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Original Research

IPAT Model Construction of Industrial Agglomeration and Urban Environmental Pollution in the Big Data Age

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Abstract

The expansion of big data, an essential factor in fostering the growth of the financial sector and the economy, is industrial agglomeration, and at the same time, it will also have a certain impact on the urban environment. Therefore, it is necessary to construct the IPAT model to study industrial agglomeration and urban environmental pollution in the era of big data, but the current IPAT model still has the problems of low industrial agglomeration, poor industrial technology level, and high industrial wastewater discharge. To better promote industrial agglomeration and reduce urban environmental pollution, this article aims to construct an IPAT model to more thoroughly analyze the mechanisms affecting environmental pollution in terms of urbanization level and industrial agglomeration. The materials and procedures of the study are first presented in the paper, which also examines the mechanisms of environmental pollution brought about by urbanization and industrial agglomeration. Finally, the traditional IPAT model is introduced, with industrial agglomeration variables added to optimize it. To analyze the practical application of the model in the research of industrial agglomeration and urban environmental pollution, this paper concludes by comparing it with the traditional model. The average test result of the industrial agglomeration model in this study is 38.14%, while the average test result of the classic model is 42.14%, according to the results. The model used in this study has an average test result of 63.24% for the industrial technology level, while the traditional model has an average test result of 57.87%. The model used in this work has an average test result for industrial wastewater discharge of 72,936,400 tons, while the traditional model has an average test result of 78,241,200 tons. This study validates the efficacy of the model in examining the relationship between urban environmental pollution and industrial agglomeration, and it also offers further insights for future in-depth research on the subject.

Keywords: Big data industrial agglomeration, urbanization level, environmental pollution, degree of industrial agglomeration

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Introduction

As urbanization continues to advance, the scale of urban industries is expanding, thus forming a situation of industrial agglomeration [1, 2]. The massive agglomeration of industries drives the development of the urban economy and forms economies of scale [3]. Meanwhile, industrial agglomeration can have both positive and negative effects on the urban environment. Its positive impact is reflected primarily in the indirect improvement of the environment, while its negative impact is reflected in the large consumption of resources [4, 5]. The more resources consumed, the more pollutant emissions can rise, thus exacerbating environmental pollution. To this end, it is also necessary to reasonably control the scale of industrial agglomeration and reduce the negative effects on the urban environment caused by industrial agglomeration.

Recently, related aspects of environmental pollution have attracted widespread academic attention, and scholars have launched studies on them. The goal of Alharthi M. was to closely examine how environmental degradation and renewable energy affect household income and health in the economies of the Middle East and North Africa (MENA). Panel data from 20 MENA countries, collected between 2000 and 2019, were used in the study. In the study, pooled mean group (PMG) regression was used to examine the data. The results demonstrate that the use of renewable energy greatly improves human health and reduces pollution in the environment. The findings also show that elevated levels of PM2.5 in the environment worsen health problems and have a detrimental effect on household income in the economies being studied [6]. Suzuki T. proposed an important system to protect the body from environmental pollution, in which KEAP1 (kelch-like ECH-associated protein 1) was a sensor protein to detect environmental pollutants and can be used to activate transcription factors. Transcription factors can protect the body from immune toxicity by inducing the activity of genes involved in detoxification, antioxidant, and anti-inflammatory activities [7]. Ventriglio A. reviewed and summarized 134 articles on environmental pollution and mental health and collected new evidence on the links between major environmental pollutants and various mental health disorders. These substances have been found to affect the central nervous system of the brain in many potential pathologies [8]. Based on the spatiotemporal heterogeneity of the level of economic development and the level of upgrading of industrial structures in the eastern area, Xi B. sought to investigate the effects of environmental pollution and the renewal of industrial structures at different phases on environmental pollution. To achieve sustainable economic development, he also investigated whether the regulatory and threshold impacts on the process of economic growth affect environmental pollution in western and central areas of China [9]. The primary objective of Yuan H. is to investigate the non-linear impacts of financial agglomeration on pollution in the environment. First, a theoretical framework is built based on the Copeland-Taylor endogenous growth model and the scale, structural, and technical innovation effects of financial agglomeration. A panel threshold regression model was presented to quantify the nonlinear association between financial agglomeration and environmental pollution using panel data from 281 prefecture-level cities in China from 2003 to 2019. The results demonstrate that financial agglomeration has a substantial effect on improving the environment, as indicated by the gradient threshold. In particular, 68.64% of the cities exceeded the threshold and reached the deceleration stage of financial agglomeration, suppressing environmental pollution [10]. The findings of these researchers shed light on the negative effects of environmental pollution on human health and the economy and offer specific recommendations for improving the use of renewable energy sources and lowering pollution. Their studies do have certain limits, though, as they are limited to particular areas or periods and do not have complete, long-term data support. As a result, it is challenging to determine the true value of the studies, and additional research is required to confirm their relevance and reliability.

