Research on the Influencing Factors of China's Industrial Agglomeration Level Based on Configuration Perspective

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Abstract. With the development of Internet and artificial intelligence, the level of industrial agglomeration has gradually become the top priority to competitiveness. This study uses the fuzzy-set qualitative comparison analysis (fsQCA), based on the configuration perspective. Based on the cross-sectional data of 31 provinces in 2023, the conditional configuration path of high industrial agglomeration level (CYJJSP) is constructed. And the influence of six main factors on CYJJSP is analyzed, which are economic development level, government intervention degree, regional innovation level, industrial structure, transportation development level, and human capital. The study shows that: First, none of the six single antecedent conditions is necessary for high CYJJSP, but it is helpful to achieve high CYJJSP in general. Secondly, high CYJJSP needs multi-condition linkage mechanism to achieve, and two configuration paths are obtained after processing data. The configuration is tested for robustness by changing the threshold or consistency, and the configuration is still stable after the test. Finally, by comparing the two configuration paths, it is found that there is an obvious substitution relationship between the condition combinations. The study explores the effect of each factor, which not only enriches the theoretical framework for achieving high CYJJSP, but also provides practical guidance for high CYJJSP.

Keywords: Industrial Agglomeration Level, Configuration Perspective, Influencing Factors, Fuzzy-Set Qualitative Comparative Analysis.

1. Introduction

With the development of Internet and artificial intelligence, the level of industrial agglomeration (CYJJSP) has gradually become the core element of competitiveness. Our research on the influencing factors of CYJJSP can provide an operable and realistic guidance path for improving CYJJSP.

Currently, there are some studies on the influencing factors of CYJJSP. For example, Yang and He (2008) studied the impact of natural resource dependence and transportation conditions on industrial agglomeration[1]. Tang and Li (2021) discussed the impact of fiscal decentralization policy on industrial agglomeration [2]. Qiao and He (2023) studied the impact of smart city on high-tech industrial agglomeration [3]. Zhang and Gao (2024) explored the impact of higher vocational education agglomeration on industrial agglomeration [4]. However, the existing research only focuses on a certain aspect, and the influence of factors on CYJJSP is a single antecedent condition, which lacks promotion and applicability, especially the in-depth study of multi-factor linkage mechanism. Based on the gaps in the existing research, this research can enhance the generalization and applicability of the results.

This study is based on the perspective of configuration, according to the cross-sectional data of 31 provinces in 2023, using fsQCA to construct the conditional configuration path of high CYJJSP, and analyze the effect of six factors on CYJJSP. The main work is as follows: First of all, draw lessons from the factors that affect CYJJSP in the existing research, and sort out the six most important factors that may affect CYJJSP. Secondly, query the cross-sectional data of these six factors in 31 provinces in 2023, apply fsQCA to find the conditional configuration path, and verify the robustness of the configuration results by changing the threshold or consistency. Finally, the path relationship between different configurations is compared, and the substitution relationship between different combinations of conditions is explored. The conclusion of this study provides theoretical value and practical guidance for the improvement of CYJJSP.

2. Literature review

At present, the research on the factors affecting the level of industrial agglomeration and improving methods can be divided into three categories.

2.1. Related research on industrial agglomeration level and resource conditions

Most of the relevant studies take resource conditions as an influencing factor. Yang and He (2008) found that the improvement of transportation conditions, the expansion of average enterprise size and the decline of local protection will all be conducive to industrial agglomeration [1]. Wei and Li (2021) researched that economic development level, transportation convenience and cultural resources can all promote the development of cultural industry agglomeration in various provinces [5]. Cheng et al. (2021) explored the value of the industrial architectural heritage of Guangzhou to the cultural and creative industry park. The study also analyzed the development conditions, economic benefits of cultural and creative industry agglomeration [6].

