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Research on differences and influencing factors of inclusive green development in Beijing-Tianjin-Hebei region

Tiejun Dai[1*] and Fubin Shi[1]

Abstract

Inclusive green development (IGD), adhering to harmonious between human and nature, is a sustainable approach pursuing economic growth, social equity, achievement sharing and ecological environment. This study takes the Beijing-Tianjin-Hebei (BTH) region as an example. After systematically sorting out the connotation of IGD, more comprehensive resource and environmental indicators are added to build an evaluation system. The entropy weight and material flow analysis method are used to study the time series characteristics of the level of IGD in BTH from 1992 to 2021, and the differences and the influencing factors among the three places are analyzed by the Theil index. The results show that: (1) The level of IGD in BTH showed a steady upward trend. (2) The Theil index curve of BTH has undergone an inverted "U"-shaped change, and has initially reached regional coordination in recent years. (3) Issues of social life as well as resource and environment, having surpassed economic issues, become main causes of differences in BTH. (4) The gaps in indicators such as industrial structure and scale, social security, information and technology popularization, natural resources, and ecological restoration ability fluctuate greatly. The gaps in population development, information popularization and environmental governance are decreasing rapidly, while industrial structure, urbanization and natural resources are increasing rapidly, deserving more concentration.

Keywords: Inclusive green development, Beijing-Tianjin-Hebei coordination, Entropy weight method, Theil index, Obstacle analysis, Regional differences analysis.

[1] School of Economics and Management, Beijing University of Technology, Beijing 100124, China. *Corresponding author.

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1. Introduction

Since the Reform and Opening up, China's economy has grown rapidly, and the comprehensive national strength is improving. As the world's second largest economy, issues such as imbalance and insufficiency became prominent, and the gaps between urban and rural areas, regions and income distribution are still large[1] (Xu et al. 2020). In key areas and links such as ecological environmental protection, people's livelihood security, and social governance, the task of reform is still arduous[2] (Xu et al. 2021).

Inclusive green development (IGD) is a sustainable development model that pays attention to "greening" and "inclusiveness" while maintaining economic growth, people's livelihood and environmental quality[3] (Zhou 2021). It is an important strategy to promote economic growth, improve people's welfare, reduce ecological and environmental risks, and achieve sustainable economic, social and environmental development[4] (Shi et al. 2018), which plays an important role in promoting regional green development and ecological civilization construction.

The Beijing-Tianjin-Hebei (BTH) region is not only one of the major economic regions in China, but also an important support to participate in international competition and modernization[5] (Jiang et al. 2019). In April 2015, the "Beijing-Tianjin-Hebei Coordinated Development Planning Outline" was officially released. In recent years, the top-level design has been basically completed, breakthroughs have been made in the three key areas of transportation, ecology and industry, regional collaborative innovation has gained momentum, and progress has been made in the co-construction and sharing of basic public services[6] (Zhao et al. 2020). However, due to factors such as the integrity of the ecological environment and the continuity of economic development, the BTH region has a large population[7] (Cui et al. 2019), a large proportion of heavy chemical industry[8] (Duan et al. 2021), frequent occurrence of smog[9] (Song et al. 2020), and the ecological load exceeds the limit[10] (Chen et al. 2022) and other issues remain to be resolved.

Inclusion is the premise of collaboration, and collaboration is the goal of inclusion[11] (Wang 2018). Under the development concept of the new era, how to guide green economic growth and inclusive transformation and further improve the level of inclusive green development has become a major challenge facing the BTH region.

2. Literature review

At present, there are abundant researches on regional inclusive green development. In terms of theoretical concepts, the Asian Development Bank[12] (2007) first proposed the concept of inclusive growth in "New Asia, New Asian Development Bank", emphasizing that the benefits brought by growth should be obtained by all (especially the poor) . In 2012, the World Bank[13] (2012) pointed out that inclusive green development is a sustainable development approach that focuses on inclusive growth and green growth. Afterwards, the connotation of inclusive green development has gone from “creating green industries and sustainable urban life to reduce poverty[14] (Spratt 2013)”, to “emphasizing social equality and

environmental sustainability to improve welfare[15] (Bouma et al. 2015)", and finally focusing on the "narrowing of the gap between the rich and the poor and the sharing of development opportunities and achievements[16] (Dhingra 2015), concentrating on the role and status of people[17] (Zhang 2014)". Now, inclusive green development is considered to be the inevitable result of the coordinated development of economy, society and environment, emphasizing the high quality of economic development, the fair sharing of social opportunities and achievements, and the maintenance and sustainability of ecology[18] (Zhou 2020);

