

# Research on the Measurement and Evolution Path of Green Collaborative Development of Producer Services and Manufacturing in the Context of Dual Carbon

Wenzhi Zheng, Haoyu Jin

School of Finance, Anhui University of Finance and Economics, Bengbu, China

## Abstract

In the context of double carbon, along with the synergistic agglomeration of industries influenced by the two-wheel drive to create a new layout for urban industrial space, green total factor productivity has become an important measure for the quality of economic development of cities in China. This project takes the synergistic agglomeration between two industries, namely, productive service industry and manufacturing industry, as the perspective, and adopts the super-efficient DEA model to analyze the mechanism and effect of the synergistic evolution of productive service industry and manufacturing industry on green total factor productivity. In addition, we will also explore the green synergistic relationship between the two, and combine the changes of green total factor productivity, set up different policy scenarios with different policy incentives through scenario simulation analysis, and further study the impact of policy incentives, so as to propose corresponding policy recommendations.

## Keywords

Industrial Co-integration; Green Total Factor Productivity; Super-Efficient DEA Model; Scenario Simulation Analysis Method.

## 1. Introduction

### 1.1. Background of the Study

In 2015, the State Council released "Made in China 2025", which clearly puts forward "the active development of service-oriented manufacturing and productive services. Accelerate the synergistic development of manufacturing and services, promote business model innovation and business model innovation, and promote the transformation of production-based manufacturing to service-based manufacturing. Vigorously develop the productive service industry closely related to manufacturing." The "Outline of Service Economy Innovation Development (2016-2025)" released in November 2016 proposed that "give full play to the fundamental role of manufacturing industry on the development of service economy, orderly promote the two-way integration of service and manufacturing, and promote the transformation of conditional manufacturing enterprises from production to production service, and the extension of service enterprises to manufacturing links ". It can be seen that to promote the development of productive service industry and promote the coordinated development of productive service industry and manufacturing industry has been raised to the height of national strategy. General Secretary Xi Jinping announced for the first time in 2020 at the 75th session of the United Nations General Assembly that China strives to reach peak CO<sub>2</sub> emissions by 2030 and strives to achieve carbon neutrality by 2060. Carbon peaking and carbon neutrality are referred to as double carbon. The double carbon strategy is a way of life that advocates green living and low-carbon travel, reduces carbon emissions, helps guide the innovation of green technologies, and improves the competitiveness of industries in the global market. China is now gradually accelerating the adjustment of industrial structure, vigorously

developing renewable energy, and accelerating the construction of large renewable energy bases in barren areas, in an effort to take into account economic development and green transformation at the same time. The construction of the "energy conservation and emission reduction" policy system in the past has accumulated a wealth of experience in reducing carbon emissions, and now the "double carbon" target has elevated carbon reduction to a new level, with a "two-wheel drive" form of energy conservation and carbon reduction work, to adapt to the national green development policy.

As the process of globalization shifts from "globalization of goods trade" to "dematerialization of globalization", the economy shows a shift from "industrial economy" to "service economy". In 2022, Premier Li Keqiang announced to lower the GDP growth target to 5.5%, which means that China has entered a period of deceleration and shift from high speed to medium speed growth, a period of structural adjustment to optimize and upgrade the economic structure, and a period of power transformation from factor investment driven to innovation driven. According to the law of evolution of industrial structure, the time has come for the integration of productive service industry and manufacturing industry.