There are studies on big data that are very popular in various industries, and related studies have been reported in the area of environmental pollution. Liu H. used big data to measure differences in environmental perception between five stakeholders and multiple regions of China and compared perceived pollution with actual pollution. His results suggested that the five stakeholders show similar perceptions of environmental pollution on a national scale, with air pollution being the most concerning issue [11]. Based on digital remote sensing technology, Chen H. had established an intelligent image monitoring technology for marine environmental pollution information, which calculated and processed the data collected through big data analysis to complete monitoring and analysis of marine environmental pollution [12]. In a study conducted between 1990 and 2019, Ibrahim R.L. looked at the effects of structural change, reliance on natural resources, environmental technologies, and renewable energy in five of the leading carbon-emitting African nations. Algeria, Egypt, Morocco, Nigeria, and South Africa. The research utilizes second-generation estimators, including quantile regression (QR), augmented mean group (AMG), common correlated effects mean group (CCEMG), and cross-sectional auto-regressive distributive lag (CS-ARDL) [13].

To provide a more scientific foundation for the development of environmental policies, scholars have combined big data and digital remote sensing technology to measure and monitor environmental problems in various aspects. However, research still lacks a comprehensive and integrated exploration of environmental problems and only focuses on specific regions or individual aspects of environmental problems. Additionally, more validation is required for model selection and data processing. This paper aims to address the shortcomings of earlier research by developing the IPAT model and incorporating the industrial agglomeration of variables into the traditional model. This will enable a more thorough analysis of the relationship between urban environmental pollution and industrial agglomeration, as well as more comprehensive recommendations for the formulation and protection of environmental policies.

This paper provided a detailed analysis of the current situation of agglomeration of the big data industry and analyzed the current situation of urban environmental pollution in China. This article also focused on analyzing the relationship between industrial agglomeration and environmental pollution, exploring the mechanism of industrial agglomeration that affects environmental pollution, and providing relevant countermeasures to improve urban environmental pollution. Meanwhile, this article combined the IPAT model to explore the impact of industrial agglomeration on environmental pollution, optimize the impact of industrial agglomeration on environmental pollution, and improve the quality of the urban environment. This research contributes to a better understanding of the connection between the industrial layout of urban development and environmental concerns. The development of the IPAT model highlights the quantitative impact of industrial agglomeration on environmental pollution and the complex interaction between urban development and environmental quality in the era of big data. The research in this paper offers a scientific foundation for developing policies related to environmental protection and urban development planning and helps to strike a balance between environmental sustainability and economic growth.

Material and Method

The formation of big data industrial agglomeration is inseparable from the strong support of the industrial environment, which includes the policy environment, talent environment, infrastructure environment, natural conditions, and other aspects. Here, the analysis is mainly conducted from two aspects: the policy environment and the talent environment:

Policy Environment

In China, there are still some differences in the preferential policies for big data among different provinces. In terms of the number of preferential policies, Guizhou Province, Jiangxi Province, and Fujian Province have absolute advantages, among which the preferential policies of Guizhou Province focus on attracting enterprises and talents to settle down; Jiangxi Province mainly focuses on enterprises and big data projects, providing preferential treatment for enterprises; and Fujian Province prefers the construction of big data industrial parks to provide preferential funds. Some provinces focus on supporting big data enterprises.

The main direction of big data industrial policy mostly focuses on health care, government affairs, and agriculture, aiming to create an innovative service model combining big data and medical treatment, among which Guizhou Province and Shandong Province are far ahead in this regard.

Talent Environment

In the big data industry, most are high-tech industries, so the industry also has certain requirements for talent quality. Combined with relevant data, some statistics on the number of talents were made in some provinces and cities in China in 2020. Table 1 shows the statistical results.

In Table 1, the number of talents in Beijing, Shanghai, and Zhejiang was relatively large, with more than 5.8 million undergraduates and more than 1.6 million postgraduates. It could be seen that these areas had gathered a massive amount of high-quality talent. The number of talents in Sichuan and Jiangsu was slightly lower than that in Beijing, Shanghai, and Zhejiang, but the overall number of talents was also relatively high. The number of talents in Hebei was relatively small.

Mechanisms of Urbanization on Environmental Pollution

China's urbanization process is still accelerating, and the country's urban population is still growing, resulting in pollution emission effects, technological effects, and agglomeration effects, which have had a certain impact on the urban environment [14]. At the same time, the scale of cities is expanding, and the level of urbanization is also improving. The mechanisms of their impact on environmental pollution are shown in Fig. 1.

Table 1. Number of talents in some provinces and cities in China in 2020.