In terms of measurement models and index selection, there are not only models such as social welfare function[19] (Ali et al. 2007), opportunity function[20] (Jacques et al. 2010), and the IDI (Inclusive Development Index) proposed by the World Economic Forum[21] (2017), but also the measurement index system constructed by scholars from different perspectives according to the connotation and characteristics. The evaluation system involves economic sustainability[22] (Fan et al. 2022), industrial structure and scale[23] (Gu et al. 2021), social opportunity equity[24] (Zhou et al. 2018), ecological protection[25] (Sheng 2017), development achievement sharing[26] (Xu et al. 2017), technological progress[27] (Duan 2020) and policy support[28] (Almas et al. 2019). There are also many methods for measuring green growth, including green GDP[29] (Hoff et al. 2020), comprehensive evaluation index[30]-[32] (Tong et al. 2020; Zhao et al. 2022b; Naseer et al. 2022), and relative efficiency evaluation assessment[33][34] (Cui and Liu 2021; Cai et al. 2022). Compared with the methodology for the measurement of inclusive growth, there are limitations in the techniques used for measuring green growth when considering the indicators of social factors.

In terms of regional differences and influencing factors, the research mainly focuses on the spatial pattern of countries[35] (Coady et al. 2017), economic belts[36] (Wang et al. 2019) and provinces[37] (Fan et al. 2022), mainly using cluster analysis[38] (Liu et al. 2011), convergence model test[39] (Zhao et al. 2020), geographic detectors[40] (Xin et al. 2020), obstacle degree model[41] (Wang et al. 2022), Tobit regression model[42] (Chen et al. 2019), grey correlation[43] (Liu et al. 2022), etc., to conduct research on coordination, internal heterogeneity and influence mechanism.

In terms of counter measures, it currently mainly includes policy (countermeasures) formulation and implementation proposals in industrial structure[44] (Wu et al. 2018), social system[45] (Bakirtas et al. 2018), infrastructure[46] (Li et al. 2019), resources[47] (Ali et al. 2019) and environment[48] (Ghorab et al. 2016), opening to the outside world[49] (Yang 2014), etc. Most of them are qualitative research to the evaluation of program effects.

Based on the above, there are still the following three aspects to be further improved: (1) the research objects are mostly countries and some typical provinces, and there is a lack of collaborative research and countermeasures on regional inclusive green development; (2) most of the resources and environmental indicators in the evaluation instructions are water and energy, which lacks natural resources such as biomass, metals, and non-metals, and environmental indicators such as atmosphere, water, solid waste and dissipative substances, resulting in a certain gap between the

empirical research conclusions and the actual situation; (3) Regional coordinated development should not only consider the impact of many internal indicators within regions, but also the impact of balance between regions. However, most of the current research lacks comprehensive diagnosis and analysis of internal and external factors, and the impact mechanism is still need to be further clarified.

Therefore, this paper will combine the material flow method, add more comprehensive resource and environmental evaluation indicators, study the evolution of the level of inclusive green development in the BTH region in the past 30 years, and use the Theil index to explore regional differences and their influencing factors. It is not only conducive to accurately grasping the green and inclusive state of economic development, ecological environment, people's livelihood at the regional level in the context of high-quality development, but also provides a new perspective for understanding and guiding the coordination of various objects in the region.

3. Methods and data

3.1 Evaluation system

From the perspective of systems theory, according to the "three circles model" constructed by Hu and Zhou[50] (2014), green development is a symbiotic interaction mechanism composed of economic, ecological and social systems. Inclusive green development, a green development with inclusiveness as the main line, its internal interaction mechanism also includes economic, ecological and social systems, and takes "premise-process-result inclusion" [51] (Wei et al. 2011) as the core to have the operation.

In the economic dimension, the fairness of the opportunity to participate in economic development is a prerequisite, mainly including whether economic development gives fair opportunities to people to participate in social activities in terms of survival and employment; the sustainability of industrial structure and scale is a process state , mainly refers to whether the state of the industrial structures and agglomeration scale is reasonable; the sharing of economic development achievements is the result, mainly including the amount of economic output, the rationality of income distribution, and whether the results of economic development are shared by the public.