2.2. Related research on industrial agglomeration level and institutional conditions

Many relevant studies are based on institutional conditions. Song et al. (2016) explored the effects of regional development strategies and plans against the background of unbalanced inter-regional economic development, focusing on the development of the manufacturing industry [7]. From the perspective of new institutional economics, You (2020) found that institutional quality improved the high-tech industry agglomeration level. The driving effect of the new model shows a significant threshold effect [8]. Tang and Li (2021) discussed the impact of fiscal decentralization and distortion effect on industrial agglomeration from the perspective of fiscal system [2]. Xu et al. (2022) empirically tested the net effect of the establishment of state-level high-tech zones on the level of industrial collaborative agglomeration based on the data of 283 prefectural cities from 2004 to 2018 [9]. Feng et al. (2022) analyzed the relationship between environmental regulation and industrial agglomeration, and also explained the heterogeneity of economic development level and environmental regulation intensity among regions[10].

2.3. Related research on industrial agglomeration level and ability conditions

Wu et al. (2010) found that the interactive influence of enterprise adaptive behavior and networking is the driving force for industrial cluster development[11]. Tang and Liu (2013) first analyzed the characteristics of the development of Tianjin's cultural industry. Then they proposed the strategy to promote the agglomeration and development of cultural industry [12]. Xu et al. (2019) comprehensively analyzed the competitiveness of China's six major automobile industry clusters, and emphasized the current situation and characteristics of the Yangtze River Delta automobile industry cluster[13]. Qiao and He (2023) found that smart city can reduce urban carbon emission levels by promoting urban technological innovation and high-tech industrial agglomeration [3]. Zhang and Gao (2024) explored the impact of agglomeration of higher vocational education on industrial agglomeration [4].

In short, the existing researches provide a rich theoretical basis and practical experience for in-depth exploration of the influencing factors and improvement paths of CYJJSP, but there is also room for further exploration. On the one hand, the existing empirical research mainly focuses on the analysis of a single antecedent variable. However, with the continuous development of economy and society, the factors reflected are more and more diversified, and the paths are different, and the conditions for multi-factor linkage research have been met. On the other hand, considering that CYJJSP is often affected by multiple complex factors, we think fsQCA has the advantage of analyzing the joint effect between variables. And it can better reveal the complex mechanism of multi-factor linkage.

3. Research method

3.1. Model Design

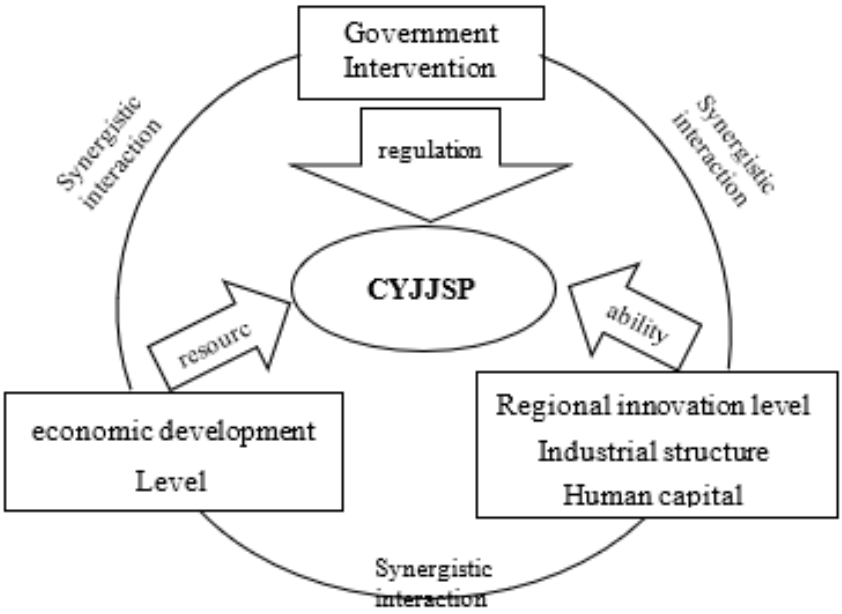

Figure 1. Research ideas of influencing factors

Taking regional CYJJSP as the explained variable, six explanatory variables affecting regional CYJJSP are obtained according to existing studies. They are: economic development level, government intervention degree, regional innovation level, industrial structure, transportation development level, and human capital. The six explanatory variables are divided into three dimensions: resources, institutions and abilities. These three aspects are the main factors affecting the regional CYJJSP, but the three dimensions do not affect the CYJJSP independently, but through the interaction and linkage mechanism between them. Therefore, we constructed the correlation graph model. The research idea of model is shown in Figure 1.