Provinces and cities	Number of undergraduate students (ten thousand)	Number of postgraduate students (ten thousand)
Beijing	652.7	210.5
Shanghai	614.6	194.7
Zhejiang	587.2	166.7
Sichuan	514.9	124.3
Jiangsu	528.9	127.4
Jiangxi	357.6	53.1
Hebei	389.4	98.4

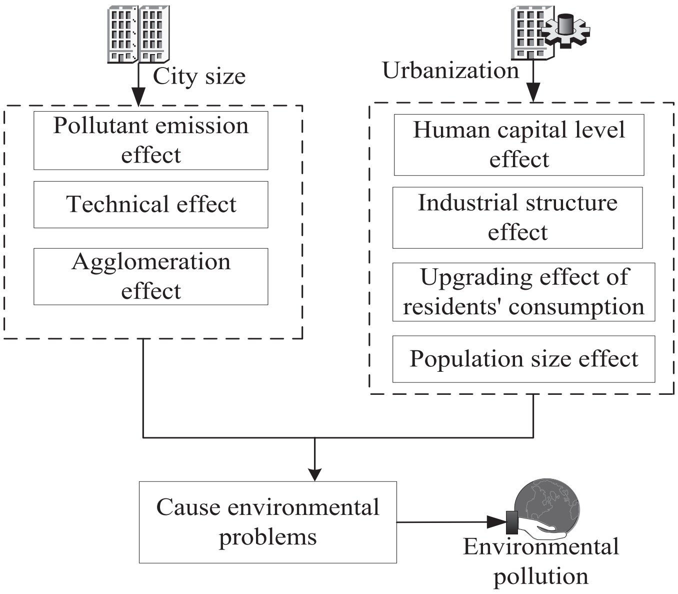

Fig. 1. Urban scale and urbanization level action mechanism on environmental pollution.

Urbanization is Accelerating the Upgrade of Urban Industrial Structures

The increasing level of urbanization can promote the development of secondary and tertiary industries, thus promoting rapid transformation, optimization, and upgrading of urban industrial structures. Cities have good human resources, production technology, and other resource elements, so strong support can be provided for the transformation and upgrading of urban industries. In the initial stage of urbanization, affected by resource conditions and technological level, the development speed of the secondary industry can be relatively fast, far exceeding that of the tertiary industry. As urbanization continues, the development of the tertiary industry continues to accelerate and occupies a greater and larger share of the economic structures. In addition, public facilities are built vigorously in urban areas to provide better life services for mankind. A strong guarantee of the development of the industry can be provided by the construction of transportation and the development of information and communication.

Impact of Upgrading Industrial Structures on Environmental Pollution

Various structures of industrial development have different impacts on the urban environment. When a city is dominated by secondary industries, the problem of environmental pollution in the city is more serious [15]. When the industrial structure begins to transform, optimize, or upgrade, the production capacity of the enterprises is also constantly improving. It is also possible to increase the efficiency of resource utilization; the emission of pollutants can be reduced accordingly. When a city is dominated by the tertiary industry, economic growth comes mainly from the service industry, which belongs to low-emission industries and brings less pollution to the urban environment, which can effectively ameliorate the environmental problems of the city.

Industrial Agglomeration and Urban Environmental Pollution

Current Situation of Urban Environmental Pollution in China

(1) Total urban pollution emissions

The growth of the urban industry has helped to expand the industrial economy but has also hurt the urban environment due to pollution emissions, causing great ecological damage. The emissions of the main industrial pollutants in 180 cities in China from 2015 to 2020 are shown in Table 2. The annual emissions of different industrial pollutants were very large, which showed that they were extremely destructive to the urban environment, but the emissions of these pollutants also showed a decreasing trend year by year, indicating that the emissions of pollutants had also been effectively controlled.

All types of waste produced by industrial operations are the main cause of environmental pollution, so it is important to examine how industry affects environmental pollution from the point of view of the industrial sector [16]. Industrial wastewater, industrial waste gas, and industrial solid waste emissions are the main causes of environmental pollution, and the discharge of these wastes plays a role in constraining economic development as well as hurting people’s health and the economy’s ability to grow sustainably.

The development of industrial agglomeration attracts a large number of enterprises to gather in cities, resulting in a surge in urban population, and the

Table 2. Emissions of major industrial pollutants in 180 cities in China from 2015 to 2020.

Year	Industrial wastewater discharge (ten thousand tons)	Industrial exhaust emissions (ten thousand cubic meters)	Industrial solid waste discharge (ten thousand tons)
2015	1648952	687452	257
2016	1503574	681576	239
2017	1495230	678512	221
2018	1304857	672598	212
2019	1185924	668145	204
2020	987452	662951	182

agglomeration process can lead to intensive effects. With a rapid increase in population, the consumption of various resources and energy increases, resulting in more pollutant emissions and increasingly serious environmental pollution issues. For this reason, the Chinese government has also begun to formulate relevant environmental protection policies to strengthen the control of environmental pollution.