## 1.2. Significance of the Study

In the new era of sustainable and high-quality development of China's economy, the trend of green synergistic development of productive service industry and manufacturing industry is becoming more and more obvious. China's productive service industry started late and has a low starting point, and the development of productive service industry is still unable to meet the needs of manufacturing industry. Therefore, green synergistic evolution of productive service industry and manufacturing industry is an inevitable requirement for China to implement the new development theory in the period of new economic normal, so as to fundamentally change the situation that China's manufacturing industry is large but not strong. The International Energy Agency (IEA) said on April 20 that global carbon dioxide emissions from energy sources are expected to increase by nearly 5 percent this year, suggesting that the reduction in carbon emissions during the new crown epidemic will be unsustainable. In its Global Energy Outlook 2021 report, the IEA predicts that carbon dioxide emissions will increase to 33 billion tons this year, up 1.5 billion tons from 2020, the largest increase in more than 10 years. With such a large increase in carbon dioxide, the harm it brings is also increasing. Excessive carbon dioxide will not only cause ocean levels to rise, flooding coastal cities and damaging the natural environment and ecosystem for humans, but will also make icebergs melt and sea levels rise, so it is urgent to develop green services and manufacturing at this time.

As the key to the development stage of economic industry, the role of production service industry is becoming more and more obvious, and with the further increase of the degree of economic service, the production service industry has gradually become the leading industry in major cities. Therefore, in the current development stage, the development of manufacturing industry needs the promotion of productive service industry, and the productive service industry also needs to develop in coordination with manufacturing industry in order to better play its economic creation ability. The synergistic development of the two is of great significance to China's economic development. The synergistic development of manufacturing and productive services promotes the transformation of China's production-based manufacturing to service-based manufacturing, and vigorously develops productive services closely related to manufacturing, with the aim of adjusting the unreasonable industrial structure, promoting the synergistic development of manufacturing and productive services, realizing the double-wheel drive of the two, and improving green total factor productivity.

The coordinated development of the two industries changes the way of value realization and competition in the industries, and has an obvious role in promoting the upgrading of industrial structure. Therefore, it is necessary to study the relationship between the structural changes of

the two industries to promote further economic development, and then to study the synergistic development path of the integration of the two industries and structural changes. By studying the synergistic development mechanism of the integration of the two industries and structural change, it not only profoundly studies the mechanism of the integration of the two industries to promote industrial structural change from a theoretical perspective, but also provides effective institutional and policy guidance for enterprises, which has important guiding value.

### 1.3. Literature Review

The research on the measurement of green synergistic development of manufacturing and service industries and their evolutionary paths is relatively small in the domestic literature, but some relevant basic research results have been achieved, which promote the coordinated development of manufacturing and productive service industries from the theoretical level. Yu Wenwen[1] measured the coordinated development level of manufacturing and productive service industries by using the coupled coordination model, and found that the coupled coordination degree of the two in each region shows an increasing trend and there is obvious regional heterogeneity, geographically it is the highest in the east, followed by the central and the lowest in the west, and the synergistic development of the two has a significant promotion effect on green total factor productivity, and it is mainly caused by enhancing the technical efficiency caused. As far as the geographical factor is concerned, so as far as the appeal research results are concerned, in order to achieve the coordinated development of manufacturing and productive service industries, then the geographical issue cannot be ignored and should be adapted to local conditions, and not be generalized. Huang Shenglan, Cai Xiaohui and Fu Ming believe that different regions should give full play to their respective advantages and strengthen the integration of production service industry and manufacturing industry in industry and space based on the industrial connection[2], optimize the spatial layout of regional production service industry and manufacturing industry under the promotion of government, improve the value chain of production service industry and manufacturing industry, and form an industrial chain with regional characteristics. This provides a development path to guide us to study the manufacturing industry and productive service industry.

Dou, Jianmin, and Liu, Ye argue that although there is variability across regions, in general, the synergistic agglomeration between these two industries increases environmental pollution in the short term, which suggests that this agglomeration may inhibit green growth efficiency by increasing environmental pollution[3]. However, Ji, Xiangyu, and Gu, Naihua suggest that the synergistic agglomeration between these two industries has a catalytic effect on the innovation efficiency of both enterprises and cities, which suggests that this agglomeration will enhance the regional green growth efficiency through the innovation path[4]. The above two research ideas suggest the way in which the coordinated development of manufacturing and productive services affects green total factor productivity in both the short term and innovation. However, in a comprehensive view, even if the synergistic development of the two industries suppresses green total factor productivity in the short term, the coordinated development of the two industries will have a positive external effect on green total factor productivity, both from the perspective of innovation and in the long term. thus will eventually enhance green total factor productivity.