In the social dimension, the provision of opportunities for social security such as education and medical care is a prerequisite, which mainly refers to the realization of social progress, and equal opportunities for people in these systems must be guaranteed; social resources and wealth sharing are process states, which mainly refer to whether people enjoy equal access to all resources in the specific process of development; the popularization of technology and information services is the result, which mainly refers to whether the main body of social activities is promoted to enjoy the convenience of life brought by the social science and technology.

In the ecological dimension, the abundance of natural resources is a prerequisite, mainly including the amount of natural resources that can be used by humans; the

degree of environmental pollution and the quality of the ecological environment are process states, which mainly refer to the degree of human pollution to the ecology in production and life, and the changes in the quality of the ecological environment under the state of economic and social development; energy consumption and ecological restoration capacity are the results, mainly referring to the state of energy use and pollution treatment by humans when having production and life.

Based on the above research framework, according to the principles of systematicness, science, dynamics, operability, etc., and considering the comparability of the selected indicators and the consistency of statistical calibers, this paper constructs an evaluation index system of inclusive green development level (as shown in Table 1), composed of three dimensions of economy, society and ecology.

Table 1: Indicator system for measuring the level of inclusive green development in BTH region

Dimension	Target	Index	Unit	Orientation
Economy	Equal opportunity to participate	Population density (ECN1)	men/km^2	-
		Proportion of employees in the secondary industry (ECN2)	%	-
		Proportion of employees in the tertiary industry (ECN3)	%	+
		Urban registered unemployment rate (ECN4)	%	-
	Industrial structure and scale	Industrial enterprises above designated size (ECN5)	decades	+
		The tertiary industry's share of GDP (ECN6)	%	+
		Fiscal revenue as a percentage of GDP (ECN7)	%	+
		Total postal service (ECN8)	MCHY	+
	Sharing of development achievements	GDP per capita (ECN9)	CHY	+
		Average salary of on-the-job employees (ECN10)	CHY	+
		Disposable income per capita (ECN11)	CHY	+
		Local general public budget revenue (ECN12)	BCHY	+
Society	Social security equity	Teacher-student ratio in ordinary primary schools (SCL1)	/	+
		Teacher-student ratio in ordinary secondary schools (SCL2)	/	+
		Health technicians per capita (SCL3)	persons	+
		Hospital beds per capita (SCL4)	beds	+
		Basic pension insurance coverage (SCL5)	%	+
		Unemployment insurance coverage (SCL6)	%	+
	Social resource sharing	Public transport vehicles per capita (SCL7)	buses	+
		Urban road area per capita (SCL8)	m^2	+
		Museums per capita (SCL9)	museums	+
		Libraries per capita (SCL10)	libraries	+
		Housing area per capita (SCL11)	m^2	+
		Urbanization rate (SCL12)	%	+
		Mobile phone per 100 people (SCL13)	units	+

	Popularization of technology and information	Patent licenses per millions of people (SCL14)	units	+
Ecology	Natural resources	Water resources (ECL1)	billion m^2	+
		Biomass resources (ECL2)	1,000 tons	+
		Fossil fuel resources (ECL3)	1,000 tons	+
		Metal resources (ECL4)	1,000 tons	+
		Non-metal resources (ECL5)	1,000 tons	+
	Environmental pollution	Atmospheric pollutant (ECL6)	1,000 tons	-
		Water pollutants (ECL7)	1,000 tons	-
		Solid waste (ECL8)	1,000 tons	-
		Dissipative substances (ECL9)	1,000 tons	-
	Energy consumption	Electricity consumption of the whole society (ECL10)	billion kw·h	-
		Energy consumption per million yuan of GDP (ECL11)	tons of standard coal	-
		Water consumption per million yuan of GDP (ECL12)	m^3	-
	Ecosystem	Urban green coverage (ECL13)	%	+
		Park green space per capita (ECL14)	m^2	+
		Air quality compliance rate (ECL15)	%	+
	Ecological restoration capability	Industrial pollution control project completed investment (ECL16)	CHY	+
		Urban sewage treatment rate (ECL17)	%	+
		Comprehensive utilization rate of industrial solid waste (ECL18)	%	+
		Harmless treatment rate of domestic waste (ECL19)	%	+