(2) Distribution of urban environmental pollution

Table 3 shows the pollution emissions in cities in different areas of China from 2017 to 2020. It could be found that the emissions of pollutants in cities were still very large, but on the whole, they showed a gradual downward trend. Among them, the reduction of industrial wastewater emissions was relatively large, and the reduction of industrial solid waste gas emissions was smaller.

The eastern region had a strong economy and a comparatively strong capacity for technological innovation. With the advancement of urbanization, the construction of urban facilities was more perfect, and the level of greening was also higher, so the pollutant emissions in the region had also been significantly reduced. Relatively, urbanization in the central and western regions had been relatively slow. Their industrial types were still dominated by primary and secondary industries, among which the manufacturing and intensive industries produced more pollutants and whose pollutant emissions were reduced less.

Mechanism of Industrial Agglomeration Affecting Environmental Pollution

Industrial agglomeration can promote the development of economies of scale, and its economies of scale effects can be demonstrated at the enterprise level, the industrial level, and the regional level. When the development of industrial agglomeration gradually matures, it can play a role in environmental pollution through the following effects: The mechanism of industrial agglomeration that affects the environment is shown in Fig. 2.

(1) Economies of scale

Industrial agglomeration affects the scale impact of the environment both positively and negatively. The negative side is that it causes pollution of the environment, while the positive side is that it can indirectly improve the environment [17]. The negative impact is as follows: When too many companies are concentrated in the agglomeration area, more arable land can be occupied. At the same time, it also increases the consumption of resources, thus increasing the emission of pollutants, resulting in more serious environmental pollution problems. The specific positive impact is that industrial agglomeration helps to expand the scale of industry, and a large number of funds gather here to form certain economic benefits, thus promoting economic development. With the improvement of human life quality, more attention is paid to environmental quality issues, and a greater awareness of environmental

Table 3. Urban pollutant emissions in various regions of China from 2017 to 2020.

Year	Eastern Region		Central Region		Western Region	
	Industrial wastewater discharge (ten thousand tons)	Industrial solid waste discharge (ten thousand tons)	Industrial wastewater discharge (ten thousand tons)	Industrial solid waste discharge (ten thousand tons)	Industrial wastewater discharge (ten thousand tons)	Industrial solid waste discharge (ten thousand tons)
2017	758214	98	514852	74	342583	46
2018	724765	90	502813	69	335891	42
2019	698620	81	499572	63	324785	39
2020	671953	69	471478	58	312045	35

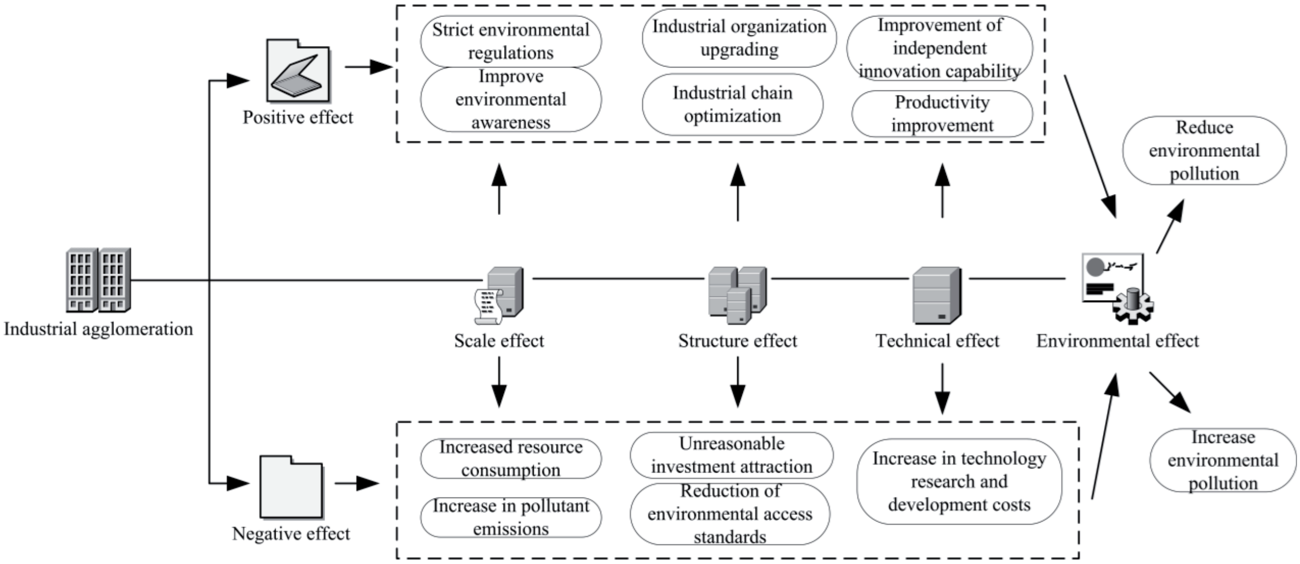

Fig. 2. Mechanism of Industrial Agglomeration Affected by the Environment.

protection is developed. Following industrial consolidation, enterprises are growing in size and can raise additional funds.

