

# Research on the Tax Policy Effect of Promoting Industrial Green Transformation and Upgrading under the Background of Double Carbon: An Analysis Based on Green Total Factor Productivity Data

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**Abstract:** Taking the promotion of tax policy as the starting point, this project explores the mechanism of tax policy in promoting industrial green upgrading and energy conservation and emission reduction on the basis of literature induction and combing, and combines the relevant data of 30 regions in China from 2008 to 2021 to build an SBM model to measure the process of regional green total factor productivity, and empirically analyze the impact effect of tax policy on industrial green upgrading. Focus on the effects of different calibers of green tax policies on the improvement of green total factor productivity; The interaction of different technological progress paths with green taxation. The research in this project will help deepen the understanding of tax policies that promote the green transformation of the industry, and help to reduce carbon emission intensity and achieve green development in the new development stage.

**Keywords:** Green taxation industrial upgrading SBM model green total factor productivity.

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## 1. Introduction

China's economic development has a long-term dependence on land resources and environment blind high input and high consumption model, this low-level extensive economic model is not conducive to the realization of high-end industrial cluster industries, nor is it conducive to solving the problem of resource development constraint effect and environmental protection. As we all know, the market-oriented economic transformation and upgrading brought about by the rapid development of the manufacturing industry not only needs macroeconomic policies to guide the economy, but also needs to be led by the government to have a set of more sound, mature, and orderly ecological environment market mechanism system as a guarantee for economic development. As an important lever to regulate social and economic policies, the green tax system can economize the environmental problems of enterprises with high emission pollution, and can better reduce or even eliminate the high pollution behavior of enterprises from the level of laws and regulations and sources. At the same time, these huge positive stimuli and effects brought about by the green tax policy will force traditional enterprises to pay attention to the overall greening of social production practice activities and their specific links by driving the change of domestic business philosophy and social production development mode, that is, emphasizing the natural environmental protection of the use of material resources. The overall high degree of environmental protection of the manufacturing industry will inevitably put forward higher specification standards for the materials commonly used by China's upstream and downstream manufacturing and processing enterprises, thus forming a continuous high level of green technology requirements and product green standards for the manufacturing industry value chain in the whole factor life cycle of the manufacturing industry. In addition, the green tax model will also have a positive effect on the resource

allocation model of social organizations. Green tax policies have a direct impact on the ecological and economic benefits of the development of environmental pollution enterprises, through the "invisible hand" of taxation to curb the development of high-polluting emission enterprises, so that private capital and social capital can flow more into environment-friendly enterprises.

## 2. Literature Review

### 2.1. Research on The Evaluation System of Industrial Green Transformation

Regarding the connotation of China's green economy transformation theory, the academic community has given a certain scientific value interpretation of theoretical cognition accordingly, but the methodology of empirical research and evaluation that is relatively clear and unified within it and standardized and complete has not yet been formed. Previously, in the new round of the United Nations Environment Programme's 12th Five-Year Plan, the second round of the World Bank's medium- and long-term special action planning, and even the National Bureau of Statistics have issued a series of important development evaluation system indicators and research projects on the transformation and upgrading of the manufacturing industry, none of them mentioned that the manufacturing process environment, resource element control and other elements have been included in the factor system of enterprise implementation of green industrial transformation and development performance evaluation and assessment. Shi Fengguang (2015) established an SBM model that included the influencing factors of undesirable economic output to measure the green level of inter-provincial industry in China and improve the social factor productivity of the whole region, and concluded that the green transformation efficiency in the eastern region was significantly higher than that in the central and western regions. Not only that, but it will also be found that the green development transformation of the

manufacturing industry is also vulnerable to some other social factors. Zhu Dongbo (2020) concluded that the important factors affecting the greening transformation process of some industrial structures may include two main factors, such as environmental regulation and technological innovation, but the synergistic effects of the above two are ultimately more conducive to the green transformation process of the entire industrial structure.

