy conservation protection, and industrial R&D funding. As for the share of total R&D expenditure, we can see from the results that each influencing factor has a positive or negative effect on the growth of total factor productivity. Relevant departments can use this as an important basis for formulating corresponding policies to promote the transformation and upgrading of industries in Henan Province.

1.3. Literature Review

Economists have a long history of research on total factor productivity, and can be traced back to the period of classical economics. Adam Smith said that social division of labor can increase the efficiency of labor production. Say then proposed the concepts of labor productivity and capital productivity. The former represents the ratio of labor to output, and the latter represents the ratio of capital to output. The classical school of economics advocated the promotion of economic growth by increasing productivity and factor input, but economists found that this method of promoting economic growth had little effect in the long-term. This is because factors have a diminishing marginal return effect. Aware of the importance of increasing the level of productivity. In 1957, Nobel Laureate in Economics Robert M. Solo systematically proposed the concept of total factor productivity, that is, an aggregate production function and growth equation with constant returns to scale. Solow established a total production function on the basis of constant returns to scale and technological neutrality-the Cobb-Douglas production function, and proposed the Solow residual value method, which removes the elements of economic growth through calculation The residual value of labor input growth and capital input growth is used to measure total factor productivity, which describes the role of technological progress, structural innovation, and specialization in economic growth. Economists at home and abroad have many methods for measuring TFP, such as: algebraic index method, Solow residual value method, stochastic frontier production function method, data envelopment analysis method and so on.

Farrel [1] added variables reflecting energy and environmental changes on the basis of measuring total factor productivity, measured green total factor productivity (GTFP) with a non-parametric method, and first defined the concept of green total factor productivity, which marked China The beginning of GTFP research. Subsequently, Surender Kumar [2] and Dong-hyun Oh [3] developed the method Malmquist–Luenberger index for measuring green total factor productivity based on consideration of resource and environmental factors, which can be roughly summarized into two categories: parametric method and non-parametric method. Parametric methods include Solow Residual Value Method, Stochastic Frontier Analysis Method (SFA), etc., and non-parametric rules are mainly a combination of data envelopment method (DEA) and exponents. The non-parametric method is the main method of empirical analysis. It can easily and accurately calculate the relative efficiency of output and input without using functional expressions and various element price information.

1.4. Definition of Related Concepts

Productivity can usually be divided into single factor productivity (Single Factor Productivity, SFP) and total factor productivity (Total Factor Productivity, TFP). SFP represents the ratio of output to a certain factor (such as labor, capital, or energy), and it can only reflect the relationship between output and a specific input; while TFP is the ratio of output to various

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inputs (such as labor, capital, energy or capital, etc.) A ratio of the weighted comprehensive investment. The improvement lies in the introduction of technological progress into the production function. It is one of the important indicators to measure the quality of economic development and evaluate technological progress and production efficiency. We generally support the view that total factor productivity is more real and objective than the comprehensive benefits of the economic system reflected by single factor productivity, and that investment can be considered more comprehensively in economic activities.

Green total factor productivity (Green Total Factor Productivity, GTFP) is an indicator of proposed in the traditional total factor productivity, based on both a difference also similar, GTFP in the traditional TFP joined the index, energy investment and environmental pollution estimates of, Perfecting and improving the total factor productivity, in line with the current ecological and environmental protection concept. With the increasingly prominent problems of global energy depletion and the deterioration of the ecological environment, economists have realized that in TFP analysis, if resources and environmental elements are ignored, they may get unrealistic evaluations. Afterwards, economists introduced factors such as resources and environment into the evaluation system of total factor productivity, further developed total factor productivity, and defined green total factor productivity. Green total factor productivity is a measure of total factor productivity. Consider the influence of variables such as energy input and pollution emissions on the basis. With the promotion of the concept of green development in recent years, the public has begun to advocate economic growth methods that do not sacrifice the environment and the concept of green sustainable development. People have gradually realized that they must attach importance to environmental protection and energy conservation. We increasingly value the quality of economic growth rather than the efficiency of economic growth, which has greatly developed the evaluation system. Therefore, economists regard the link between economic growth and resources and the environment as a key research direction, and total factor productivity considering resource and environmental factors has also become a research hotspot in economics. Domestic economists generally define total factor productivity considering resource and environmental issues as green total factor productivity, while abroad it is called sensitive total factor productivity.

