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Research on the economic resilience of Chinese cities and analysis of its influencing factors - Based on the perspective of China's three major urban agglomerations

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Abstract: *The spatial and temporal evolution patterns of the economic resilience of the three major urban agglomerations in China from 2011 to 2019 and the influencing factors were quantitatively analyzed using ENTROPY, AHP hierarchical analysis, GIS spatial analysis and Delphi methods: (1) The economic resilience of China's three major urban agglomerations has been on a year-on-year upward trend, but the gap has increased year by year, indicating a weak capacity for synergistic upgrading. (2)The economic resilience all demonstrate a core-edge spatial distribution pattern of "The core-edge spatial distribution pattern is the highest, the geographically adjacent cities the second highest and the peripheral cities the lowest". (3)The rate of university students has a significantly positive impact on the increase of economic resilience, foreign direct investment, urban construction and urbanization rate as well as urban GDP growth rate have less impact on the increase of economic resilience and economic agglomeration has uncertainty on the increase of economic resilience. In the future, China's three major urban agglomerations should develop synergistic measures to enhance economic resilience in terms of narrowing the gap between urban agglomerations and strengthening inter-city economic relationships.*

Keywords: *Economic resilience; Spatial and temporal evolution; Synergistic upgrading; Three major urban agglomerations*

1. Introduction

The global economic situation is changing, the traditional governance mechanisms are in their old age and are subjective to the influence of many factors, such as trade and economic games between countries, fluctuations in economic cycles, economic restructuring, the impact of technological revolutions, the chain of economic crises and the global impact of sudden public crises. "Change and adaptation" has thus become a prominent feature of economic development in this period. The trend of change, differentiation and adjustment in the world economy will continue for a longer period of time and sudden external risk factors and disruptive factors will continue to be released. How to adequately resist the disturbance of external complex factors, promote stable and sustainable economic growth, achieve quality and efficiency development, and thus enhance the "resilience" of economic development has become a topic of in-depth discussion in various countries. The current epidemic prevention and control of the new crown has also made it clear that enhancing economic resilience has a significant impact on quality economic development, and that building a more resilient economy and society should become an important strategy.

A great deal of research has been conducted by domestic and international scholars around economic resilience, mainly focusing on the basic concepts and evaluation measures. Resilience was first introduced to ecology by Holling and has since been extended to economics, especially since the outbreak of the financial crisis has led to a sudden increase in the risk of instability in the economic system, and economic resilience has received increasing attention from governments and academics [1]. Hassink et al. proposed that economic resilience is the capacity of an economic system to recover after being negatively affected by changes in the external environment [2]. Martin et al. argue that economic resilience is the ability of an economic system to adapt and leap to a new steady state in the face of external shocks [3]. Zeng Bing et al. further emphasize that economic resilience is characterized by the

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dynamic adaptation and evolutionary adjustment of the economic system, with a continuous dynamic evolutionary capacity [4]. The measurement of economic resilience can start from several dimensions. Chen Yiwei et al. used the real GDP growth rate of several prefecture-level cities as the measurement data to measure economic resilience and calculated the difference between the real GDP growth rate of each city and the city's GDP growth rate in 2008 to reflect the change in resilience [5]. Sun Jiuwen et al. used the GDP growth rate of each province to reflect the trend of economic resilience and the development pattern [6]. While most of the above cases use the core indicator method to measure economic resilience, the multidimensional indicator method mainly refers to the construction of a comprehensive evaluation indicator system based on the connotation characteristics of economic resilience, such as the ability to resist risks, adaptability and innovation and transformation, in order to measure economic resilience. In summary, the core indicator method focuses on the economic resilience of a certain period of time and its resilience index lacks time continuity, while the multidimensional indicator method is relatively more comprehensive in characterizing and quantifying the connotation characteristics and dimensional indices of economic resilience. This paper adopts the multidimensional indicator method to measure the economic resilience of different urban agglomerations.

2. Indicator Selection

As the table below (Table 1), this paper selects four criteria to study the level of economic resilience of cities. The industrial agglomeration degree is mainly used as the urbanization rate, which is a positive indicator. The city GDP growth rate mainly reflects the macroeconomic development level of a city and is the best and positive indicator to measure the economic situation of a region. The proportion of tertiary sector income to GDP is an important and positive indicator of the optimization of a city's industrial structure, the greater the proportion of this indicator, the more rational the economic development structure of the region tends to be. The sensitivity of the city's economy is mainly selected from the proportion of FDI to GDP, the proportion of income from primary industry to GDP and the rate of university students per 10,000 people in school. Except for the rate of university students per 10,000 people, which is also a positive indicator, the other two indicators are all negative.