(2) Structural effects

The impact of industrial agglomeration on the effect of environmental structure is divided into positive and negative aspects [18]. Industrial agglomeration not only makes the links between enterprises in the region closer but also aggravates the competition between them. With the continuous competition for land, labor, and other resources, production costs gradually increase. However, some regions seek excessive economic benefits. To encourage various international investors to make investments here, they reduce environmental access standards. It seems to change the industrial structure, but it does not achieve the goal of upgrading the industrial structure and aggravates environmental pollution.

(3) Technology effects

The technological effect of industrial agglomeration refers to the promotion of technological innovation through the use of knowledge spillover and technology spillover effects, especially environmental protection technology. The improvement of the technological level can increase energy utilization efficiency, conserve energy, reduce emissions, and improve environmental quality [19]. Industrial agglomeration makes the industrial division of labor more detailed and specific, and after the division of labor tends to be specialized, labor productivity is improved accordingly. Geographically, industrial concentration helps speed up the flow of knowledge, technology, and ideas. Agglomeration can promote the circulation of different factors in the region to achieve the optimal allocation of resources, but also to maximize the use of enterprise resources, and technical efficiency can be improved.

Countermeasures to Improve Urban Environmental Pollution

(1) Guiding moderate industrial agglomeration and improving technological level

To establish an industrial agglomeration, it must be effectively controlled and its scale kept within reasonable bounds. In China, the level of industrial agglomeration is not high, so further improvement of the level of industrial agglomeration is necessary. Effective control of the scale of industrial agglomeration and maintenance of industrial agglomeration can help alleviate the problem of environmental pollution in the region.

The level of industrial technology needs to be improved. In the industrial agglomeration formation process, the level of industrial technology is one of the key elements. The higher the level of industrial technology, the more obvious the advantage of entering the industrial agglomeration zone, helping to improve the overall industrial level of the region. The sharing of technology can also enhance the overall competitiveness of industrial agglomeration areas.

(2) Strengthening policy guidance and planning of industrial agglomeration

Friendly cooperation between superior industries is strengthened to improve the overall competitiveness of agglomeration areas. The one-sided pursuit of geographical industrial agglomeration cannot effectively improve environmental problems, let alone economic benefits [20, 21]. In the process of industrial agglomeration, the industrial agglomeration leading industry should be given priority as much as possible. Industrial agglomeration zones must be formed. Information circulation between industries should be promoted, and competitiveness should be enhanced. Environmental problems can be effectively improved.

The industrial agglomeration in the eastern region is slightly better compared to the central and western regions. Therefore, the advantages of the eastern region should be fully exploited, and government departments should allow high-value-added industries to enter the eastern region [22, 23].

IPAT Model Settings

The IPAT model, which is used primarily to study the effects of population growth on the environment, integrates the key components of environmental issues and human driving forces to provide the appropriate analysis framework. The impact of an area on the environment or ecosystem is influenced by population size and affluence, as well as by the level of technology that underpins that affluence. The IPAT model is also applied to analyze the environmental impact caused by human activities and to account for the main causes of environmental problems [24, 25].

The classic IPAT model is expressed as

$$\text{Impact(I)} = \text{Population(P)} \times \text{Affluence(A)} \times \text{Techology(T)} \tag{1}$$

When analyzing a single variable, it is necessary to optimize the performance of the IPAT model. The formula can be expressed as

$$I_q = wE_q^r T_q^y Y_q^u p_q \tag{2}$$

Among them, q represents the year; w represents the coefficient of the model; r, y, and u represent the driving force index of demographic factors, affluence factors, and technological factors respectively; p_q represents the random error term.

Industrial agglomeration variables are incorporated into the IPAT model to examine the impact link between industrial agglomeration and environmental pollution and the IPAT model is expanded to obtain [26, 27]:

$$I_q = wE_q^r T_q^y Y_q^u A_q^s p_q \tag{3}$$

Among them, A_q^s represents the variable of industrial agglomeration, and s represents the driving force index of industrial agglomeration.

After logarithmic processing of the extended model, it can be obtained that:

$$\ln I_{jq} = w + r\ln E_{jq} + y\ln T_{jq} + u\ln Y_{jq} + s\ln A_{jq} + p_{jq} \tag{4}$$

Among them, j represents the regional scope.