Based on previous economists' research conclusions, we innovatively define the measurement method of Henan's green total factor productivity: First, the measurement of total factor productivity takes the industrial capital stock and labor population in Henan's industry as input factors, and industrial added value as the output factors, the total factor productivity can be derived from the ratio of the two. Unlike TFP, the measurement method of industrial green total factor productivity must take energy consumption into consideration, take environmental pollution and pollutant emissions as undesired output, and calculate the number of industrial laborers, industrial capital stock, and energy consumption. As input, total industrial output value as expected output, and general industrial solid waste and sulfur dioxide emissions as a ratio of undesired output. It can be disassembled when analyzing the specific driving factors of green total factor productivity.

2. ANALYSIS OF THE STATUS QUO AND PROBLEM ANALYSIS OF INDUSTRIAL GREEN TOTAL FACTOR PRODUCTIVITY IN HENAN PROVINCE

This article takes the industry of Henan Province as the research object, from the perspective of 18 prefecture-level administrative units under the jurisdiction of Henan Province, calculates its industrial GTFP and comprehensively evaluates the industrial economic development of Henan Province. This paper uses the DEA-Malmquist index analysis method to measure and analyze the industrial total factor productivity and industrial green total factor productivity of

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18 prefecture-level administrative units in Henan Province. The data in this article mainly come from the Henan Provincial Statistical Yearbook (2013-2017) and the statistical bureaus of each city.

Table 1. Division of Economic Regions and Related Data in Henan Province

area	Including prefectures and cities	Accounted for the total area (%)	Accounted for the total population (%)
Central Plains City Group	Zhengzhou, Kaifeng, Luoyang, Pingdingshan, Xinxiang, Jiaozuo, Xuchang, Luohe, Jiyuan	35.3	45.11
Yubei area	Anyang, Hebi, Puyang	8.3	10.90
West Henan Southwest	Sanmenxia, Nanyang	22.3	12.94
Huanghuai area	Shangqiu, Xinyang, Zhoukou, Zhumadian	34.1	31.05

Data source: "Statistical Yearbook of Henan Province" and "Development Status of the Four Economic Zones in Henan Province"

2.1. Malmquist Productivity Index Method

DEA-Malmquist method is a model that combines data envelopment analysis (DEA) and Malmquist index to measure total factor productivity (TPP). Data envelopment analysis is a research method based on the piecewise linear combination of selected inputs and outputs. Its advantage is that it does not need to consider the specific production function form and factor price information, and can perform cross-sectional analysis of more than one decision-making unit. Periodic research is very convenient to calculate efficiency. Therefore, the DEA method has been widely used. However, this traditional method is powerless when facing the problem of undesired output. Therefore, the Malmquist-Luenberger index is introduced to better consider The impact of environmental pollution. Specifically, the DEA-Malmquist method is to first obtain the production frontier through data envelopment analysis, then determine the distance function among them, and use the distance function to calculate the TFP index to measure the growth rate of TFP. The specific formula is as follows:

$$ML = \left(\frac{D^t(x_{t+1}, y_{t+1}|CRS)}{D^t(x_t, y_t|CRS)} \times \frac{D^{t+1}(x_{t+1}, y_{t+1}|CRS)}{D^{t+1}(x_t, y_t|CRS)} \right)^{1/2}$$