## **2.2. Research on the Impact of Green Taxation on Industrial Transformation**

There has always been controversy over the role of green taxation in the green transition to manufacturing. The analysis in the research report of He Na (2018) et al. found that there are obvious heterogeneity differences in the collection mechanism of environmental protection tax in the manufacturing economy, and the introduction of the environmental protection tax mechanism itself is not conducive to the improvement of innovation ability and comprehensive upgrading of industrial technology in the manufacturing industry. Gan Xingqiong (2019) and other scholars have found that the total tax revenue in the process of transformation and upgrading of the secondary industry also plays a positive role in the process of transformation and upgrading, but it plays a negative role in the transformation and upgrading of the tertiary industry structure. Wang Xiaoming et al. (2016) and others also analyzed and found that China is currently actively encouraging all kinds of high-tech enterprises to carry out technology product application and research and development, and one of the better economic and effective transfer practices adopted in the practice of supporting the green development and innovation of domestic traditional advantageous enterprises in the economic transformation is that the government actively guides the implementation of preferential tax policies for specific enterprises. In general, there is still uncertainty about the direct driving role of the government's green tax intensity indicators involved in the government's policy of promoting the green sustainable development of modern manufacturing and the transformation-driven development policy. Therefore, the implementation of green tax policies should be based on multi-faceted factors such as the policy itself and the public's demands, and cannot be considered only in terms of the "Porter effect" or the "squeeze out effect".

## **2.3. Analysis of Tax Policy Mechanism**

The empirical evaluation and analysis of the relevant policy effects of the current establishment of a green tax system in China by scholars at home and abroad mainly focuses on the specific environmental protection effects and economic effects brought about by them. Fu Sha et al. (2018) found that in order to exert the green effect of taxation in the future, Fu Sha et al. (2018) found that in order to exert the green effect of taxation in the future, it is necessary to gradually incorporate the tax energy conservation and emission reduction targets and the relevant national environmental protection and measure system into the environmental comprehensive capability evaluation and inspection evaluation standard system. Zhang Tongbin (2017) proposed that resource and environmental policies or regulatory economic measures are positively correlated with the current expected level of domestic economic growth, and long-term gains will make up for their short-term interest losses. The analysis presented by Xuan Chen et al. (2020) using the

systematic GMM model concluded that the current formal and informal technological environmental policies are critical to the industrial transfer in these regions.

## **3. Mechanism Analysis and Hypothesis Interpretation**

### **3.1. Explanation of the Role of Green Taxation in The Green Transformation of The Manufacturing Industry**

#### **3.1.1. Direct Impact of Green Taxation**

At present, China emphasizes the green transformation direction of the manufacturing industry for ecological and economic efficiency, and green taxation is divided into environmental taxes on enterprises that pollute the environment and tax subsidies for the green transformation of enterprises. In recent years, the tax department has actively participated in the construction and implementation of a policy structure with environmental protection as the mainstay and green tax subsidies as a supplement, helping the comprehensive green transformation of economic and social development.

The purpose of improving the environment through environmental taxes is the first operation to develop environmental taxes; Although the environmental tax increases the cost burden of enterprises, this can further promote the green transformation of the manufacturing industry through the expansion of production costs, eliminate manufacturers with low market resource utilization efficiency and environmental pressure through the extrusion effect, improve the efficiency of market resource utilization, and improve the ecological environment of the manufacturing industry.

The data are all from the National Bureau of Statistics, and the revenue of environmental protection tax in 2020 and 2021 is 21.32 billion yuan and 19.64 billion yuan, respectively. This shows that the pollution emissions of the manufacturing industry continue to decrease, the green manufacturing industry continues to develop, and the green tax such as the environmental tax has an obvious effect on the green transformation of the manufacturing industry. The data shows that the green tax with environmental tax as the main body has brought obvious emission reduction effects, as well as related green preferential policies, which have stimulated the enthusiasm of enterprises for the transformation and development of green industries and effectively guided enterprises to carry out active structural upgrading. Secondly, tax subsidies are provided for the green upgrading of the manufacturing industry to reduce the production costs of enterprises, and enterprises will obtain more funds to transform and upgrade. On the basis of the updated and issued guidelines on preferential tax policies in recent years, the State Administration of Taxation has issued the Guidelines on Preferential Policies for Taxes and Fees to Support Green Development, which provides preferential tax policies for supporting the transformation of green development.