The degree factor of agglomeration in Formula (4) is decomposed, and the model is transformed into the following:

$$\ln I_{jq} = w + r\ln E_{jq} + y\ln T_{jq} + u\ln Y_{jq} + s\ln A_{jq} + s_2(\ln A_{jq})^2 + s_3(\ln A_{jq})^3 + p_{jq} \tag{5}$$

The degree of industrial agglomeration is indicated by the entropy index, which has the following calculation formula.

$$D_{jq} = \frac{f_j}{\sum_{j=1}^{m} f_j} / \frac{G_j}{\sum_{j=1}^{m} G_j} \tag{6}$$

Among them, f_j represents the relevant indicators of a region; G_j represents the relevant indicators of a higher level of the region; m represents the number of industrial sectors.

The improved IPAT model is processed by logarithm on the data, and the formula is as follows:

$$\ln(\text{FUS}_{jq}) = w + r\ln(\text{PTP}_{jq}) + y_1\ln(\text{PGDP}_{jq}) + y_2\ln(\text{PGDP}_{jq})^2 + u\text{STP}_{jq} + s\text{STM}_{jq} + p_{jq} \tag{7}$$

Industrial Agglomeration and Environmental Pollution Analysis Experiment

This study collected panel data from five Chinese provinces between 2019 and 2022 as a sample data set for experimental research to confirm the usefulness of the IPAT model in assessing industrial agglomeration and environmental pollution [28, 29]. This article performed comparison experiments using standard models and evaluated and analyzed data sets from different provinces using the IPAT model. The test findings are shown below.

Industrial Agglomeration Test

This paper investigated and examined the data sets of each province in terms of industrial agglomeration to compare the performance differences between the two models, and the test results are shown in Fig. 3.

Fig. 3a) shows the test of the degree of industrial agglomeration under the model method in this paper.

Fig. 3b) shows the test of the degree of industrial agglomeration under the traditional model method.

Generally speaking, industrial agglomeration has a certain negative effect on urban environmental pollution; that is, the higher the degree of industrial agglomeration, the more serious the environmental pollution in the city [30, 31]. In Fig. 3, it can be seen that there are also some differences in the test of the degree of industrial agglomeration in various provinces under different model methods. In Fig. 3a), the overall degree of industrial agglomeration in different provinces is controlled below 40%. Among these provinces, Jiangxi Province has the lowest degree of industrial agglomeration, 37.26%, and Zhejiang Province has

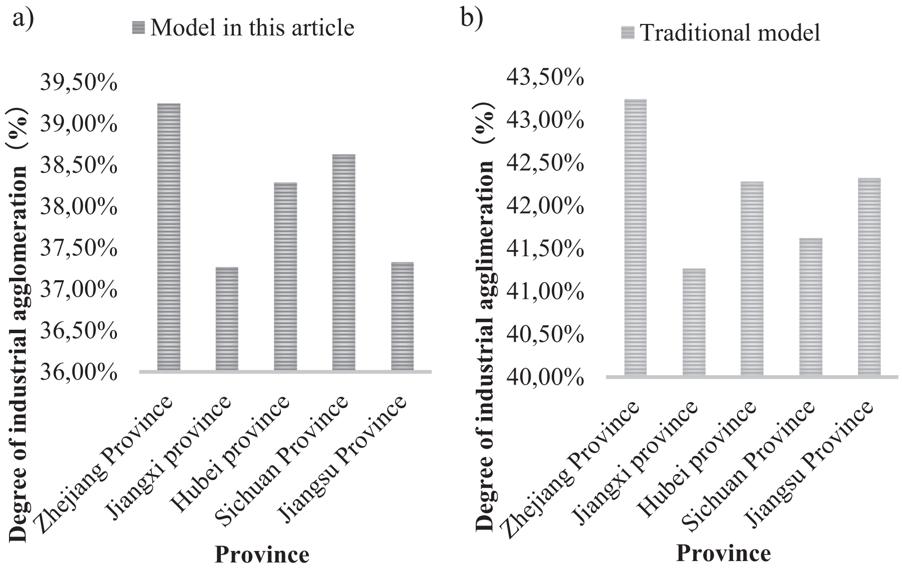

Fig. 3. Test of Industrial Agglomeration Degree Under Different Model Methods.

the highest degree of industrial agglomeration, reaching 39.24%. The average degree of industrial agglomeration in each province is 38.14%. In Fig. 3b), the overall degree of industrial agglomeration in each province exceeds 40%, and the overall degree of industrial agglomeration is higher. Among them, Jiangxi province has the lowest degree of industrial agglomeration, which is 41.26%, and Zhejiang province has the highest degree of industrial agglomeration, which is 43.24%. The average degree of industrial agglomeration in each province can be calculated at 42.14%. From the above data, it can be seen that the degree of industrial agglomeration in each province is lower and the environmental pollution problem is smaller under the model method in this paper, which shows that the model method can effectively improve the urban environmental pollution problem.

Industrial Technology Level Test

This article also conducted a pertinent test analysis from the perspective of industrial technology to further examine the variations between various model approaches. The test results are shown in Fig. 4 [32, 33].