## 2. Research Methodology

### 2.1. Literature Research Method

Through studying the relevant domestic and foreign literature in this field, we understand the current research results. The mutual promotion role of productive service and manufacturing industries in the double carbon background is clarified, which further deepens the

understanding of the double carbon background boosting service industry and facilitates further research on the topic.

2.2. Field Survey Method

Through the field survey, we can grasp the basic status of the integration of productive service and manufacturing industries through green total factor productivity in cities. We interviewed professionals to obtain the development status of the integration of productive service and manufacturing industries in the context of double carbon, which makes the study more relevant.

2.3. Contrast Analysis Method

After the model design and construction, the green factor productivity levels between the whole country and regions, and between regions are compared and analyzed to show the development status and law of green total factor productivity in cities, and to make an objective analysis and evaluation of the integration of productive service and manufacturing industries under the current double carbon background based on the analysis of the comparison results.

2.4. Qualitative Analysis Method

We analyze the "qualitative" aspects of the green total factor productivity, use inductive and deductive methods, analysis and synthesis, and abstraction and generalization to process the data on the scale of coaggregation and the green total factor productivity measurement data, and reveal the effect of coaggregation of productive service and manufacturing industries on green total factor productivity. productivity, and the mechanism and role in it.

3. Measurement of Green Synergy Development between Productive Service Industry and Manufacturing Industry

To further evaluate the green development status of productive service and manufacturing industries, this paper uses green total factor productivity to account for it. Neoclassical economic growth theory believes that productivity growth is an important engine of economic growth. Total factor productivity is relative to the traditional single factor productivity such as labor productivity and capital productivity, and it highlights the growth of economic growth that is triggered by technological progress and efficiency improvement in addition to the growth of input factors[5]. Therefore, total factor productivity is more reflective of the quality of economic growth. And with the prominence of environmental externalities, more and more studies have argued that environmental effects should be included in the accounting of economic growth, and that the emission of environmental pollution should be considered as a negative product of economic growth, leading to the concept of green total factor productivity[6].

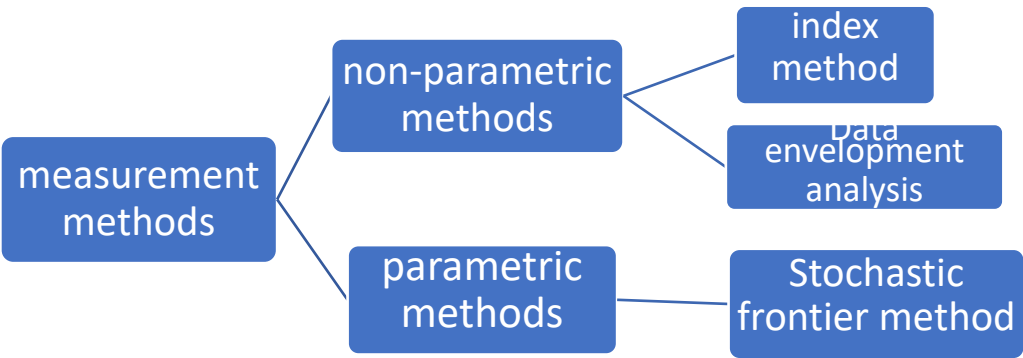


Figure 1. Method classification diagram

In recent years, a relatively uniform understanding of the concept and measurement of green total factor productivity has emerged. It is generally believed that accounting for green total factor productivity should treat energy input as one of the input factors, while treating environmental pollution emissions as a non-desired output of growth, i.e., bad output. In terms of measurement methods, research now basically extends the measurement model of total factor productivity, which can be divided into two categories: parametric and non-parametric methods, as shown in the figure 1.