In summary, green taxation has an important impact on the current construction of green manufacturing.

#### **3.1.2. Indirect Impact of Green Taxation**

The purpose of tax policies such as sewage charges and environmental taxes is to make the manufacturing industry green transformation, and enterprises will upgrade their production in order to reduce production costs and obtain

national green tax subsidies, on the one hand, to improve the effective use of resources by enterprises and reduce the production pressure of enterprises; On the other hand, after the industrial upgrading of enterprises, the advantages of human resources will continue to expand, reduce human resource costs, and improve profit margins. The improvement of profits in turn has a positive impact on the green upgrading of the industry.

### 3.1.3. The Hypothesis Is Proposed

As described above, the "extrusion effect" and "collective effect" provide a theoretical basis for green taxation to transform the manufacturing industry green. The "crowding out effect" is mainly that green taxes increase the tax burden of enterprises, consume transformation funds, and hinder the green transformation of the manufacturing industry. But the "pooled effect" is the opposite, and green taxes promote green transformation.

Hypothesis 1: The implementation of green tax policies can have a positive effect on the green transformation of the manufacturing industry.

## 3.2. Measurement of Indicators for Green Transformation of Industrial Structure

### 3.2.1. Calculation Model and Index Selection

This article defines the criteria for how to make a green transition for manufacturing people as the unification of economic and environmental perspectives. Viewing environmental damage as an unintentional output, examining its output ratio to the production factors of enterprises, that is, using green total factor productivity to measure the degree and efficiency of the green transformation of the manufacturing industry.

### 3.2.2. SBM Model with Undesired Outputs

Expressed as N input elements; Expressed as M type of willingness to produce; It is expressed as K kinds of non-voluntary outputs, and the input factors, willing outputs, and non-voluntary outputs in the t-year of the i region are expressed as; Represented as positive and negative effect vectors, and represented as remaining vectors. Provinces can be represented based on a function SBM model with positive and negative effects that contain unintended outputs

$$pS_v^t(x_i^t, y_i^t, b_i^t, g^x, g^y, g^b)y = \frac{1}{3} \max \left[ \frac{1}{N} \sum_{n=1}^N \frac{S_n^x}{g_n^x} + \frac{1}{M} \sum_{m=1}^M \frac{S_m^y}{g_m^y} + \frac{1}{K} \sum_{k=1}^K \frac{S_k^b}{g_k^b} \right]$$

$$s.t. \lambda Y - S_m^y = y_{im}^t, \check{m}; \quad \lambda B + s_k^b = b_{ik}^t, \check{k}; \quad \lambda X + s_n^x = x_{in}^t, \check{n};$$

$$\lambda \geq 0, \quad \lambda l = 1; \quad s_n^x \geq 0, s_m^y \geq 0, s_k^b \geq 0$$

### 3.2.3. Luenberger Productivity Indicators

In most models, the Malmquist-Luenberger index reflects changes in the productivity of enterprises. This paper draws on the practice of the usual model, adopts the changing Luenberger productivity, and examines the time change results from the t period to the t+1 period of provinces and regions. Here's how:

$$LTFP_t^{t+1} \frac{1}{2} \{ [\overline{S}^{t+1}(x^t, y^t, b^t; g) - \overline{S}^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}; g)] + [\overline{S}^{t+1}(x^t, y^t, b^t; g) - \overline{S}^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}; g)] \}$$

When the LTFP is greater than (less than) 0, the green total factor productivity of this period has increased (decreased) compared with the previous period. Both decomposition indicators also take 0 as the criterion to investigate the change of the adjacent period of the corresponding index.

### 3.2.4. The Selection of Measurement Indicators

(1) Investment indicators. Human resources, capital stock, and production momentum are indispensable elements for enterprise production, so the three are defined as input factors. Based on the focus of this article on Chinese manufacturing enterprises, the average number of employees in the entire industry in the manufacturing industry represents the human resource element, and the stock of fixed assets is the capital factor from the official website of the China Bureau of Statistics in previous years. In addition, the industrial kinetic energy consumption value of each region represents energy input. The specific data of human resources, capital stock and kinetic energy consumption are all derived from the data of the National Bureau of Statistics from 2016 to 2021.