In the above formula, X is the input vector, Y is the output vector, CRS represents the DEA model under Constant Return to Scale, and VRS represents the DEA model under Variable Return to Scale. $D^t(x_{t+1}, y_{t+1})$is defined by the first t of the technology cycle represented by t+1 technical efficiency cycle; ; $D^t(x_t, y_t)$ refers to the t profit technical efficiency technology period indicated; $D^{t+1}(x_{t+1}, y_{t+1})$ refers to the t+1 second cycle techniques represented by t The technical efficiency level of 1 cycle; $D^{t+1}(x_t, y_t)$ refers to the current technical efficiency level represented by the technology of the t+1 cycle. If M<1, it means that the overall efficiency level has decreased; if M>1, it means that the overall efficiency level has risen. The above formula can be further decomposed into technical efficiency indicators (Effch) and technical progress indicators (Techch). Technical efficiency can be further divided into pure technical efficiency and scale efficiency:

$$M = Techch \times Effch$$

$$Pech = \frac{D^{t+1}(x_{t+1}, y_{t+1}|VRS)}{D^t(x_t, y_t|VRS)}$$

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$$\text{Sech} = \left(\frac{D^{t+1}(x_{t+1}, y_{t+1}|\text{CRS})}{D^{t}(x_{t+1}, y_{t+1}|\text{CRS})} \times \frac{D^{t}(x_{t}, y_{t}|\text{VRS})}{D^{t+1}(x_{t+1}, y_{t+1}|\text{VRS})} \right)$$

In the above three formulas, Techch represents the technological progress index, Pech represents the pure technical efficiency index, and Sech represents the scale efficiency index. The product of the three forms the Malmquist index, the formula is:

$$M = \text{Techch} \times \text{Effch} = \text{Techch} \times \text{Pech} \times \text{Sech}$$

The total factor productivity and green total factor productivity in this article are measured through DEAP2.1 software, and the specific calculation process will be described in detail below.

2.2. Data Variables and Sources

The measurement method of green total factor productivity is defined as follows: Henan industrial green total factor productivity is based on the measurement of industrial total factor productivity, taking energy consumption into account as input, and taking environmental pollution and pollutant emissions as undesired output. The output takes the number of industrial labor force, industrial capital stock, and energy consumption as inputs, total industrial output value as expected output, and general industrial solid waste and sulfur dioxide emissions as a ratio of undesired output. The input-output variables used in the model and related descriptions are as follows:

2.2.1. Input variables

(1) Labor input (L). Labor input is measured by the sum of the number of industrial labor employees above designated size and the number of industrial employees below designated size in 18 prefecture-level administrative units in Henan Province from 2013 to 2017, covering all types of industrial employees, and the unit is 10,000.

(2) Capital investment (K). Due to the lack of statistical data on capital investment in the Henan Statistical Yearbook, the perpetual inventory method pioneered by Gordon Smith is used to calculate the capital stock to express the capital input. The unit of capital stock is 100 million yuan. The formula is: $K_{it} = K_{it-1}(1 - \delta_{it}) + I_{it}$, where the depreciation rate δ_{it} refers to Shanhaojie's estimation of China's capital stock, take 10.96%; the current investment volume is expressed by the constant-price industrial fixed capital investment calculated at the fixed investment price. The industrial capital stock of Henan Province from 2013 to 2017 is calculated through the above formula, and finally, the specific capital stock of each city is calculated based on the ratio of the total industrial fixed capital formation of each city in Henan Province to the total industrial fixed capital of Henan Province.

(3) Energy input (E). The comprehensive energy consumption of industrial enterprises above designated size in 18 prefecture-level administrative units in Henan Province is estimated. In this paper, the municipalities of Henan Province 2013-2017 total energy consumption data for energy input indicators, expressed in tons of standard coal.

2.2.2. Output variables

(1) Industrial output value (Y). The industrial output value selected the industrial added value of the 18 prefecture-level administrative units in Henan Province from 2013 to 2017 as the expected output value, calculated at the price of the current year, and the unit is 100 million yuan.