### 3.1. Green Total Factor Productivity Measurement Model

Based on the analysis of the advantages and disadvantages of the above methods, this paper also uses data envelopment analysis (DEA) to account for the green total factor productivity per unit of productive services and manufacturing industries, considering the differences in the construction of production functions between productive services and manufacturing industries, which makes it difficult to set the specific form of production functions when they are constructed. The data envelopment analysis (DEA) method uses maturity planning to solve the problem, which does not require high quantitative rigidity for inputs and outputs and does not require prior determination of the weights of each indicator, which can avoid subjective defects of human determination and also effectively avoid the problem of inconsistent quantitative rigidity when dealing with indicators by parametric methods[7].

This paper measures the green total factor productivity of productive service and manufacturing industries based on the SBM model. Therefore, this paper constructs a green total factor productivity evaluation model based on provincial and municipal panel data by considering each provincial and municipal area's productive service industry or manufacturing industry as a decision unit respectively and introducing expected output and non-expected output.

The directional distance function (DDF) can customize the projection direction of the DMU to the frontier, and the projection direction defined by the function is determined by the direction vector, including the input direction vector and the output direction vector, and the output direction vector in the directional distance function (DDF) can include the desired output[8]. Therefore, it is applicable and feasible to choose the directional distance function for production set construction to measure green total factor productivity, assuming that each decision making unit (DMU) includes  $n$  kinds of inputs  $x$ , which will produce  $m$  kinds of expected outputs  $y$  and  $r$  kinds of non-expected outputs  $u$ , counting as

$$x = (x_1, x_2, \dots, x_n)$$

$$y = (y_1, y_2, \dots, y_m)$$

$$u = (u_1, u_2, \dots, u_r)$$

Then assume that the possible set of production at time  $t$   $P^t(X)$  is

$$P^t(X) = \{(y^t, u^t): x \text{ 生产 } (y^t, u^t)\}$$

This production possibility set should satisfy the requirements of closed and bounded sets, free disposition of desired output and inputs, weak disposition of total output and the null hypothesis theorem, on the basis of which, considering the possible errors in efficiency measures arising from the non-contemporaneous characteristics of the technology, it can be modeled using data envelopment analysis (DEA).

where  $\lambda_k^t$  denotes the weight of the input and output values of the  $k$ th decision unit in period  $t$ .  $\lambda_k^t \geq 0$ , the scale payoff of production technology is constant, the  $\sum \lambda_k^t = 1$ ,  $\lambda_k^t \geq 0$ , the above equation is regarded as the global production technology set.



$$P^t(X) = \begin{cases} (y^t, u^t) \sum \lambda_k^t y_{kn}^t \geq y_n^t \\ \sum \lambda_k^t x_{km}^t \leq x_m^t \\ \sum \lambda_k^t u_{kr}^t = u_r^t \\ \sum \lambda_k^t = 1, \lambda_k^t \geq 0 \end{cases}$$

### 3.2. Indicator Selection and Data Sources

As mentioned earlier, manufacturing industry is the main source of environmental pollution emissions in China, and its negative environmental output categories are more numerous and vary greatly among different subdivided industrial sectors, while productive service industries are mostly knowledge, capital and information-intensive industries, and their negative environmental output effects are relatively simple in terms of industrial nature. On the other hand, the statistics of environmental pollution emission data in China's existing statistics also focus on industrial manufacturing industry, therefore, in order to compare the green development of productive service industry and manufacturing industry, considering the availability of data, this paper chooses carbon emission as the non-expected output of green total factor productivity and industrial value added as the green total factor productivity for the industrial differences between productive service industry and manufacturing industry. The expected output of green total factor productivity.

In terms of input factors, since 2010, the development of manufacturing industry has also entered the process of shifting to high-end manufacturing, and industries such as precision electronics and equipment manufacturing have become increasingly important in the manufacturing industry, and the manufacturing industry has also undergone a period of structural adjustment, but there is still great variability among the industrial sectors. In this paper, in order to unify the measurement scale of green total factor productivity of productive service and manufacturing industries, labor, capital and energy consumption are still selected as input factors.