3.2 Weights of indexes

The commonly used weight determination methods mainly include the subjective weighting method and the objective weighting method. In line with the principles of low data requirements and easy operation of methods, being able to analyze the dynamic changes and the degree of closeness between elements, this paper draws on the practice of Wu[44] (2018) and chooses the entropy weight method to weight the indicators. It is an objective empowerment method that is not easily disturbed by human subjective factors. The entropy weight method calculates the corresponding index weight in the system according to the information entropy of the index and the amount of related information, and then weights all the indexes to the comprehensive score. Compared with the subjective weighting method, it is not easily disturbed by subjective factors, with high precision and wide application

range. At the same time, it is not easily disturbed by human factors, so the results are closer to reality. The development level *D* is obtained by adding up the development degrees *d* of all indexes. The formula is as follows:

$$D = \sum_{i=1}^{n} d_j = \sum_{i=1}^{n} x_i w_i$$

In the formula, x_i is the i index after dimensionless; w_i is the weight of the index obtained by the entropy weight method; d_i is the development degree of each index; *n* is the number of indexes.

3.3 Regional differences

The overall development of the region should comprehensively consider the influence of each other. This paper draws on the practice of Li Jiangsu[52] (2020) and uses the Theil index to measure the regional gap of inclusive green development in Beijing, Tianjin, and Hebei. The Theil index, also known as the Theil entropy standard, was used to measure differences in regional income levels, and was later widely used by academia to measure differences in various regional socioeconomic phenomena. The formula is as follows:

$$T = \frac{1}{n} \sum_{i=1}^{n} \frac{d_i}{A_D} \ln \frac{d_i}{A_D}$$

In the formula, *T* is the Theil indes; A_D is the average value of the development degree of each index.

3.4 Influencing factors

The development of regional economy should comprehensively consider the influence of each other. Existing studies generally use measurement methods or regression models to research the contribution of criteria-level indicators to the development index. This paper draws on the practice of Guo Yanhua[53] (2020) and uses the obstacle degree model to diagnose the factors affecting the level of inclusive green development in Beijing, Tianjin and Hebei. The obstacle degree is calculated comprehensively by the index deviation index and the factor contribution index, and the primary and secondary relationship and influence degree of obstacle factors are determined by their values. Compared with the external system applicable to traditional regression and measurement methods, the barrier degree model takes advantages in analyzing the internal factors of the system and their effect. The formula of barrier degree S_i for each index is as follows:

$$\mathrm{S_i} = \frac{(1 - \mathrm{x_i})\mathrm{w_i}}{\sum_{\mathrm{i=1}}^{\mathrm{n}} (1 - \mathrm{x_i})\mathrm{w_i}} \times 100\%$$

3.5 Data

The data involved are mainly from China Statistical Yearbook, China Regional Yearbook, Beijing Statistical Yearbook, Tianjin Statistical Yearbook, Hebei Statistical Yearbook, China Population and Employment Statistical Yearbook, China Land and Resources Statistical Yearbook, China Environment Yearbook and other official statistical yearbooks, and secondly from the statistical bulletin of economic and social development issued by the National Bureau of Statistics and the statistical bureaus of Beijing, Tianjin and Hebei. The resource and environmental data are estimated according to the material flow analysis method[54][55] (Dai et al. 2018; 2020), and the missing year data needs to be obtained by appropriate calculation based on statistical laws.

4. Results and discussions

4.1 The level of inclusive green development in Beijing-Tianjin-Hebei region

The key step in calculating the inclusive green growth level is to set the indicator weight. This paper draws on the practice of Wu[44] (2018) and chooses the entropy weight method to weight the indicators. The levels of inclusive green development in Beijing, Tianjin, Hebei and BTH region from 1992 to 2021 were calculated respectively, and the results are shown in Figure 1.

