The Impact of High-Tech Industrial Agglomeration on China's Green Economy

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Abstract. Based on the panel data of 30 provinces in China from 2010 to 2020, the green economic development index of each province is calculated by the entropy method, and the Tobit model is used to explore the influence of high-tech industry agglomeration on the green economy. As far as China's current development is concerned, the agglomeration of China's high-tech industries plays a prominent role in promoting the green economy.The empirical results show that: (1) High-tech industrial agglomeration has a significant inverted "U" shape on the development of green economy. (2) The degree of effect of high-tech industrial agglomeration on different regions is heterogeneous; The impact of high-tech industrial agglomeration on the eastern and central regions showed a significant inverted "U" shape, and had no significant impact on the western region. (3) Analysis of control variables. This article adds a new variable, Education Cost. The results of the analysis are as follows：the level of financial investment and education investment have a positive impact on the green economy, while the level of foreign direct investment and urbanization have a significant negative influence on the green economic development.

Keywords: Green economy, high-tech industrial agglomeration, Tobit model, nonlinearity.

1. Introduction

1.1 Background

The development of green economy is the only way to achieve sustained and healthy economic development, and it is an inevitable product under the background of sustainable development of human society. The green economy has attracted great attention from the international community and the related research literature is rapidly growing. The 14th Five-Year Plan emphasizes the continued adherence to green development. In the era of advocating the development of green economy, high-tech industry, as an important influencer of production mode change, reduces energy consumption and environmental pollution through technological innovation, and promotes the development of green economy. In view of this, this paper will explore the impact of high-tech industrial agglomeration on green economy and analyze the heterogeneity of different regions.

1.2 The concept of green economy

For the first time,the term green economy was coined by Pierce, but with the development of society and in-depth research by scholars, the concept of green economy has been enriched. Lingling Wang and Hao Feng define green economy as an economic model based on modern and efficient agriculture, industry, and service industry, which ensures sustainable and healthy development of both ecological environment and economy. [1] Shang Di, Li Huajing and Yao Jun showed that the core of green economy is human development, and proposed that green economy refers to improving the speed of economic development on the basis of not damaging the ecological environment from three aspects: economic, social and ecological. It is characterized by a greater focus on the equity of social distribution [2]. For how to measure the extent of green economy development, most scholars in the existing literature have used the non-expected output SBM model, data envelopment analysis to measure the total factor productivity of green economy and green economy development efficiency in each province or prefecture-level city from both input and output aspects[3-5].

1.3 The concept of high technology industry clustering

High-tech industries mainly refer to knowledge and technology intensive industries with high human capital and R&D capital investment and low consumption. As a pioneer industry, high-tech industry has a strong penetration power, and its core is technological innovation. Its technology penetrates into agriculture, industry and service industry, which can realize the change of production methods, greatly improve the production efficiency and reduce the pollution to the environment and the consumption of resources, and realize the modernization development of three industries. And technological innovation activities due to the limitations of knowledge spillover and the low dependence on natural conditions prefer a state of agglomeration, which also forms a form of agglomeration organization of high-tech industries [6-7]. Fully exploit the advantages of economies of scale and reduce costs.While the competition and cooperation among enterprises will accelerate the speed of technology update and iteration， and promote the improvement of regional innovation level, which in turn will facilitate the development of regional green economy. At present, scholars at home and abroad usually use location entropy, industry concentration, and Hirschman index to calculate the degree of concentration of high-tech industries [8].

1.4 The impact of High-Tech Industrial Agglomeration on Green Economy

With the increasing awareness of environmental protection and the importance of ecological environment in various countries. Domestic and foreign scholars have conducted lots of research on green economy development. From the perspective of the digital economy, the results show that the digital economy promotes the development of the green economy by accelerating technological innovation and promoting industrial upgrading, and there is regional heterogeneity in its effects [9-10]. Studied from the perspective of productive service industry agglomeration, scholars have found that the agglomeration of productive services has a significant positive effect on the green economy and enhance green economy efficiency, and there is hierarchical heterogeneity [11]. From the analysis of industrial agglomeration, scholars found that industrial specialization agglomeration significantly inhibits green economy efficiency, while diversification agglomeration has a "U" shape impact on green economy efficiency.[12]. In summary, there is little literature to analyze the impact of high-tech industry agglomeration on green economy and the possible regional heterogeneity from its perspective. Therefore, this paper adopts the entropy value method to measure the green economy development index of each province and uses the Tobit model to explore the impact of high-tech industrial agglomeration on the green economy.On this basis, further heterogeneity analysis is conducted for different geographical areas in the east, middle and west of China.