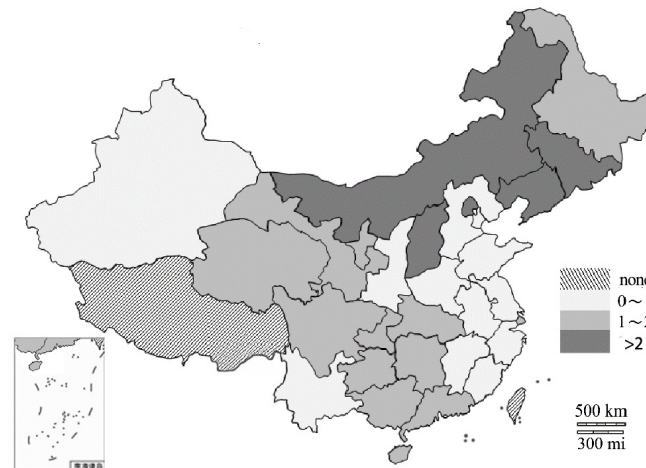
Since China had an industrial sector adjustment in 2004, in order to maintain the consistency and accuracy of the data, this paper takes 2004 as the base year, because the SBM model requires the use of panel data, this paper collects data on the above indicators by province, and in view of the lag of energy consumption and other data, in order to unify the standards, this paper collects data on the corresponding indicators from 2004-2017 for 31 provinces and regions across China. The data of energy consumption and carbon emissions in some provinces and regions are missing, so they are excluded from the calculation to obtain the green total factor productivity data of regional productive service and manufacturing industries in China. The data collected in this paper are from the China Statistical Yearbook, the Energy Statistical Yearbook, and the statistical yearbooks of each province and region.

## 4. Exploring the Current Situation and Evolutionary Path of Green Synergy between Productive Service Industry and Manufacturing Industry

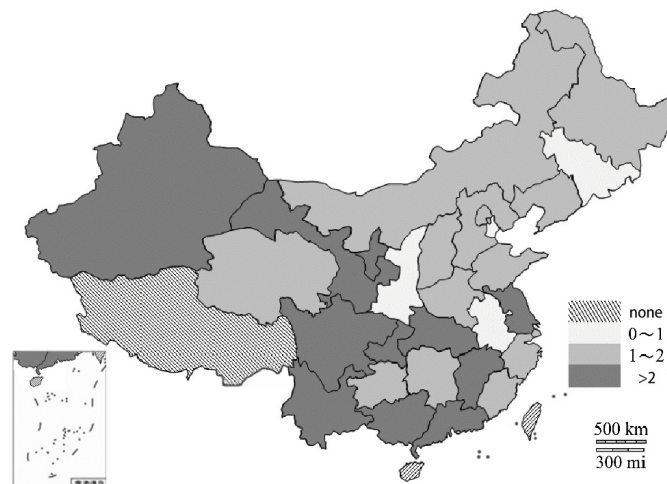
### 4.1. Analysis of the Current Situation of Green Development of Productive Service Industry and Manufacturing Industry

We analyze the evolution of production service industry and manufacturing industry from the perspective of the development of China's industrial structure, and compare and analyze the differences of green total factor productivity between production service industry and manufacturing industry and the differences of their regional distributions in different

provinces and regions of China from the perspective of synergistic agglomeration between production service industry and manufacturing industry. From the above results, we can see that there are great regional differences in the green total factor productivity of production service industry and manufacturing industry in China. According to the criteria of green total factor productivity measurement, green total factor productivity values less than 1 are considered inefficient, and those greater than 1 are considered efficient, then the following regional distribution map can be obtained.



**Figure 2.** National green total factor productivity of manufacturing industry



**Figure 3.** National service industry green total factor productivity

From the above comparison, it can be seen more intuitively that the green total factor productivity level of production service industry in each province and region of China is significantly better than that of manufacturing industry, and there are significant regional differences.