Table 1: The comprehensive system of indicators to evaluate economic resilience

Base level	Indicator level	Directionality
Degree of industrial agglomeration	Urbanization rate	Positive
Level of economic growth	Urban GDP growth rate	Positive
Degree of industrial structure optimization	Tertiary sector as a share of GDP	Positive
Urban Economic Sensitivity	FDI as a share of GDP	Negative
	Primary sector as a share of GDP	Negative
	Rate of university students per 10,000 population	Positive

3. Research Method

According to the definition of entropy, the smaller the entropy value of an indicator, the greater the dispersion of the indicator, the greater the impact (i.e. weight) of the indicator on the overall evaluation. This paper will use this method to score the economic resilience of cities.

Hierarchical analysis or AHP for short, which is used in indicator selection, is a decision-making approach in which the elements always relevant to a decision are broken down into levels of objectives, standards and options, on the basis of which qualitative and quantitative analysis is carried out.

The GIS spatial analysis approach refers to the implementation of the analysis of spatial data in GIS (Geographic Information System), i.e. obtaining and analyzing information about the spatial location, distribution, morphology, formation and evolution of geographical objects from spatial data. In this paper, this approach will be used to study the level and distribution of urban economic resilience in three major urban agglomerations.

The Delphi method is essentially a feedback-based and anonymous correspondence method. Its general process is that after obtaining the opinions of experts on the issues to be predicted, they are collated, summarized and counted, then anonymously fed back to each expert, opinions are sought again, aggregated again and fed back again until a consensus is obtained. In this paper, this method will be used to determine the indicator weights in order to study the impact of each indicator on the economic resilience of cities.

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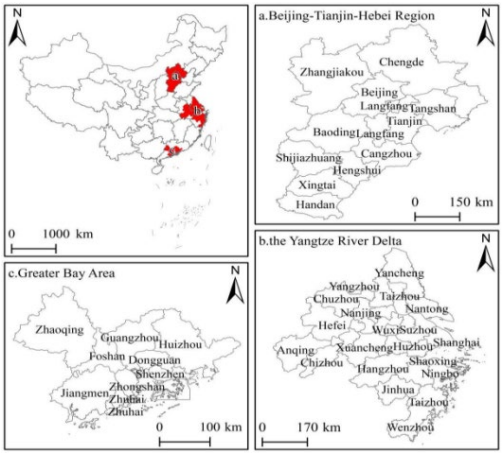

***Analysis of empir**ical results*

As you can observe from Figure 1, the three major urban agglomerations in this paper refer to the Beijing-Tianjin-Hebei Region, the Yangtze River Delta and the Greater Bay Area, mainly including three municipalities and five provinces, with 48 prefecture cities.

Figure 1: The map of the administrative divisions of the three major urban agglomerations

4.1 Temporal Dimension

Based on the average economic resilience score for each agglomeration from 2011 to 2019 calculated by the above methods, a line chart has been created according to the classification of urban agglomerations.

According to the data shown in Figure 2, the average economic resilience of China's three major urban agglomerations from 2011 to 2019 showed a year-on-year upward trend, from 36.45 in 2011 to 36.74. The economic resilience of the Beijing-Tianjin-Hebei Region, the Yangtze River Delta and the Greater Bay Area urban agglomeration all showed a year-on-year upward trend, from 35.79, 36.58 and 36.98 in 2011 to 35.94, 36.98 and 37.30 in 2019, respectively. Among them, the Greater Bay Area urban agglomeration has the highest level of economic resilience, the Yangtze River Delta has the second highest level of economic resilience and the Beijing-Tianjin-Hebei Region has the lowest, the gap between the Beijing-Tianjin-Hebei Region and the remaining two urban agglomerations is relatively obvious. In summary, although the economic resilience of China's three major urban agglomerations is stably increasing, their ability to improve collaboratively is weak.