2. Variable Description

2.1 Entropy method

Most of the existing literature uses the SBM model of undesired output efficiency, and this paper uses the entropy method to calculate the green economic development level of 30 provinces in China from 2010 to 2020, calculate the weight of each index, and measure the comprehensive index of green economic development in each region:

$$\begin{cases} Y_{it} = \sum_{j=1}^{n} W_j \times x'_{ij} \\ i = 1, 2, \cdots 30;\ j = 1, 2, \cdots 9 \\ t = 2010, 2011, \cdots 2020 \end{cases} \tag{1}$$

Where, Y_{it} represents the green economy index of 30 provinces in China, $x_{ij}^{'}$ is the standardized value, W_j is the index weight, t represents the year, j represents the index used to calculate the green economy index, i represents the province, and the higher the composite index Y_{it} is, the higher the level of green economy development of the province.

2.2 Tobit model

The green economy development index of 30 provinces in China ranges from 0 to 1. Therefore, the Tobit model can be used to explore the impact of high-tech industrial agglomeration on the green economy, and the benchmark model is established as follows:

$$\begin{cases} Y'_{it} = \alpha_0 + \beta_k Z_{it} + \varepsilon_{it} \\ if \quad Y'_{it} > 0, Y_{it} = Y'_{it} \\ if \quad Y'_{it} < 0, Y_{it} = 0 \\ i = 1, 2, \cdots 30; t = 2010, 2011 \cdots 2020 \end{cases} \tag{2}$$

In addition to the explanatory variables, the control variables also have an impact on green economic development, so the baseline model is refined as shown below:

$$Y'_{it} = \alpha_0 + \beta_1 htic_{it} + \beta_2 fist_{it} + \beta_3 enre_{it} + \beta_4 urba_{it} + \beta_5 ede_{it} + \beta_6 FDI_{it} + \varepsilon_{it} \tag{3}$$

Where Y'_{it} is the green economic development index, α_0 is a constant term, $htic_{it}$ Represents the degree of high-tech industry agglomeration, $fist_{it}$represents the level of fiscal input, $enre_{it}$ represents environmental regulation, $urba_{it}$ represents the urbanization rate, ede_{it} represents education expenditure, FDI_{it} represents the amount of foreign direct investment, and ε_{it} represents the random disturbance term.

2.3 Variable Description

(1)Explained variables

The green economic development index mainly refers to the evaluation index system of Shang Juan and Wang Zhenmeng [13], fully considering the peculiarities of low energy depletion, low pollution and high output of green economic development, mainly through three perspectives of energy consumption, environmental pollution and social benefits, nine indicators are chose to measure the green economy development index (see Table 1 below).Energy consumption is mainly from human, financial and material aspects, pollution is mainly from industry, so industrial "three wastes" is selected as the measurement index, social benefits should include both economic growth and environmental protection. Finally, the green economic development index of each province is measured by the entropy value method.

Table.1. Green Economy Development Index Indicators 1

Tier 1 Indicators	Secondary indicators
Energy consumption	Number of people employed in the whole society
	Fixed Asset Investment
	Total energy consumption
Environmental pollution	Total industrial waste gas sulfur dioxide emissions
	Total chemical oxygen demand discharge of industrial wastewater
	Industrial solid waste generation
Social benefits	Gross Regional Product
	Green space per capita

(2) Explanatory variables

High-tech industry agglomeration. The regional heterogeneity as well as the scale of high-tech industry development in China plays a strong role. In order to better respond to the effect of industrial agglomeration in different geographical spaces in each province. This essay uses location entropy to measure the degree of high-tech industry agglomeration, and the calculation formula is shown below:

$$LQ_{is} = \frac{L_{is} / \sum_{s=1}^{m} L_{is}}{\sum_{i=1}^{n} L_{is} / \sum_{i=1}^{n}\sum_{s=1}^{m} L_{is}} \tag{4}$$

Where L_{is} represents the amount of employees in industry s in region i, $\sum_{s=1}^{m} L_{is}$ represents the number of industrial employments in region i, $\sum_{i=1}^{n} L_{is}$ represents the amount of employees in high-tech industries nationwide, and $\sum_{i=1}^{n}\sum_{s=1}^{m} L_{is}$ represents the number of industrial employments nationwide.