The provinces with green total factor productivity of manufacturing industry greater than 1, for the efficient state are mostly the provinces whose economic development level does not rank in the top, the higher provinces are Beijing, Inner Mongolia Autonomous Region, Jilin, Liaoning and Shanxi Province, followed by Gansu, Qinghai, Sichuan, Chongqing, Guangxi, Guizhou, Guangdong, etc., which are located in the central and western regions. Among them, Beijing has been committed to the development of productive service industry, and its service industry has accounted for more than 70% of GDP, and its productive service industry has accounted for more than 70% of service industry, making it the first province and city in China to step into

service orientation. The green total factor productivity of the manufacturing industry in the traditional eastern coastal regions of China with more developed economic development, on the other hand, is in a relatively inefficient state, with values less than one, indicating that there is still a long way to go for the green development of the manufacturing industry in these provinces. Further detailed analysis of the values of these regions in each year shows that in recent years, the green total factor productivity of manufacturing industries in these provinces has mostly entered the category of efficiency, but the inefficiency level in the early years is more obvious and pulls down the mean score level.

The green total factor productivity of production service industry shows less similar characteristics to that of manufacturing industry. The average value of green TFP of production service industry is greater than 1 in most provinces and cities in China, and only three provinces and cities in Anhui, Shaanxi and Heilongjiang have green TFP less than 1, i.e., they are at relatively inefficient level. The green total factor productivity levels of the provinces with the highest average green total factor productivity in manufacturing are also in the efficient range, but the values are ranked between (1, 2), while the provinces with the average green total factor productivity in manufacturing are in the second echelon, and their average green total factor productivity in production services is greater than 2, ranking in the first echelon. The average value of green total factor productivity of the production service industry in the economically developed eastern coastal region exceeds 1, i.e., it is in a relatively efficient state, among which, the average value of green total factor productivity in Jiangsu exceeds 2, indicating that the green development of the production service industry in the economically developed eastern coastal region is better than that of the manufacturing industry. It can be seen that the green development of manufacturing and production service industries is relatively unbalanced in most provinces and regions, and the synergy between production service industries and manufacturing industries is not high on the road of "greening".

#### **4.2. Exploring the Path of Synergistic Evolution of Productive Service Industry and Manufacturing Industry**

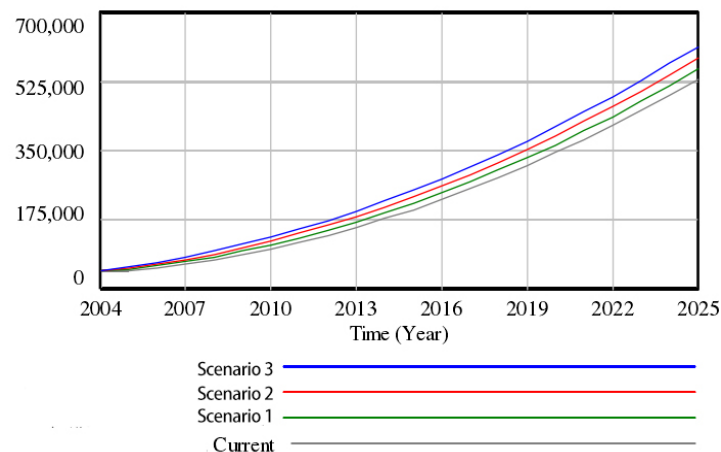
By constructing a dynamics model of the green synergistic development system of productive service and manufacturing industries and running the model to 2025 respectively, the effects of different environmental regulations on the green synergistic development system of productive service and manufacturing industries are simulated and the corresponding effects are analyzed. In this paper, we set up an environmental regulation policy scenario with economic incentives, and observe the rate of change of value added of production service industry and value added of manufacturing industry by adjusting the parameters of different variables in the model. current model is a simulation of the system based on historical values, and it is used as a control group to compare and analyze the changes with other scenario models. The economic incentive scenario is to study the impact of stimulus-based economic policies on the green synergistic development of productive service and manufacturing industries through the perspective of economic incentives, which is achieved by changing the GDP growth rate in this paper. Scenario 1, Scenario 2, and Scenario 3 are designed according to the economic stimulus from weak to strong, and three models.