(2) The amount of general industrial solid waste generated (W). This paper selects the general industrial solid waste generation of 18 prefecture-level administrative units in Henan Province as the statistical indicator, the unit is 10,000 tons.

(3) Sulfur emissions (S). This paper selects the sulfur dioxide (SO_2) emissions of 18 prefecture-level administrative units in Henan Province as the statistical indicator, the unit is 10,000 tons. The main way of producing sulfur dioxide is industrial production. The fuels

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needed for industrial production, such as coal and petroleum, generally contain sulfur compounds, and sulfur dioxide gas is produced during the combustion process.

Table 2. Henan Province Industrial Green Total Factor Productivity Evaluation Index System

variable	Evaluation index	
Input variable	Labor input (L)	Industrial employees / 10,000 people
	Capital investment (K)	Industrial capital stock / 100 million yuan
	Energy input (E)	Comprehensive energy consumption / 10,000 tons of standard coal
Output variable	Gross Industrial Product (Y)	Industrial added value of the year / 100 million yuan
	General industrial solid waste generation (W)	General industrial solid waste generation / 10,000 tons
	Sulfur emissions (S)	Sulfur dioxide emissions / 10,000 tons

2.3. Empirical Results and Analysis

2.3.1. Analysis of DEAP software output results

Table 3. Comparison of total factor productivity and green total factor productivity of 18 cities in Henan Province from 2013 to 2017

area	2013-2014		2014-2015		2015-2016		2016-2017	
	TFP	GTFP	TFP	GTFP	TFP	GTFP	TFP	GTFP
Zhengzhou	1.045	1.068	0.982	1.004	1.186	1.235	1.088	1.088
Kaifeng	1.050	0.956	0.929	0.883	1.107	0.915	1.094	0.968
Luofeng	0.735	0.737	0.920	0.951	1.668	1.672	1.142	1.132
Pingdingshan	0.884	0.878	0.938	0.959	1.497	1.476	1.065	1.050
Anyang	0.799	0.814	0.946	0.943	1.581	1.560	1.31	1.296
Hebi	0.915	0.914	0.995	1.001	1.103	0.994	1.11	1.060
Xinxiang	0.833	0.845	0.960	0.966	1.597	1.404	1.105	1.108
Jiaozuo	0.872	0.903	0.933	0.938	1.381	1.300	1.089	1.084
Puyang	0.967	1.012	1.036	1.062	1.413	1.187	1.081	1.060
Xuchang	0.857	0.923	0.943	1.008	1.323	1.168	1.121	1.183
Luohe	0.887	0.893	0.961	0.967	1.489	1.100	1.001	1.000
Sanmenxia	0.772	0.815	0.960	0.956	1.546	1.493	1.279	1.240
Nanyang	0.803	0.916	0.923	0.895	2.117	1.550	1.212	1.175
Shangqiu	0.841	0.918	0.916	0.925	1.399	1.199	1.026	0.886
Xinyang	1.039	1.007	0.929	0.914	1.363	1.136	1.065	1.002
Zhoukou	0.991	1.101	0.933	0.968	1.386	1.140	1.039	0.995
Zhumadian	0.958	0.948	0.925	0.899	1.322	1.123	1.146	0.972
Jiyuan	0.838	0.902	0.959	0.970	1.458	1.244	1.122	0.911
average	0.889	0.915	0.949	0.955	1.425	1.256	1.114	1.062

Through the DEAP2.1 software, the Malmquist index is constructed according to the output orientation, and the industrial total factor productivity and green total factor productivity of 18 prefecture-level administrative units in Henan Province are measured. The calculation results are shown in Table 3.