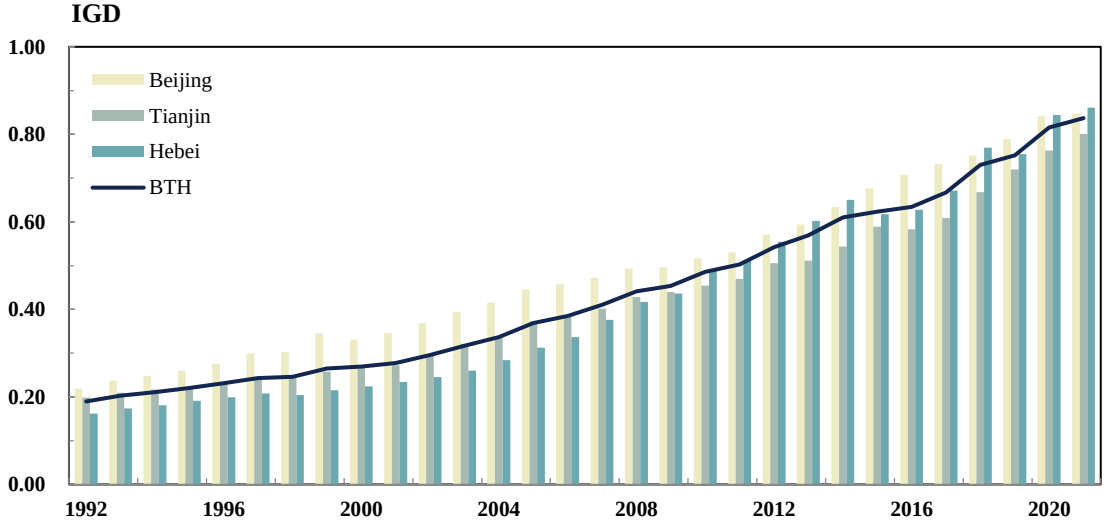


Figure 1: Levels of IGD in Beijing, Tianjin, Hebei and BTH region

On the whole, the level of inclusive green development in the BTH region shows an obvious steady growth trend. The development index has increased from 0.19 in 1992 to 0.84 in 2021, with an average annual growth rate of 5.26%. The trend is

pretty good. According to the development level, it can be divided into three periods: the initial development stage, the high-speed development stage and the preliminary coordination stage.

The initial development stage was 1992-2001. The total regional development degree increased from 0.19 to 0.28, with an average annual growth rate of 4.33%, which was generally at a low level and grew slowly. From the perspective of the gap between the three places and the region's level, Beijing far exceeds the overall level by about 20%, Tianjin basically reaches the overall level, and Hebei is about 15% behind the overall level. In this period, local development is in its infancy, and Beijing, relying on earlier development, has taken the initiative in economics, thus contributing more development levels and becoming the main driving force for regional development.

The period of rapid development was from 2002 to 2013. At this stage, the development degree has increased from 0.30 to 0.57, with an average annual growth rate of 6.16%. The region is at a moderate level and the growth rate is relatively fast. From the perspective of the gap between the three places and the overall level, Beijing still occupies a dominant position, but the gap with the overall level has dropped to about 13%; Tianjin continues to maintain a trend close to the overall level, but slightly declined in the later period; the gap between Hebei and the region has narrowed to 7%, and slightly overtake in the later stage. This shows that the development momentum of the BTH region is basically unchanged, but with the emphasis on the economy and the gradual attention to the ecological aspect, the gap between regions has narrowed significantly, and the Beijing-Tianjin-Hebei synergy has begun.

The initial synergy phase is 2014-2021. The overall development degree is at a relatively high level, increasing from 0.61 to 0.84, with an average annual growth rate of 4.67% and a steady growth. From the perspective of the gap between the three places and the whole, Beijing has entered a period of low-speed growth, only 2% higher than the overall level; Tianjin has insufficient development potential, opening a gap of about 7% with the overall; Hebei has played a huge growth potential, becoming another booster for overall development, about 5% above the region's level. This shows that although the gap between Beijing, Tianjin and Hebei still exists, their respective development levels are relatively high. At the same time, the overall level of the region has also been steadily improved by the comprehension and coordination of the three in terms of economy, society and ecology.

Therefore, the BTH region should change the development thinking of "only GDP" and incorporate inclusive green growth into the assessment of governments at all levels. While developing the economy, it is necessary to protect the environment and maintain social equity to improve the well-being. The massive industrialization process frequently seeks to maximize economic rewards, which eventually leads to environmental degradation and pollution[56][57] (Fu 2021; Ghafarpasand et al. 2021). The process of innovation may produce new products, new technologies, or new business models[58] (Zhang et al. 2021a). Accelerate the construction of the government's performance appraisal, protection inspection and responsibility

accountability mechanism for ecological and environmental protection, and improve the inter-governmental horizontal ecological compensation mechanism.

4.2 Analysis of differences among Beijing, Tianjin and Hebei in inclusive green development

The overall development of the region should comprehensively consider the influence of each other. This paper draws on the practice of Li Jiangsu[52] (2020) and uses the Theil index to measure the regional gap of inclusive green development in Beijing, Tianjin, and Hebei (the results are shown in Figure 2). The higher the Theil index, the greater the regional differences.