(2) Output indicators. In this paper, the increase in output measured by province and region is the intended output. For the statistics of unintended output, industrial pollution such as industrial wastewater is calculated and weighted by the assignment method, and the environmental pollution index is comprehensively calculated. The steps are as follows:

Standardized treatment of forward indicators:

$$X_{ij} = \frac{X_{ij} - \min_{ij}}{\max_{ij} - \min_{ij}}$$

Calculation of the weight of industrial three wastes:

$$P_{ij} = X_{ij} / \sum_{i=1}^{30} X_{ij}; e_j = -\frac{1}{\ln(30)} \sum_{i=1}^{30} P_{ij} * \ln(P_{ij}); d_j = 1 - e_j; w_j = d_j / \sum_{j=1}^3 d_j$$

Comprehensive calculation of pollution index:

$$S_i = \sum_{j=1}^3 w_j * P_{ij}$$

The green total factor productivity involved in this paper regards environmental pollution as a kind of unintended output in the calculation process, and examines its ratio with human resources, capital stock, kinetic energy and enterprise output, that is, using green total factor productivity to evaluate the efficiency of green construction in manufacturing and improve the accuracy of data results. Finally, according to the results of the model operation, the relevant theories of green taxation are formed, and the development decision-making suggestions are put forward for real enterprises according to the model data.

### 3.2.5. Analysis of Measurement Results

Based on the above indicators, the calculation results are summarized as shown in the following figure.

**Table 1.** Green total factor productivity and decomposition indicators of China's manufacturing industry from 2016 to 2021

Year	Green Factor Productivity LFTP	Pure Technology Advances LPTP	Pure Technology Efficiency Changes LPEC
2016	0.0989	0.0440	-0.0064
2017	0.1356	0.0630	0.0013
2018	0.1467	0.0860	0.0067
2019	0.1536	0.1240	0.0236
2020	0.2420	0.1456	0.0450
2021	0.2830	0.1650	0.0690
mean	0.1766	0.1046	0.0232

(1) The national average green total factor production efficiency is about 0.1766, showing an upward trend, but the upward span is not large, that is, the industry as a whole is moving towards the green and the economy, but the progress is slower than that of other countries.

(2) The rate of change of pure technological progress accounts for the overall upward trend of the progress weight of green production factors, indicating that the national technological level has risen steadily and has brought positive effects to the green transformation of the manufacturing industry.

(3) By comparing the differences between provinces, economically developed areas tend to have higher data, and economically underdeveloped areas tend to have lower values.

## 4. Variable Selection and Model Design

### 4.1. Variable Selection

(1) Interpreted variables. Green Transformation of Manufacturing: This paper LFTP measures the efficiency of green transformation in the manufacturing industry.

(2) Explanatory variables. Green taxation in a broad sense: sewage charges levied to protect the environment. middle green taxation, which refers to the removal of some unimportant types of taxes on the basis of generalized taxation. Green tax in the narrow sense: only refers to the tax

revenue of sewage charges. The data is from the relevant survey of the China Bureau of Statistics from 2016 to 2021.

(3) Control variables. Green demand ---- the consumption income of new products of enterprises in various regions; Patented technology ---- the number of national patents of enterprises in each region; Environmental regulation ---- the amount of local industrial pollution control restrictions imposed by regional governments.

### 4.2. Model Design

First build the model 1-1 to see the relationship between green taxes of different calibers and all green elements Secondly, according to the above analysis, the impact of technological progress is greater, so build model 1-2 to analyze whether green tax policies have a positive effect on technological progress. The model is built as follows:

$$LTFP_{it} = \delta_0 + \delta_1 \times g_{tax_{it}} \text{ or } m_{tax_{it}} \text{ or } n_{tax_{it}} + \delta_2 \times \text{ControlVariables} + u_{it} + \tau_{it} + \mu_{it} \quad (\text{model1-1})$$

$$LPTP_{it} = \delta_0 + \delta_1 \times g_{tax_{it}} \text{ or } m_{tax_{it}} \text{ or } n_{tax_{it}} + \delta_2 \times \text{ControlVariables} + u_{it} + \tau_{it} + \mu_{it} \quad (\text{model1-2})$$