Fig. 4a) shows the test of the industrial technology level under the model method in this paper.

Fig. 4b) shows the test of the level of industrial technology using the traditional model method.

There is a certain link between the level of industrial technology and urban environmental pollution. The higher the level of industrial technology, the lower the pollutant emissions and the smaller the environmental pollution problems. According to Fig. 4, under different model methods, the level of industrial

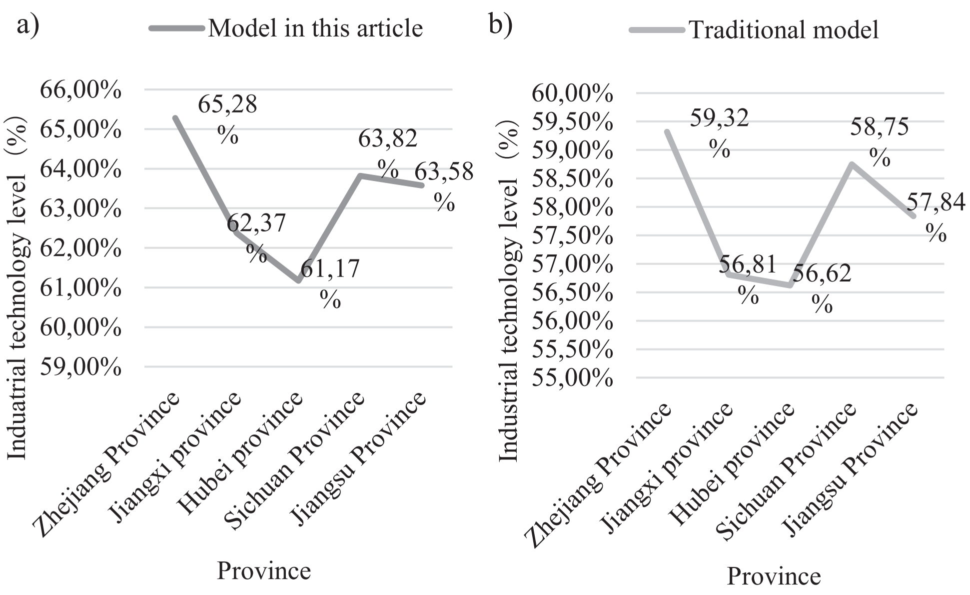

Fig. 4. Industrial technology level test under different model methods.

technology tests in each province is also different. In Fig. 4A, among these provinces, Hubei province has the lowest level of industrial technology, only 61.17%, and Zhejiang province has the highest level of industrial technology, reaching 65.28%. The average level of industrial technology in each province is 63.24%. In Fig. 4B, among these provinces, Hubei province has the lowest level of industrial technology, only 56.62%, and Zhejiang province has the highest level of industrial technology, reaching 59.32%, which can be calculated to indicate that the average level of industrial technology in each province is 57.87%. The aforementioned data indicate that each province's industrial technology level is higher when using the model method described in this paper. This indicates that the model method can efficiently optimize the level of industrial technology, lowering pollutant emissions and addressing urban environmental issues.

Industrial Wastewater Discharge Test

To compare the advantages and disadvantages of the two model methods more thoroughly, this article also carried out relevant tests and analyses in various provinces in terms of industrial wastewater discharge [34]. Fig. 5 shows the test findings.

Fig. 5a) shows the test of industrial wastewater discharge under the model method in this paper.

Fig. 5b) shows the test of industrial wastewater discharge using the traditional model method.

Results and Discussions

Big data industrial agglomeration helps to expand the economic scale. Industrial agglomeration is essentially consistent with the development of enterprises. According to Fig. 5, there is a direct link between industrial wastewater discharge and urban environmental pollution, and the greater the discharge of industrial wastewater, the greater the pollution to the urban environment. According to the data in Fig. 5, there are also obvious differences in industrial wastewater discharge in different provinces under different model methods. In Fig. 5A, the overall discharge of industrial wastewater in different provinces remained below 75 million tons. Among them, Hubei province had the lowest discharge of industrial wastewater, reaching 71.352 million tons, and Sichuan province had the highest discharge of industrial wastewater, reaching 74.656 million tons. The average discharge of industrial wastewater in each province is 72.9364 million tons. In Fig. 5B, the discharge of industrial wastewater in each province exceeds 75 million tons. Among these provinces, Hubei Province has the lowest industrial wastewater discharge, reaching 76.671 million tons, and Sichuan Province has the highest industrial wastewater discharge, reaching 79.578 million tons. The average discharge of industrial wastewater in each province can be calculated to be 78.2412 million tons. In summary, under the model method in this document, the discharge of industrial wastewater in each province is lower, indicating that the model method can effectively control the discharge of industrial wastewater and reduce environmental pollution.