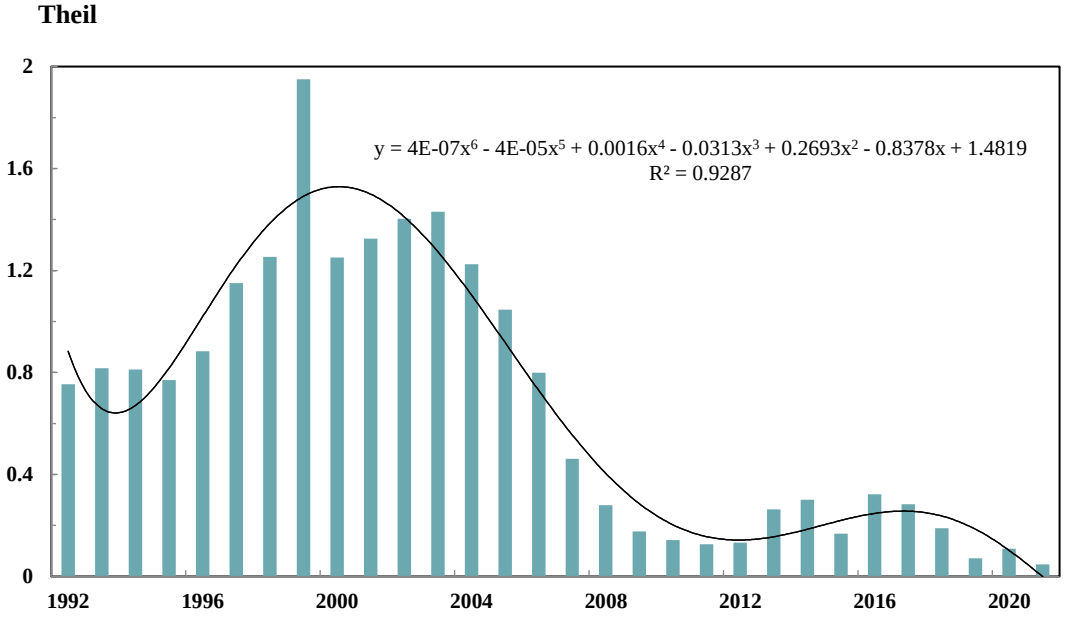


Figure 2: Theil indexes of inclusive green development in BTH region

During the evaluation period, the Theil index curve of the inclusive green development in BTH region experienced an obvious inverted "U"-shaped change, after fitting. It first increased and then decreased. Although the difference has increased slightly in recent years, it has stabilized at a low level, basically realizing the coordination of Beijing-Tianjin-Hebei.

From 1992 to 2000, the gap between Beijing, Tianjin and Hebei gradually increased. The Theil index rose from 0.75 to 1.95, an annual growth rate of 12.68%. This period is in the early stage of the development of the BTH region. The development of Beijing and Tianjin relies on advantageous industrial structure and scale and has a relatively high starting level. Hebei is at a low level of development, but due to

better resource endowments, it shows good development potential.

From 2001 to 2011, the gap between Beijing, Tianjin and Hebei gradually narrowed, and Beijing-Tianjin-Hebei began to form a synergy. Theil index fell to a minimum of 0.13, with an annual decline rate of 23.72%. This stage is in the middle stage of the development of the BTH region. Beijing continues to maintain a high level of steady growth. Tianjin's growth trend and speed gradually slows down but it retains certain advantages in terms of social and people's livelihood. Hebei has undertaken most of the industrial industries in this region and takes advantage of natural resources and geographical location to vigorously develop and catch up.

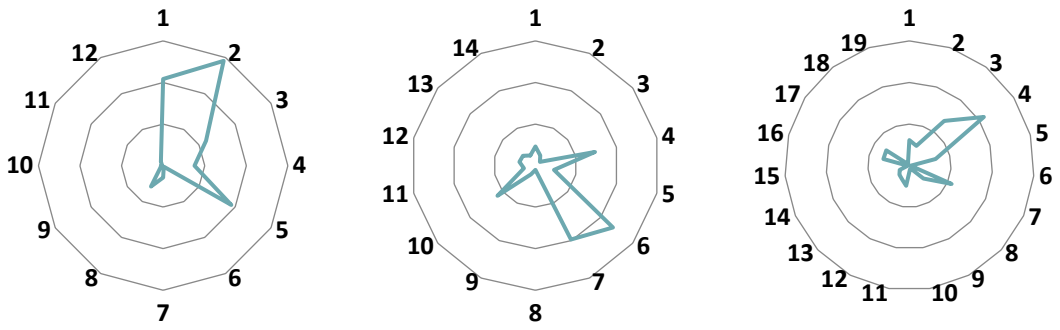
From 2012 to 2021, the BTH region will initially reach a synergistic level. Although the Theil index fluctuates and increases occasionally, it basically remains at around 0.15. This period is at a high level of development in the BTH region. The three places earnestly implement the "Beijing-Tianjin-Hebei Coordinated Development Planning Outline" to promote high-quality regional development. Beijing has gradually shifted its development center from economy to society and ecology, Hebei has also undergone a green economic transformation, and Tianjin has focused on using cultural and location advantages to improve people's livelihood. While developing themselves, three places learn strengths from each other and complement weaknesses, strengthen division of labor and cooperation, and achieve complementary advantages.