Scenario 1: GDP growth rate increases to 6.5% from the original 6%.

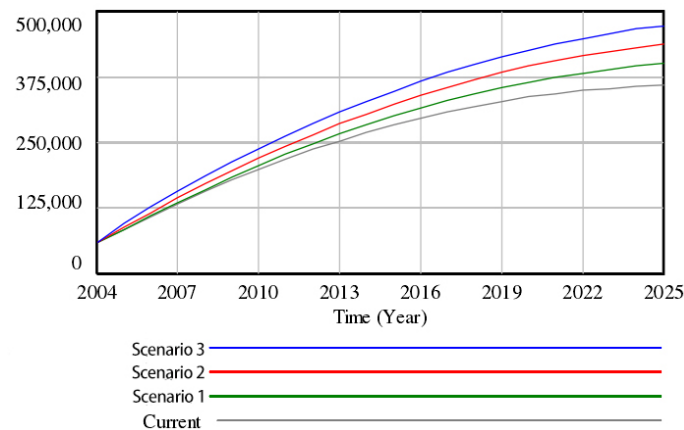
Scenario 2: GDP growth rate increases to 7% from the original 6%.

Scenario 3: GDP growth is increased to 7.5% from the original 6%.





**Figure 4.** Comparison of changes in producer services



**Figure 5.** Comparison of changes in manufacturing industry

The simulation results show that the GDP growth rate of green synergistic development scenarios 1-3 development mode of productive service industry and manufacturing industry gradually increases, which has a significant contribution to the value added of productive service industry, value added of manufacturing industry, total energy consumption and carbon emission. In terms of productive service industry, the value added of productive service industry in 2025 increases from 532184.36 billion yuan in control group Current to 614838.01 billion yuan in scenario 3, an increase of 15.44%. The value added of manufacturing industry in 2025 increases from RMB 35858684 billion in the control group Current to RMB 472668.20 billion in Scenario 3, an increase of 31.81%. With the increase in production services and manufacturing output, total energy consumption also increases from 5007.908 million tons in the control group Current in 2025 to 5568.793 million tons, an increase of 11.20%. Although GDP growth has also led to increased investment in science and technology, improved energy efficiency and technology, and effectively increased energy utilization and optimized energy structure, in terms of results, China's economic development has always been based on the idea of development before optimization and governance. The reasons for the intensification of energy consumption are: (1) while the government emphasizes the deepening of energy system reform, there are still some regions where the proportion of coal and fuel oil energy consumption will grow too fast, not only limited to the resource endowment structure and immediate needs, the crude economic growth deepens the dependence of industrialization on fossil energy, the distorted price system makes the scarcity of resources and environmental externalities are seriously underestimated, while the renewable energy The technology,

infrastructure and policy bottlenecks of renewable energy have been slow to break through; (2) The existence of the rebound effect makes the energy savings from technological progress or energy consumption provision partially or completely offset, resulting in lower-than-expected energy savings and thus reducing the effectiveness of government policies. Ai Mingye et al. concluded that the energy rebound effect in China's petrochemical industry was at 32.23%[9]. Chen Hongtao et al. argue that the rebound effect of energy consumption of urban residents in China offsets 70% of the energy savings from technological progress[10]. The growth of carbon emissions driven by energy consumption. Total carbon emissions from energy consumption in Scenario 3 will rise to 1,694,578,000 tons in 2025, an increase of 347,415,000 tons, or 25.78%, compared to the control group Current's 1,471,325,000 tons. Observing the growth rate of carbon emissions shows that the growth rate of carbon emissions in each scenario is gradually slowing down, but the total amount is still rising, and the peak of carbon emissions is expected around 2030.