## 5. Empirical Analysis

### 5.1. Descriptive Statistics

**Table 2.** Descriptive statistical analysis results

Variable Name	Mean	Standard Error	Min Value	Maximum	Number of Samples
LTFP <sub>it</sub>	0.0513	0.1056	0.3214	0.5324	
g <sub>tax<sub>it</sub></sub>	532.2530	386.6729	14.745	2036.7523	
m <sub>tax<sub>it</sub></sub>	325.5162	6.7845	1763.3730	1689.4740	
n <sub>tax<sub>it</sub></sub>	4.7853	6.6233	0.4561	23.3064	
gd <sub>it</sub>	356.3246	526.3264	0.7532	2864.6523	
th <sub>it</sub>	14.0582	23.7764	0.9831	146.3480	
er <sub>it</sub>	2.0456	1.8845	0.0365	13.1462	

The content of the analysis table can be learned that, first, the standard error value of green total factor productivity is small, and the gap between the minimum and maximum values is not very large, which can reflect that green taxation has a certain improvement in the efficiency of China's manufacturing industry transformation, but the impact is not very large, and the overall change range has not been faulty; Second, the standard error of the three indicators of generalized taxation, green taxation and patent technology is large, and the maximum and minimum values are extreme, in order to eliminate the impact of different dimensions, the

analysis below will do logarithmic processing of the above indicators.

### 5.2. Basic Analysis of The Role of Green Taxes of Different Calibers on The Green Transformation of The Manufacturing Industry

The basic regression results of green tax policies of different calibers are as follows:

**Table 3.** Basic regression results of green taxation on green total factor productivity and pure technological progress

variable name	LTFP <sub>it</sub>	LTFP <sub>it</sub>	LTFP <sub>it</sub>	LPTP <sub>it</sub>	LPTP <sub>it</sub>	LPTP <sub>it</sub>
	equation(1)	equation(2)	equation(3)	equation(4)	equation(5)	equation(6)
Ing_tax <sub>it</sub>	0.0562 (1.66)			0.0574 (2.39)		
Inm_tax <sub>it</sub>		0.0322 (1.74)			0.0409 (2.00)	
Inn_tax <sub>it</sub>			0.0088 (0.38)			0.151 (0.089)
Ingd <sub>it</sub>	0.053 (2.53)	0.0535 (2.52)	0.527 (2.50)	0.0391 (2.52)	0.0391 (5.52)	
Inth <sub>it</sub>	0.0418 (1.93)	0.0522 (1.88)	0.0054 (0.27)	0.0538 (2.44)	0.0427 (2.10)	0.0156 (1.05)
er <sub>it</sub>	-0.0240 (-2.15)	-0.0238 (-2.12)	-0.024 (-2.14)	-0.0237 (-2.89)	-0.024 (-2.91)	-0.0238 (-2.87)
adj-R <sup>2</sup>	0.1723	0.1835	0.1536	0.2465	0.2761	0.2847

Analyzing the above table, equations (1), (2), (3), indicating that green taxation in the broad sense and medium sense have certain positive benefits for the transformation and upgrading of China's manufacturing industry, and have reached a significance level of more than 10% after a significance test. By observing the regression coefficient of generalized taxation and Zhongyi taxation, it can be seen that the promotion effect of generalized taxation is strong, reaching 5.62%, and the effect of neutral taxation is 3.22%, while the effect of narrow taxation is minimal, not only the level of significance is not high, but also the positive promotion benefit is very small, which fails to reflect the role of narrow taxation policy in the transformation and upgrading of China's manufacturing industry. The reason is that in the selection of the above variables, this paper defines the narrow tax as the revenue of sewage charges in the past years, for the transformation of the manufacturing industry, the use of this indicator is a bit off the theme, first of all, the sewage charges are not mandatory, and there are companies or enterprises that evade the sewage charges, resulting in the lack of accuracy and authority of this data compared with other taxes; Second.