It can be seen from Table 3 that, with the exception of individual cities such as Kaifeng and Shangqiu, the traditional TFP and green TFP of most cities showed a fluctuating upward trend from 2013 to 2017. This shows that with economic growth, the industrial productivity of all

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cities in Henan Province has At the same time, energy saving and emission reduction policies and environmental protection concepts have played a certain role. However, the specific point of view, some of the recent city in Henan province, such as Shangqiu, Jiyuan, with its green TFP of Malmquist index <1 , which shows in some of the major industries rely on push Henan GDP regional growth, due to the green backward technology, industry Pollution is serious, the concept of environmental protection in the whole society is not popular enough, and the government's environmental policy is not in place, resulting in a decline in GTFP . Therefore, the industrial development of Henan Province must pay attention to the local area, and use the priority development area to drive the industrial progress and environmental improvement of the later development area.

2.3.2. Decomposition of total factor productivity and green total factor productivity

Total factor productivity, as an index used to measure production efficiency, is composed of three factors: one is the improvement of efficiency, the other is technological progress, and the third is the effect of scale. Based on this, industrial total factor productivity can be expressed as effch , techch , pech , sech, and tfpch , which respectively represent technical efficiency change indicators, technical progress indicators, pure technical efficiency change indicators, scale efficiency change indicators, and total factor productivity; similarly, The relevant decomposition indicators of green total factor productivity are represented by geffch , gtechch , gpech , gsech, and gtfpch , which respectively represent the changes in green technology efficiency, green technology progress indicators, pure green technology efficiency change indicators, and green technology after considering energy and environmental factors. Scale efficiency change indicators and green total factor productivity.

Table 4. The breakdown of industrial total factor productivity and green total factor productivity of Henan Province from 2013 to 2017

	effch	geffch	techch	gtechch	pech	gpech	sech	gsech	tfpch	gtfpch
2013-2014	0.983	0.973	0.904	0.940	0.989	0.978	0.994	0.995	0.889	0.915
2014-2015	0.985	0.975	0.964	0.980	0.986	0.991	0.999	0.984	0.949	0.955
2015-2016	0.992	1.065	1.437	1.179	0.967	1.042	1.026	1.022	1.425	1.256
2016-2017	0.981	1.002	1.135	1.060	0.985	1.004	0.997	0.999	1.114	1.062
average	0.985	1.004	1.110	1.040	0.982	1.004	1.004	1.000	1.094	1.047

Judging from the average values of industrial GTFP and TFP in Henan Province in Table 4, after considering resources and environmental factors, the average annual growth rate of GTFP in 18 cities in Henan Province from 2013 to 2017 was 4.7%, which is slightly lower than traditional TFP overall. The average annual growth rate of 9.4%. This shows that the consideration of resources and environmental factors has led to the loss of productivity, that is, resource consumption and environmental pollution will cause the decline of industrial productivity in Henan Province. The overall effect is reverse, which is easy to be ignored when only considering the TFP index; However, there is little difference between the basic trends of total factor productivity of industry and total factor productivity of green industry in Henan Province. This shows that the two factors that mainly affect industrial development are labor and capital. This proves that Henan industry is still mainly driven by capital and labor. .

Through the TFP and GTFP trends and indicators of decomposition analysis shows that, in 2013-2016 between years, calculated GTFP in the 2013-2015 period has been <1 until 2015-2017 between years to reach 1 above, this is because of Henan Province In the early days, industrial pollution was serious and the implementation of environmental policies was not in place, which caused people not to pay enough attention to energy conservation and environmental protection, and GTFP was low. According to the breakdown of the growth of

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Henan's industrial GTFP index, each breakdown index has a very obvious impact on GTFP. During 2013-2015, the decomposition indicators, especially the green technology efficiency indicators and the green technology progress indicators, are relatively small, and the overall impact on the green TFP index is negative, so it may cause the industrial GTFP to be negative before 2015. This phenomenon in 2015 to get better year after, 2015 - 2017 Between GTFP greater than 1 , decomposition analysis can be seen in 2015-2017 years, GTFP decomposition indicators, the decomposition of the basic indicators are greater than 1 , in particular green technologies and progress indicators The pure green technical efficiency index shows that the introduction of advanced domestic and foreign technologies in Henan's industrial industries during this period not only improved production efficiency, but also helped implement energy-saving and emission-reduction policies. It has a positive effect on Henan's industrial GTFP. Therefore, in recent years, Henan Province's industrial green total factor productivity generally shows an increasing trend.