China's digital economy has begun to develop rapidly, gradually integrating and infiltrating various fields such as government governance, enterprise production, and resident life. Economic and social development is under profound change. In this context, this article selected panel data from five provinces in China from the database of online platforms as the sample data set for experimental research. This article tested and analyzed data sets from various provinces using the IPAT model and conducted comparative experiments using traditional models. The main conclusions are as follows: Firstly, the digital economy has significantly

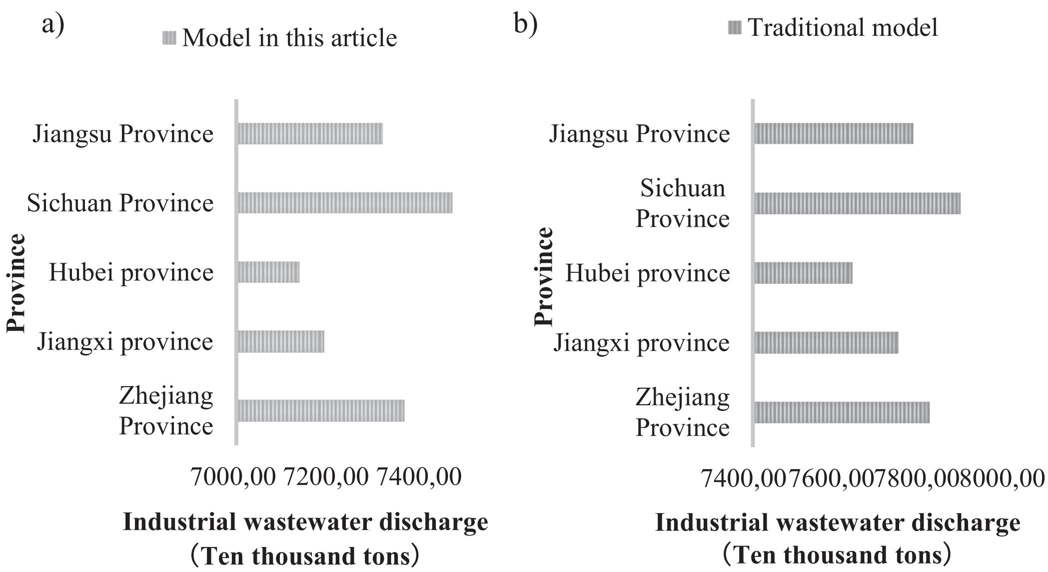

Fig. 5. Test of industrial wastewater discharge under different model methods.

reduced the emission of urban environmental pollutants. After conducting robustness tests using the instrumental variable method, introducing exogenous policy shocks, and replacing explanatory variables, this conclusion still holds. In terms of regional heterogeneity, the pollution reduction effect of the digital economy in the eastern region is greater than in the central and western regions. Second, the spatial spillover effect of the digital economy on urban environmental pollution has also been confirmed, indicating that the digital economy helps to reduce overall regional environmental pollution emissions. Third, the development of the digital economy contributes to the optimization of industrial structure and the improvement of green innovation level and reduces urban environmental pollution emissions through the effects of green innovation and industrial structure optimization.

Conclusions

In the new era, industrial agglomeration tends to be big data, and there is also a big data industry agglomeration, which has expanded the economic scale and promoted the development of finance to a certain extent. This study examined the primary mechanisms by which industrial agglomeration affects environmental pollution, with a particular focus on the impact on urban environmental pollution based on industrial big data agglomeration.

Moreover, this paper constructed an IPAT model, added random variables to the model, and proposed an improved IPAT model. Combined with the model, industrial agglomeration and environmental pollution were tested and analyzed. The experimental results showed that: under the model method in this paper, the degree of industrial agglomeration in each province was lower; the level of industrial technology was higher; and the discharge of industrial wastewater was less. These indicated that the model method could reasonably control the degree of industrial agglomeration, improve the level of industrial technology, and reduce the discharge of industrial wastewater to reduce urban environmental pollution and improve the urban environment. The enhanced IPAT model must also continuously adjust to the real-world requirements of industrial agglomerations, enhance the model's performance, and offer more useful assistance in fostering the coordinated growth of urban environments and industrial agglomerations in future research projects. This study makes the following recommendations based on the aforementioned research findings: The government should encourage the growth of industrial clusters in China that focus on high technology and low pollution, as well as improve its support for technical innovation and environmental protection technologies. Simultaneously, the government should devise and enhance the industry access system, manage the unchecked growth of heavily polluting companies, and institute favorable policies to foster the growth of environmentally conscious businesses. Along with ensuring that environmental protection policies are implemented, the government should also bolster environmental supervision, penalize businesses that break laws and regulations, actively support industrial restructuring, encourage enterprise transformation and upgrading, and foster the coexisting development of the environment and economics.

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Conflict of Interest

The authors declare no conflict of interest.

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