3.2. Methods

Although the correlation graph model between the variables is constructed, the exact mechanism of the influence between the explanatory variable and the explained variable needs to be further studied. In order to analyze the specific influence mechanism, this paper adopts fsQCA, and the specific reasons are as follows.

First, cross-sectional data of 31 provinces on these six variables were obtained through the National Bureau of Statistics. The fsQCA method is suitable for this type of sample and can compare data across 31 provinces, providing reliable analysis results even if the sample size is small.

Second, because there are six condition variables in our study, the causal relationship with the outcome variable CYJJSP is complex. And fsQCA can identify and analyze this complex causal relationship, which is suitable for research needs.

In addition, compared with other methods, fsQCA can effectively identify the combination of conditions and analyze different configuration paths. Not only does it help us to understand the relationship between different factors, but it also provides practical guidance for the real path, and the analysis results are highly reliable.

3.3. Variable indicators

Taking the CYJJSP of the region as the explained variable, the industrial agglomeration level index is used to measure it by drawing lessons from existing research. The index of industrial agglomeration level is the average of the location entropy of the secondary industry and the location entropy of the tertiary industry.

Entropy is the ratio of ratios, which reflects the degree of specialization of an industrial sector and the status and role of a region in a high-level region. Location entropy is a meaningful index in measuring the spatial distribution of a regional element, reflecting the degree of specialization of an industrial sector, and the status and role of a region in a high-level region. The following is the formula 1.

The calculation formula of location entropy is:

$$LQ\text{ij} = \frac{\frac{qij}{qj}}{\frac{qi}{q}} \quad (1)$$

In this formula, *LQij* is the location entropy of industry i in region j in the whole country, *qij* is the relevant index of industry i in region j (such as output value, employment number, etc.); *qj* is the relevant index of all industries in region j; *qi* refers to the relevant index of industry i in the whole country; *q* is the relevant index of all industries in the whole country. The higher the value of *LQij*, the higher the level of regional industrial agglomeration.

Six influencing factors are regarded as the explained variables, which are abbreviated as the first letter of the Chinese name. This study is divided into three levels of index system, as well as data sources and references, as shown in Table 1.

Table 1. Index System of Industrial Agglomeration Level

First-level indicator	Secondary indicator	Short name	Three-level indicator	Data source	References
The level of industrial agglomeration	Industrial Agglomeration Level Index	CYJJSP	The average location entropy of the second industry and the third industry	China Statistical Yearbook-National Bureau of Statistics	Tang and Li, 2021[2]
Influencing factors	Economic development level	JJFZSP	Per capita GDP (yuan/person)	China Statistical Yearbook-National Bureau of Statistics	Sun et al., 2024[14]; Wei and Li, 2021[5]
	Government intervention degree	ZFGYCD	General expenditure of local finance/GDP (%)	China Statistical Yearbook-National Bureau of Statistics	Zhang et al, 2024[15]
	Regional innovation level	DQCXSP	Annual number of patents authorized by region (piece)	China Statistical Yearbook-National Bureau of Statistics	Xu et al, 2022[9]
	Industrial structure	CYJG	Tertiary industry output value/GDP(%)	China Statistical Yearbook-National Bureau of Statistics	Sun et al., 2024[14]
	Transportation development level	JTFDCD	Total freight volume of the region in one year (10,000 tons)	China Statistical Yearbook-National Bureau of Statistics	Zhang and Gao, 2024[4]
	Human capital	RLZB	Number of students in regional institutions of higher learning (person)	China Statistical Yearbook-National Bureau of Statistics	Xu Shidao et al., 2022[9]

4. Analysis of results

4.1. Variable calibration

In fsQCA, calibration is the process of classifying cases into fuzzy sets. The degree of dependency of the calibration is in the range of 0 to 1. In order to map the value of the conditioning variable to the interval, the actual distribution of the conditioning variable needs to be considered in the study. And the value representing the moderation of the conditioning variable needs to be selected as the reference point for calibration.