In general, Beijing has fairer participation opportunities and a more reasonable industrial layout in the economic system, and has an early urbanization and a relatively sound social security system in the social system. The coefficient of financial development is not significant, which is different from existing studies[59] (Tian et al. 2021). Compared to the management of water and air pollution, many urban areas are facing increasingly severe issues regarding solid waste management[60] (Lee et al. 2021). Consequently, it led in the region. Tianjin and Hebei were chasing after, in addition to learning from Beijing's advanced experience, they must also rely on their own resources and location advantages to develop characteristic industries.

4.3 Analysis of influencing factors of inclusive green development in Beijing-Tianjin-Hebei region

Considering that the IGD relates to the fields of economic growth, carbon emission reduction, carbon tax, resource development and utilization, social equity, and social inclusion[61]-[66] (Ojha et al. 2020; Wang et al. 2020a; Mccartney and brunner 2020; Soma et al. 2018; Brand et al. 2017; Spash 2020), we divide the indicator system for measuring IGD into the following three dimensions: economic dimension, social dimension, and environmental dimension. The development of regional economy should comprehensively consider the influence of each other. This paper draws on the practice of Guo Yanhua[53] (2020) and uses the obstacle degree model to diagnose the factors affecting the level of inclusive green development in Beijing, Tianjin and Hebei (the results are shown in Figure 3). The

higher the obstacle degree, the more the impact of the indicator on the whole.



(a) Economy（ECN） (b) Society（SCL） (c) Ecology（ECL）

Figure 3: Obstacle degrees of indicators in BTH region

On the whole, the society and the ecological environment have relatively large obstacles, accounting for about 40% of the total obstacles respectively, followed by economic development, accounting for about 20%. It shows that with the development of BTH region and all places, the economic gap has been greatly reduced compared with the initial stage. In the next step, the government should focus on improving social livelihood and the environment while developing the economy.

For the obstacle factors at the index level, the economy dimension mainly includes population density (3.82%), the proportion of employees in the secondary industry (5.33%), and industrial enterprises above designated size (3.47%). The society dimension mainly includes hospital beds per capita (5.97%), unemployment insurance coverage rate (9.70%), public transport vehicles per capita (8.01%), and the ecology dimension mainly includes fossil fuel resources (5.61%), metal resources (8.79%), and water pollutants (4.55%). It shows that in the development of the region, demands of publics have gradually changed from "quantity" to "quality", and they are more pursuing the quality of life and spiritual culture. The three places need further coordination in terms of the opportunities for individuals to participate in economic activities, the support of industrial scale for sustainable economic development, medical equity, social security benefits, the degree of infrastructure sharing, energy resources and water pollution.

Specifically, by analyzing the range, variance and growth rate of the Theil index of key obstacle factors (as shown in Table 2), the degree of fluctuation and trend of change can be judged, so as to formulate countermeasures according to the characteristics of the index.

Table 2: Descriptive statistics of Theil indexes of key indicators

Dimension	Index	Initial value	Range	Variance	Growth rate
Economy	ECN1	0.306	0.077	0.06	-0.26%
	ECN2	0.115	0.459	2.03	1.46%
	ECN5	0.206	0.485	1.84	0.01%
Society	SCL4	0.319	0.278	1.03	0.92%
	SCL6	0.518	0.317	1.55	1.03%
	SCL7	0.328	0.375	1.14	1.25%
	SCL10	0.369	0.057	0.04	-0.19%
Ecology	ECL3	0.430	0.387	1.38	0.74%
	ECL4	0.429	0.450	3.16	1.42%
	ECL7	0.359	0.472	1.85	0.78%

Judging from the comprehensive characteristics of all evaluation indicators, the change rate of economic factor indicators is generally faster, about 0.12%, the initial value of the Theil index of social factor indicators is generally higher, about 0.2, and the average variance of ecological factor indicators is larger, about 0.78.