## 5. Conclusion and Recommendations

This paper presents here some suggestions in order to promote the green and coordinated development of manufacturing and productive services:

1. Deepen the reform of institutional mechanism, provide institutional guarantee for the synergistic development of manufacturing and productive service industries, because the coordinated development of the two industries is still in the exploration stage, which can not avoid the cost of trial and error, then most of the losses caused by failure is not want to see but inevitable, so the construction of a guarantee system is necessary.
2. Further improve the taxation system, reduce the proportion of taxation in the production service industry, and guide the synergistic development of manufacturing and production service industry in the form of taxation preferential policies, which can not only reduce the cost of developing production service industry for enterprises, but also promote the coordinated development of the two industries.
3. Due to the influence of geographical factors, achieving the coordinated development of the two industries may break the current industrial distribution pattern, so a reasonable industrial transfer policy needs to be formulated to ensure that the transfer between regions can be carried out successfully, and in addition, through industrial transfer, the coast transfers advanced technology and talents to the inland, and the inland provides a broad market. The industrialization of service industry requires the manufacturing industry to continuously strengthen the feedback to the productive service industry, so as to improve the operational efficiency of both industries and jointly enhance the green total factor productivity.

## Acknowledgments

Funded by Anhui University of Finance and Economics Undergraduate Scientific Research Innovation Fund Project (XSKY22013ZD).

## References

- [1] Yu W.W., Tian W.D., Hong Chenxiang. The impact of synergistic development of manufacturing and productive service industries on total factor productivity--an empirical study based on 31 provinces in China[J]. Economic Research Reference, 2021, No.2973(05):53-71.
- [2] Huang Shenglan, Cai Xiaohui, Fu Mingjuan. Research on the synergistic development of productive service and manufacturing industries in Jiangxi under the new economic normal[J]. China Collective Economy, 2022, No.695(03):32-33.

- [3] Dou Jianmin, Liu Ye. Whether synergistic agglomeration of production service and manufacturing industries can promote economic growth--based on panel data of 285 prefecture-level cities in China[J]. *Modern Finance and Economics*, 2016, 36(04):92-102.
- [4] Ji Xiangyu, Gu Naihua. Does the synergistic agglomeration of productive service industry and manufacturing industry have innovation-driven effect[J]. *Journal of Shanxi University of Finance and Economics*, 2020, 42(07):57-70.
- [5] Chen Shiyi. China's green industrial revolution: an explanation based on environmental total factor productivity perspective (1980-2008)[J]. *Economic Research*, 2010, 45(11): 21-34.
- [6] Li Ling. Research on Green Total Factor Productivity and Influencing Factors in Chinese Industry [D]. Jinan University, 2012.
- [7] Chung Y H, Fare R, Grosskopf S. Productivity and undesirable outputs: a directional distance function approach [J]. *Management*, 1997, 51(3): 229-240.
- [8] Takehiro Fukuyama, Takahiro Kozawa, Hiroki Yamamoto, Seiichi Tagawa, Makiko Irie, Takeyoshi Mimura, Takeshi Iwai, Junichi Onodera, Ichiro Hirosawa, Tomoyuki Koganesawa, Kazuyuki Horie. Effect of Polymer Protection and Film Thickness on Acid Generator Distribution in Chemically Amplified Resists[J]. *The Society of Photopolymer Science and Technology (SPST)*, 2009, 22(1).
- [9] Ai, Mingye, Li, Chengxiang, Why energy consumption in China's petrochemical energy industry continues to increase - A rebound effect and factor substitution perspective[J]. *Journal of Beijing University of Technology*. 2017, 19(5):1-9.
- [10] Chen, H. T., Yue, S. J., Zhu, Y. T., Is there a rebound effect in point quantity consumption of urban residents in China? [J]. *China Mining University Journal of Science*. 2019, (4): 71-83.