According to liu et al.'s research (2024)[16], we selected 95%, 50%, and 5% as calibration points in this study. Excel is used to calculate the intersection point for each variable. And the calibration points for each variable are shown in Table 2.

Table 2. Calibration of conditions and results of industrial agglomeration level

Conditions and results		Calibration point		
		Full affiliation	Intersection	Not affiliated at all
Result variable	CYJJSP	1.23	0.94	0.73
Resource conditions	JJFZSP	170125.86	73617.78	52991.85
	JTFDCD	358833.00	179704.00	20656.00
Institutional conditions	ZFGYCD	48.59	21.76	12.77
Ability conditions	DQCXSP	414420.50	60120.00	7175.00
	CYJG	68.95	52.40	43.65
	RLZB	2636960.00	1137073.00	130047.50

4.2. Analysis of necessary conditions

In the study, fsQCA is used to analyze whether the six condition variables are necessary conditions for CYJJSP. As shown in Table 3.

Table 3. Analysis of Necessary Conditions for Industrial Agglomeration Level

Condition variable	High level of industrial agglomeration		Non-high industrial agglomeration level	
	Consistency	Coverage	Consistency	Coverage
JJFZSP	0.802	0.826	0.494	0.526
~JJFZSP	0.540	0.508	0.837	0.814
ZFGYCD	0.455	0.474	0.782	0.842
~ZFGYCD	0.849	0.790	0.512	0.492
DQCXSP	0.771	0.886	0.399	0.474
~DQCXSP	0.542	0.466	0.903	0.803
CYJG	0.703	0.737	0.559	0.605
~CYJG	0.623	0.578	0.757	0.725
JTFDCD	0.730	0.757	0.498	0.534
~JTFDCD	0.551	0.515	0.773	0.747
RLZB	0.706	0.725	0.531	0.536
~RLZB	0.574	0.543	0.740	0.722

Note: ~ indicates logical not.

For regions with high CYJJSP, despite their generally high coverage and explanatory nature, the agreement for a single conditioning variable is below 0.9, the lower bound on the necessity of the necessary condition. This shows that there is no necessary condition to produce a high CYJJSP region. For the non-high CYJJSP region, only the non-high DQCXSP was consistent above 0.9. This shows that a non-high DQCXSP is a necessary condition for a non-high CYJJSP.

4.3. Configuration analysis

Due to the weak explanation of a single condition factor for the high level of industrial agglomeration, based on the calibrated truth table, the consistency threshold is set to 0.8. The frequency is set to 1, and the PRI consistency is greater than 0.70. Then two configuration paths are obtained. The configuration results are shown in Table 4.

Table 4. Configuration Analysis of High Industrial Agglomeration Level

Condition configuration	Configuration 1	Configuration 2
JJFZSP	●	●
ZFGYCD	⊗	⊗
DQCXSP		●
CYJG	●	
JTFDCD	⊗	●
RLZB	⊗	●
Consistency	0.916	0.904
Original coverage	0.336	0.511
Unique coverage	0.134	0.309
Consistency of solutions	0.905	
Coverage of solutions	0.645	

Note:●or● indicates that the condition exists, and⊗or⊗indicates that the condition does not exist;●or⊗indicates the core condition, ●or⊗indicates the auxiliary condition. A blank represents the presence or absence of a condition. The following tables are interpreted in the same form.

Table 4 presents two configuration paths of high industrial agglomeration level, and each column represents a possible condition configuration. The consistency index of single configuration is higher than critical value of 0.8, which indicates that the configuration has certain credibility as a sufficient condition for high industrial agglomeration level. And the overall consistency is 0.905, indicating that the configuration under the complete solution belongs to the high level of industrial agglomeration by 90.5%. The coverage of the complete solution is 0.645, which indicates that the case of the configuration under the complete solution has 64.5% degree of explanation. From the single condition (horizontal) analysis, it is found that the high level of economic development appears in the two configuration paths, indicating that the high level of economic development plays a key role in the high level of industrial agglomeration.