Among the key obstacle factors, the proportion of employees in the secondary industry and industrial enterprises above designated size, the coverage rate of unemployment insurance and the penetration rate of mobile phones, metal resources and the completion of investment in industrial pollution control projects, have large variance and range in each dimensional-level indicator. It shows that the three places have large fluctuations in industrial structure and scale, social security system, popularization of information and technology, natural resources, and ecological restoration capabilities, which are more sensitive to policies. Dealing with such issues requires ongoing policy support.

From the perspective of changing trends, the indicators that have decreased rapidly are: population density (0.26%), mobile phone penetration rate (1.10%), and investment in industrial pollution control projects (1.59%). Coordinated policies in environmental governance have achieved initial results, and only simple improvements to existing policies are required. The indicators with faster growth are: the proportion of employees in the secondary industry (1.46%), the urbanization rate (1.23%), and the metal resources (1.42%). These are key areas where the governments need to work together, clarify the division of labor, and carry out policy regulation.

According to the above all, local governments in the BTH region should continue to optimize and adjust the industrial structure, population density, and marketization level, and continue to promote the rationalization and upgrading of the industrial structure. Prior studies have found that strengthening basic public services, particularly the equitable distribution of medical resources, was conducive not only to the promotion of inclusive growth[67] (Saniya et al. 2021) but also to the reduction of CO_2 emissions and, therefore, the promotion of green growth[68] (Faik et al. 2021).

Further, unhealthy interactions among IGD subsystems may lead to coronavirus transmission, and the discrepancy between medical demand and expenditure has increased as a result of the COVID-19 pandemic[69] (Zhang 2021). Efforts will be made to improve the regional scientific and technological innovation capabilities, so that economic development will shift from relying on factors and investment-driven to "innovation-driven, technology-led, industrial upgrading, green growth". To solve the problem of Beijing-Tianjin-Hebei synergy, it is necessary for the three places to perform their respective responsibilities, continuously optimize the external environment, and promote inclusive green growth.

5. Conclusions and implications

1) From 1992 to 2021, the overall level of inclusive green development in BTH showed a steady upward trend. In the initial stage, the development level was low and grew slowly. After that, the development level increased rapidly, and it has been stable at a relatively high level in recent years.
2) The Theil index curve of the inclusive green development of Beijing-Tianjin-Hebei has experienced an obvious inverted "U"-shaped change. Beijing is basically in a leading position, Hebei has a low start but huge growth potential, and Tianjin grows slowly. The three places have undergone coordinated transformation in recent years and have initially reached the level of regional coordinated development.
3) People's livelihood and environmental issues have surpassed economic development issues, becoming the main causes of differences in the inclusive green development of Beijing-Tianjin-Hebei, which are embodied in the opportunities for individuals to participate in economic activities, the support of industrial scale for sustainable economic development, and medical equity, social security benefits, sharing of infrastructure, energy resources and water pollution.
4) The initial value of the Theil index of social indicators is generally higher, the fluctuation of ecological factor indicators is greater, and the Theil index of economic indicators generally changes faster. Among the key obstacle factors, industrial structure and scale, social security system, popularization of information and technology, natural resources, and ecological restoration are more sensitive to policies. Among them, the industrial structure, urbanization and natural resources increase rapidly, which are the focus of the collaborative work, while the population development, information popularization and environmental governance indicators are rapidly decreasing, and it is only necessary to simply improve the status quo.

According to the above research results, the following inspirations are put forward: (1) Continue to strengthen the basic theoretical research of inclusive green development. The connotation of regional development and its theoretical research are still in the exploratory stage. In the future, the definition and driving mechanism of the connotation under the multidisciplinary perspectives of geography,

environmental science, and economics should be further improved. (2) Strengthen the multi-scale regional comparative research on green growth, reveal the spatial differences in the driving mechanism of green growth in different regions, and form a regional green growth differential regulation, monitoring and early warning mechanism. (3) Strengthen the quantitative evaluation of the implementation effects of policies and countermeasures. Actively use systematics, dynamics and other methods to set up different development models, compare and analyze the advantages and disadvantages of each plan, try to find the optimal solution, and provide more basis for countermeasures and suggestions.

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