(3)Control variables

There are many factors influencing the development of green economy. Combining with previous studies in the literature, this paper mainly selects the following five indicators as control variables: (1) The level of financial investment : the ratio of research expenditure in the financial expenditure of each province is selected to measure in this paper. (2) Environmental regulation: the amount of pollution control is used to indicate. (3)Urbanization level: the proportion of urban population to the total population is used to express. (4) Level of investment in education: expressed using the total expenditure on education in each province, including the central government's expenditure on education in that place and the province's own expenditure on education. (5) Foreign direct investment: calculated by converting the amount of foreign direct investment into RMB using the annual exchange rate.

2.4 Data source

This paper takes 30 Chinese provinces (excluding Tibet, Hong Kong SAR, Taiwan and Macau SAR) from 2010 to 2020 as the sample. The relevant data are mainly obtained from China Statistical Yearbook,China High Technology Industry Statistical Yearbook, China Energy Statistical Yearbook, China Industrial Statistical Yearbook, China Environmental Statistical Yearbook, the statistical yearbooks of each province in the past years and the database in Guotaian, and the missing values in the data are obtained by adding the average of the two years before and after.

3. Regression results

3.1 Analysis of benchmark results

Tobit regression results are shown in Table 2 below. Model (1) shows that China's high-tech industries at this stage have a significant positive impact on the development of green economy. Model (2) is the result of adding the squared term, which shows that the impact of high-tech industry on the development of green economy shows a significant inverted "U" shape, that is, the appropriate degree of high-tech industry agglomeration can produce economies of scale, reduce the production and research costs of enterprises in the agglomeration area, and agglomeration makes the dissemination of knowledge and technology between enterprises and learning efficiency and cost

reduction. The competition and cooperation between enterprises accelerate the pace of technological innovation, which is applied in manufacturing and agriculture to improve production technology, reduce environmental pollution and promote the development of green economy. When high-tech industries are over-agglomerated, the crowding effect will lead to the intensification of the seizure of production factors such as land rent resources, resulting in increased production costs, more enterprises imitating others, and inhibiting regional technological innovation.Excessive concentration of industries will increase the consumption of energy and resources in the region, increasing the pressure on energy supply and resources. And the excessive concentration of personnel will cause the waste of human resources and produce the effect of diseconomies of scale, which is not favorable to the local technological innovation activities. By inhibiting technological innovation as mentioned above, the development of local green economy will be inhibited.

Table.2. Table of model results

variables	GE			East	Middle	West
	(1)	(2)		(3)	(4)	(5)
htic	0.0491***	0.1543***		0.2064**	0.2096*	0.0934*
	(0.0162)	(0.0371)		(0.0883)	(0.0863)	(0.5052)
htic2		-0.0488***		-0.0693*	-0.1590*	-0.0359
		(0.0156)		(0.0312)	(0.0796)	(0.0219)
fist	1.4412***	1.5238***		3.3792***	-0.1443	1.6386
	(0.4822)	(0.4747)		(0.8515)	(0.6728)	(1.0047)
enre	-1.5619	-1.7173		-0.0749	1.3534	-0.2148
	(2.6602)	(2.6151)		(8.5221)	(7.2660)	(2.1805)
urba	-0.4615***	-0.4593***		-0.7831***	-0.9036***	-0.3723***
	(0.0754)	(0.0747)		(0.1462)	(0.1616)	(0.1026)
ede	0.0288***	0.0210**		0.01819	0.0986***	0.0618***
	(0.0088)	(0.0090)		(0.0143)	(0.0220)	(0.0189)
FDI	-0.0029*	-0.0031*		-0.0031	-0.0087	-0.0139
	(0.0016)	(0.0016)		(0.0021)	(0.1489)	(0.0120)
Cons_	0.6161***	0 .5854***		0.8006***	0.7626***	0.4666***
	(0.0398)	(0.0408)		(0.1002)	(0.0779)	(0.4448))
/sigma_u	0.0912***	0.0932***		0.0830***	0.0495***	0.0586***
	(0.0130)	(0.0133)		(0.0232)	(0.0133)	(0.0143)
/sigma_e	0.0343***	0.0337***		0.0402***	0.0259***	0.0240***
	(0.0014)	(0.0013)		(0.0027)	(0.0020)	(0.0016)
rho	0.8758	0.8844		0.8099	0.7843	0.8559
	(0.0328)	(0.0308)		(0.0921)	(0.0962)	(0.0638)
LR	351.69***	349.2***		66.97***	58.19***	86.74***
N	330	330		121	88	121

Note: ***, **, * represent 1%,5%,10% significance levels, respectively, and ( ) is the standard error.