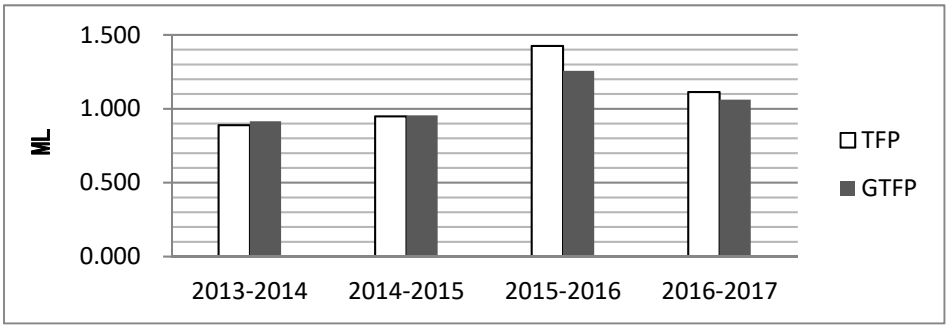

Figure 1. Comparison of the change trend of average TFP and GTFP in Henan Province from 2013 to 2017

2.3.3. Analysis of the Dynamic Change Trend of Industrial Green Total Factor Productivity in Henan Province from 2013 to 2017

Figure 1 is a comparison chart of the average TFP and GTFP index of 18 cities in Henan Province from 2013 to 2017. According to the bar chart, it can be analyzed that if the two undesired outputs of resources and environmental pollution are not included, only labor is considered (L) and capital (K) factors, Henan Province, a traditional industrial TFP calculated Malmquist index 2015 less than before or close to 1 ; 2015 after two years of industrial development trend of cities are better, Henan Province, a traditional industrial TFP of Malmquist index greater than 1 , in particular the 2015 - 2016 industrial Total Factor productivity in the years to reach 1.425 , because since 2016 since, I encourage the government to seize the national strategy to promote the supply side structural reforms, speed up industrial power conversion, Henan Province, to promote the industry as a whole It is in a growth trend, but the growth rate is not large.

Looking at the general trend of Henan green industry total factor productivity change, 2013 to 2017 years, Henan Province, 18 Industrial green TFP overall upward trend 2 015-2016 largest increase during the period. Henan's industrial green total factor productivity has basically grown steadily, but it still fluctuates. This shows that industrial pollution and energy consumption have not been completely suppressed. We are still on the path of low output and high input, so we must persist in the transformation and upgrading of industrial industries. In the future, the road of industrial development in Henan Province should pay attention to improving the level of production technology, optimizing the industrial structure, and using reasonable means to reduce pollutant emissions in industrial and economic progress. Among the driving forces of the industrial green TFP index, the improvement of green efficiency and

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the progress of green technology are both important sources of economic growth. This shows that the industry in Henan Province needs to use science and technology to promote environmental improvement and resource utilization efficiency, while increasing industrial production efficiency. In addition to industrial production efficiency, more attention should be paid to policies and measures to improve the quality of industrial production.

3. SUGGESTIONS AND CONCLUSIONS

Based on the above specific analysis of Henan Province's industrial green total factor productivity and its influencing factors, it can be seen that among the various factors affecting green total factor productivity, increase energy industry investment, increase industrial fixed capital investment, rational use of foreign capital, and increase energy conservation Protection expenditures and increased investment in R&D will help increase industrial green total factor productivity, promote the growth of industrial production efficiency in Henan Province, and ultimately achieve sustainable industrial development. Therefore, the conclusions and recommendations of this article are as follows:

(1) Increase investment in the energy industry and steadily promote the adjustment and optimization of the energy structure.