Longitudinal analysis of these two paths shows that the high level of industrial agglomeration in each region is affected by the three dimensions of resources, systems and capabilities. In order to further identify the differentiated adaptation relationship of resources, systems and capabilities in affecting the level of industrial agglomeration, it can be summarized as follows:

(1) Level of economic development-industrial structure driven path. Corresponding to configuration 1 in the table, the core conditions are the existence of the level of economic development and the absence of the degree of government intervention. The auxiliary conditions are the existence of industrial structure, the degree of transportation development and the lack of human capital. The configuration shows that without considering the level of regional innovation, when the level of government intervention, transportation development and human capital of a province are at a low level, it can achieve a high level of industrial agglomeration by paying more attention to improving the level of economic development and optimizing the industrial structure. Representative areas are Beijing, Tianjin, Shanghai and Chongqing. Taking Beijing as an example, Beijing's transportation development and human capital rank relatively low in the country, and the degree of government intervention is low, so it does not have a comparative advantage. However, as the capital, Beijing has a high per capita GDP, a high level of economic development, a continuous improvement of the total economic volume and remarkable advantages. At the same time, with the promotion of Beijing-Tianjin-Hebei integration, Beijing's industrial structure is constantly optimized and upgraded,

and the industry is transforming to high-end manufacturing, especially the rapid development of high-tech industries[17]. The industrial structure has been constantly adjusted, and the industrial structure has shown high-quality development. Beijing's economic advantages and industrial structure optimization promote the improvement of Beijing's industrial agglomeration level and lay a solid foundation for high-quality industrial development.

(2) Economic development level-regional innovation level-transportation development level-human capital synergy driving path. Corresponding to the configuration 2 in the table, the core conditions are the existence of the level of economic development and the absence of the degree of government intervention. The auxiliary conditions are the level of regional innovation, the degree of transportation development and the existence of human capital. The configuration shows that, without considering the industrial structure, when the degree of government intervention in a province is low, it should pay attention to the level of regional innovation, the degree of transportation development and human capital, especially the level of regional economic development. Then it can also have a high level of industrial agglomeration. The representative provinces are Jiangsu, Guangdong, Hubei, Shandong, Zhejiang, Anhui and Hunan. Taking Jiangsu Province as an example, the level of economic development ranks first in China, and shows a sustained and steady growth trend. Jiangsu Province has many colleges and universities, attracting a large number of highly educated people to gather[18]. So, the education level of residents is in the forefront of China, the level of regional innovation is high, and the level of human capital is also high. At the same time, the province's infrastructure construction investment is large, highway, railway, water and air transport services continue to upgrade, promote the innovation and transformation of the transport industry, and improve the level of transport development. The level of economic development, regional innovation ability, transportation development and human capital have made Jiangsu Province achieve a high level of industrial agglomeration.

4.4. Robustness test

The above results were tested for robustness. The robustness of the configuration is checked by changing the threshold or consistency. First, the threshold is modified to 0.75, resulting in two configuration paths. In addition, the consistency can also be modified to 2 for robustness test. The test results obtained are shown in Table 5. The analysis shows that after the robustness test, the configuration is still stable and the reliability of the results is high.

Table 5. Robustness test of high industrial agglomeration level configuration

Condition configuration	Threshold changed to 0.75		For consistency read 2	
	Configuration 1	Configuration 2	Configuration 1	Configuration 2
JJFZSP	●	●	●	●
ZFGYCD	⊗	⊗	⊗	⊗
DQCXSP		●		●
CYJG	●		●	●
JTFDCD	⊗	●	⊗	●
RLZB	⊗	●	⊗	●
Consistency	0.916	0.904	0.916	0.920
Original coverage	0.336	0.511	0.336	0.420
Unique coverage	0.134	0.309	0.134	0.218
Consistency of solutions	0.905		0.917	
Coverage of solutions	0.645		0.554	

4.5. Analysis of substitution relationship among influencing factors

Further comparison of condition configurations 1 and 2 identifies potential substitution relationships, as shown in Figure 2.