The control variable analysis, the regression results in model (2) show that the level of local financial investment has a significant positive impact on the green economy, which may be due to the fact that local governments increase investment in science and technology through finance, on the one hand, leading the public to invest, on the other hand, direct subsidies, reducing the cost of enterprise innovation, encouraging enterprise technological innovation, thereby promoting the development of green economy. Education funding also has a significant positive impact on the green economy,probably due to the fact that the schools cultivate a green lifestyle for students through ideological leadership. Stimulate industrial green product production by increasing the demand for

green products. The urbanization rate has a significant negative impact on the green economy. The reason may be that farmers' migration to the city has not brought about an increase in production efficiency, but rather lacks technical knowledge and can only engage in low-end manufacturing. At the same time, it increases the demand and consumption of resources and energy. And the willingness to buy green products with high prices is low, which is not favorable to stimulating the development of green industries. Foreign direct investment also has a significant negative impact on the development of green economy. The reason may be that due to the technological blockade, most of the foreign investment in China is concentrated in low-end manufacturing with high pollution and low efficiency, resulting in increased energy and resource consumption in China, aggravated environmental pollution, and restricted the development of China's green economy.

3.2 Heterogeneity Analysis

Regional heterogeneity analysis, because the national positioning of regional development is different, so the degree of high technology industry agglomeration in each region is different and its technological capability is also different, so the degree of influence of high technology industry agglomeration on the development of green economy is different between regions. The results of model (3) and (4) show that the impact of high-tech industry agglomeration on green economy in the eastern and central regions shows a significant inverted "U" shape, which may be due to the national strategy of prioritizing the development of the eastern region, so the high technology industry in the eastern region is developed earlier, while the central region is radiated by the high technology industry agglomeration in the eastern region, and has a better grasp of technology and knowledge, and the infrastructure in the eastern and central regions is more perfect, and has a more mature market system and perfect market environment. The results of model (5) show that the primary term coefficient of high-tech industry agglomeration in the western region has significant but weak influence on the development of green economy, and the secondary term coefficient is not significant, probably due to the unfavorable conditions of the geographical environment, the characteristics of wide and sparse land and limited educational resources and insufficient relevant talents in the western region, the scale of its high-tech industry is small and the agglomeration effect is not obvious.And the limited data make it difficult to conduct effective data analysis.

4. Conclusions and Recommendations

4.1 Conclusions

This essay uses the provincial data from 2010 to 2020 to measure the green economy development index of each province using the entropy method and the degree of high-tech industry agglomeration using location entropy. On this basis, control variables are added and Tobit regression analysis is used to analyse the impact of high-tech industrial agglomeration on green economy, and the heterogeneity of different regions is studied in depth. The major conclusions are as follows: 1. high-tech industries have a significant promotion effect on green economy development, but their utility is weakened after the degree of agglomeration reaches the inflection point. 2. there is heterogeneity of high-tech industry agglomeration on green economy development, which has a significant promotion and then suppression effect on eastern and central regions, but no significant effect on western regions.3. The level of financial investment and education funding have a positive effect on the green economy, while the level of urbanization and foreign direct investment show a significant negative effect on the development of the green economy.

4.2 Recommendations

Therefore, in order to further develop high-tech industries and promote the development of green economy, the following suggestions are made:

(1) Seize the wave of digital economy. By promoting the deep integration of artificial intelligence, big data, Internet of Things and high-tech industries to promote the digitization and intelligence of

high-tech industries. Establish an intelligent supply, management and production system, accelerate the renewal and iteration of new products and technologies, and accelerate the efficiency of cross-regional dissemination of production factors such as information, knowledge and technology. We will give full play to the knowledge and technology-intensive advantages of high-tech industries, make use of the "dry learning" and knowledge spillover brought by agglomeration, improve the regional innovation level and promote the development of regional green economy.

(2) Each region should make policies for the development of high-tech industries according to local conditions. For the eastern region, its high-tech industry concentration is more obvious, so it should make full use of this advantage to take the lead in completing the optimization of industrial structure and the transformation of economic growth mode, so as to provide a path for other regions to imitate. At the same time, non-core industries should be relocated to avoid excessive concentration and thus limit the development of green economy; for the central region, it should make full use of the radiation effect of eastern high-tech industries, and at the same time, the government should increase financial investment in high-tech industries to accelerate industrial development and technological innovation; for the western region, the government should establish high-tech industrial parks to create an environment conducive to scientific and technological innovation and attract high-tech industries from eastern and central regions.

(3) Strengthen inter-regional cooperation. Encourage the exchange of high technology industries between different regions, establish a mechanism to help as well as a long-term mutually beneficial regional cooperation mechanism to achieve the flow of technology, knowledge, talent and other factors of production to regions with slower development rates, and provide support for strengthening inter-regional ties to form a good innovation ecosystem.

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