Most of the collection of sewage charges is manufacturing, heavy industry enterprises, state organs on this aspect of the punishment is not enough, while the tax rate is not high, resulting in the cost of enterprise violations of fines less than the normal cost of emission reduction and pollution reduction, therefore, enterprises often do not consider to innovate energy conservation and emission reduction technology, but to get over and pass, illegal discharge; Third, the company's sewage fee payment lacks transparency and fails to realize the exclusive use of funds.

### 5.3. Robustness Test

In the analysis of this paper, it mainly revolves around the two indicators of green tax and green total factor productivity, so in the robustness test, it is intended to use the variable substitution method to test the relationship between the two. Only regression results for key variables are reported in the following tables.

#### 5.3.1. Robustness Test of The Base Model

**Table 4.** Robustness test results

variable name	LTFP <sub>it</sub>		LPFT	
	equation(15)	equation(16)	equation(17)	equation(18)
Ing_tax <sub>it</sub>	0.0429 (1.78)		0.0487 (2.41)	
Inm_tax <sub>it</sub>		0.0477 (1.86)		0.566 (3.29)
Control variables	Control	Control	Control	Control
Individual, point-in-time effects	fixed	fixed	fixed	fixed

Table 4 reports the relationship between broad and medium green taxation and green total factor productivity and pure technological progress. Compared with the test results in Table 3 above, the key variable regression coefficient symbols are consistent, indicating that there is no pseudo-regression in the test results.

## 6. Conclusion and Enlightenment

### 6.1. Research Conclusions

This paper mainly studies the promotion utility of green taxation on industrial green transformation and upgrading, through the theoretical analysis of relevant literature, with a preliminary understanding and ideas after empirical testing, the results: First, China's manufacturing green transformation

and upgrading mainly rely on pure technological progress, positive utility is more obvious; Second, green taxation in the broad sense and medium sense has certain positive benefits for the transformation and upgrading of China's manufacturing industry, while the effect of narrow taxation is minimal, not only the level of significance is not high, but also the positive promotion benefits are also very small, which fails to reflect the role of narrow tax policies in the transformation and upgrading of China's manufacturing industry.

### 6.2. Revelation

#### 6.2.1. Improve the Tax System

Coordinate to promote the diversification of taxes, greening, the high pollution, high energy consumption, high

emission of the industry are levied a certain proportion of environmental protection tax, while increasing the tax ratio of existing taxes, the cost of violations of enterprises is higher than the cost of pollutant discharge, so that enterprises from the perspective of interests, will take the initiative to perform the responsibility of emission reduction, green transformation, and help to promote enterprise scientific and technological innovation, fully and effectively use value-added tax and relevant parts of corporate income tax, optimize the tax payment system.

### **6.2.2. Strengthen the Role of Environmental Protection Taxes**

It is necessary to strengthen the enforcement effect of green taxation, optimize the design of environmental protection tax, appropriately adjust the tax rate of environmental protection tax, expand the coverage of green tax to all industries with high pollution, set the responsibilities of all parties, control pollution with strong tax effectiveness, and supervise the thorough implementation of grass-roots level.

### **6.2.3. Encourage Technological Innovation of Enterprises, Expand Green Tax Incentives, And Promote the High-quality Development of The Manufacturing Industry.**

Manufacturing transformation and upgrading means more high-tech industries and high-tech, in these newly developed areas, green taxation should also involve and give compensation, for some new technology and new industrial

chain and other aspects of the corresponding financial and tax subsidies, can achieve the entire industrial chain full coverage of tax incentives, so that enterprises can rest assured of innovation, upgrade technology, and then achieve a comprehensive green transformation and upgrading of the manufacturing industry.

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## **References**

- [1] He Wujie, Chen Hanhua. Research on the Impact of Green Taxation on Green Transformation of Manufacturing Industry: Based on Empirical Data of Green Total Factor Productivity[J]. Journal of Guizhou Business School, 2021, 34(02): 56-67
- [2] Zhang Jun. Reflections on Green Taxation Promoting the Green Transformation of Manufacturing Industry[J]. Western China Finance and Accounting, 2021, (11): 13-16.
- [3] He Wujie. Green Taxation, Technological Progress and Green Transformation of Manufacturing Industry: An Analysis of the Intermediary Effect of Different Technology Sources[J]. Journal of Tongling University, 2021, 20(05): 44-49.