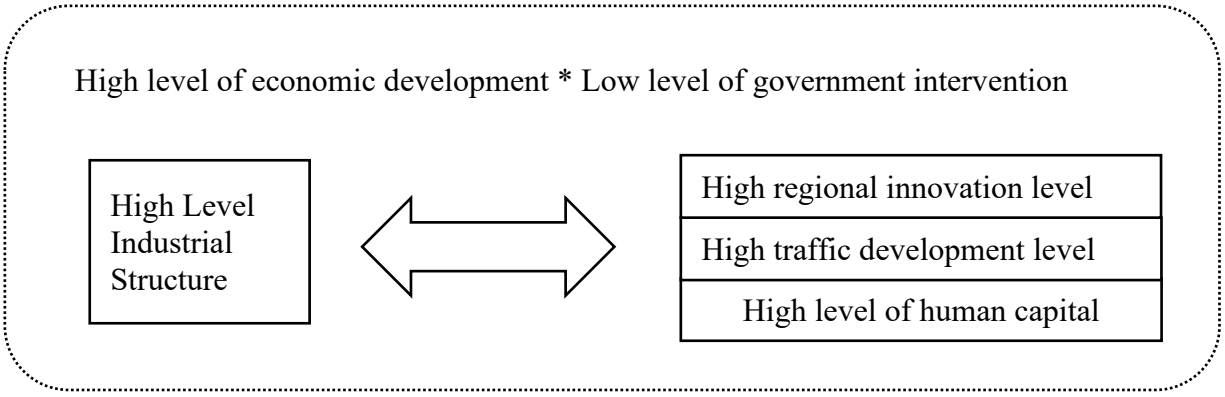

Figure 2. The substitution relationship between the influencing factors

By comparing condition configuration 1 and 2, it is found that there is obvious substitution relationship between industrial structure and the combination of conditions of regional innovation level, traffic development level and human capital, that is, under the condition of high economic development level and low government intervention level, When combined with the combination of high-level industrial structure or high regional innovation level, high level of traffic development and high level of human capital, the high level of industrial agglomeration can be presented, as shown in Figure 2. In summary, the high-level industrial structure has more important applications.

5. Research contribution

5.1. Theoretical contribution

This paper provides a theoretical contribution to the study of the level of industrial agglomeration. First of all, this study enriches the relevant research on the level of industrial agglomeration in China and builds a more perfect theoretical framework. In addition, this paper is also conducive to expanding the related research of configuration theory, confirming multiple paths to achieve high CYJJSP, and further promoting the configuration perspective.

5.2. Countermeasures and suggestions

According to the research in this paper, there are four suggestions as follows.

First of all, for areas with low government intervention, traffic development and human capital, the level of industrial agglomeration can be improved by optimizing and upgrading the industrial structure, especially the level of economic development. Regions with a high level of economic development have a higher per capita GDP and a significant advantage in economic aggregate. At the same time, the continuous optimization and upgrading of the industrial structure promotes the high-quality development of the industrial structure. The economic advantage and the optimization of industrial structure together push the improvement of industrial agglomeration.

Secondly, for areas lacking the degree of government intervention, the level of industrial agglomeration can be improved by improving the level of economic development, improving the regional innovation ability, improving the level of transportation development, and improving the role of human capital. The gathering of highly educated talents is conducive to improving the regional innovation level and human capital level. The promotion of infrastructure construction has promoted the innovation and transformation of the transportation industry, and the development level of transportation has been continuously improved.

In addition, generally speaking, the improvement of the level of regional industrial agglomeration is the core condition of the improvement of the level of economic development and the lack of government intervention. Therefore, improving the level of regional economic development is the top priority.

Finally, there is a substitution relationship between industrial structure and regional innovation level, traffic development and human capital, and the high-level industrial structure plays a more

important role in the level of industrial agglomeration. Under the condition of high level of economic development and low degree of government intervention, the combination of high level of industrial structure or high level of regional innovation, high level of traffic development and high level of human capital can present a high level of industrial agglomeration. From this point of view, upgrading the industrial structure can play a greater role in promoting industrial agglomeration.

6. Conclusions

This study provides practical suggestions for each province to improve the level of industrial agglomeration. It can be seen from this study that there are multiple configuration paths to achieve high-level industrial agglomeration. Among them, improving the level of economic development is the core condition for industrial agglomeration. The degree of government intervention can be lacking. And there is a substitution relationship between industrial structure and regional innovation level, traffic development and human capital, and the high-level industrial structure plays a more important role in the level of industrial agglomeration.

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