Energy industry investment has a positive relationship with the industrial green total factor productivity of cities in Henan Province. The current situation is that Henan Province has relatively serious industrial pollution, which has greatly inhibited the increase in green total factor productivity. In the future development of Henan's industry, we must adhere to the concept of low-carbon development, gradually improve the energy structure, and develop and utilize new clean energy. The next goal is to continue to promote the development of non-fossil energy and accelerate the use of natural gas. In the process of promoting clean and efficient use of coal, we must steadily develop renewable energy such as wind and solar energy, and actively promote the replacement of coal and oil with clean energy such as natural gas in industrial production.

(2) Focus on economic construction, increase labor income, and improve production efficiency and quality.

Through the analysis, it can be seen that the industrial green total factor productivity of Henan Province increases with the increase of industrial fixed capital investment. The two have a strong relationship. Therefore, it is necessary to focus on economic construction to improve the level of economic development, increase labor wages, and increase Material capital investment to increase industrial productivity. In the production process, fixed capital can maintain its original physical form for a long time, and has long-term value. As the company's production and operation activities, its value will gradually be transferred to product costs. At the same time, it can also increase the asset-liability ratio and increase the company's strength and competition. force. my country's industrial enterprises will become bigger and stronger, and they will eventually be able to feed back the economic construction and increase the industrial green total factor productivity.

(3) Increase the degree of opening to the outside world, vigorously develop the foreign economy, and rationally use foreign capital.

Reasonable use of foreign capital means not only to expand the scope of foreign capital use, but also to pay attention to the quality and efficiency of foreign capital use, to use foreign capital and technology to promote domestic technological progress, to improve the core competitiveness of Chinese enterprises, to feed back the foreign economy, and to increase foreign capital. The ability to earn foreign exchange through exports. The government can attract foreign investment by formulating preferential tax policies, creating a superior investment environment, rationally using foreign investment to promote foreign economic

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development, and combining the introduction of advanced technology, the development of export trade, and other foreign economic and technological cooperation in order to promote traditional industries more effectively. Transform into a modern green industry and bring into play the benefits of foreign capital utilization.

(4) Optimize the economic structure, adhere to the concept of green economy, and promote the development of circular economy.

Increasing expenditure on energy conservation and environmental protection is conducive to improving the industrial green total factor productivity of Henan Province. Therefore, in the future industrial development of Henan Province, the concept of green development must be established and adhered to, and energy conservation and environmental protection capabilities must be improved through technological progress. According to the needs of economic development and the degree of environmental pollution, the corresponding environmental protection regulations and standards shall be formulated and perfected, a sound environmental protection indicator system and supporting environmental pollution control system shall be established, and environmental governance and law enforcement shall be strengthened to be formed in the whole society. Paying attention to the environment of environmental protection and energy conservation is conducive to promoting the development of circular economy.

(5) Improve the ability of independent innovation and thoroughly implement the strategy of rejuvenating the country through science and education and the strategy of strengthening the country through talents.

The increase in R&D investment has greatly promoted the growth of industrial green total factor productivity in Henan Province. Therefore, in the future public budget, it is necessary to increase expenditures for improving independent innovation capabilities. The specific tasks are as follows: First, in order to promote the reform of the scientific and technological system, we must learn from the skills of the foreigners to control the foreigners, vigorously introduce foreign advanced technologies, actively participate in international scientific and technological exchanges and cooperation, and ultimately improve our independent innovation capabilities; secondly, we must create technological innovations. In a good market environment, the government can encourage innovation through transfer payments and subsidies to establish and improve the incentive mechanism for independent innovation; finally, it is necessary to establish and improve the intellectual property protection system, increase people's awareness of intellectual property protection, and increase protection of knowledge The enforcement of property rights allows the majority of innovators to have the law as a shield to protect their rights and interests, so that people have no worries about innovation.

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