Figure 2: The average score of economic resilience of urban agglomerations from 2011 to 2019

4.2 Spatial Dimension

The economic resilience of 48 cities in China's three major urban agglomerations was classified according to their high, medium and low levels using the equipartition method, just as shown in Figure 3 (2011) and Figure 4 (2019). However, in terms of the proportion of cities with high levels of economic resilience within urban agglomerations, the Greater Bay Area has the highest proportion at 44.44%, the Yangtze River Delta has the second highest proportion at 34.62% and the Beijing-Tianjin-Hebei Region has the lowest proportion at 23.08%.

It can be seen that the spatial distribution pattern of economic resilience of China's three major urban agglomerations is basically the same, cities with high economic resilience mainly being the central cities

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of the three major urban agglomerations, mainly cities at sub-provincial level or above, cities with medium economic resilience mainly surrounding the central cities and in geographical proximity to cities with high economic resilience, while cities with low economic resilience are mainly peripheral cities, distributed in the peripheral areas of their respective urban agglomerations. In summary, the economic resilience of China's three major urban agglomerations shows a spatial distribution pattern of "central cities are the highest, geographically adjacent cities are the second highest, and peripheral cities are the lowest", the gap in economic resilience between cities within each urban agglomeration is relatively obvious.

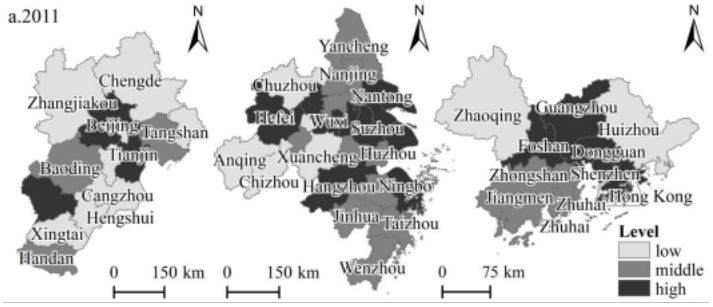

Figure 3: Spatial distribution pattern of economic resilience of urban agglomerations in 2011

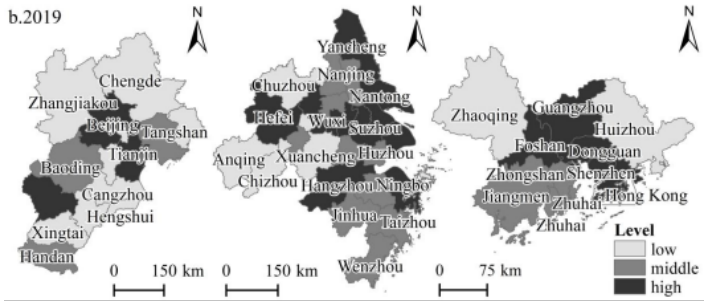

Figure 4: Spatial distribution pattern of economic resilience of urban agglomerations in 2019

4.3 Analysis of influencing factors

There is variability in the influence of different indicators on urban economic resilience. Table 2 demonstrates that the impact of the percentage of university students on the economic resilience of a city is significant. The reason is that the rate of university students reflects a city's investment in research and innovation, cities with a higher rate of university students have a higher capacity for research and innovation. The reason is that the ratio of university students reflects a city's investment in research and innovation, and cities with a higher ratio of university students are more capable of research and innovation and have a greater advantage in facing external shocks. The followings are the urbanization rate and urban GDP growth rate, which also affects the city's economic resilience to a large extent.

Table 2: The final weights of each indicator determined by Delphi method (Unit: %)

Analysis factors	2011	2012	2013	2014	2015	2016	2017	2018	2019
Urbanization rate	2.0	1.5	2.02	1.2	2.1	2.4	2.3	2.2	2.5
Urban GDP growth rate	10.7	11.7	0.134	17.7	23.7	16.4	16.3	17.8	16.9
Tertiary sector as a share of GDP	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
FDI as a share of GDP	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Primary sector as a share of GDP	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Rate of university students per 10,000 population	33.4	33.5	35.4	35.3	35.4	35.6	35.4	35.7	35.6

5. Conclusions and recommendations for countermeasures

5.1 Basic conclusions

(1) In terms of the temporal dimension, the average economic resilience of China's three major urban

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agglomerations on the whole from 2011 to 2019 shows an upward trend year by year, among which, the Greater Bay Area urban agglomeration has the highest level of economic resilience, the Yangtze River Delta has the second highest level of economic resilience and the Beijing-Tianjin-Hebei Region has the lowest level of economic resilience. The gap between the Beijing-Tianjin-Hebei urban agglomeration and the other two urban agglomerations is relatively obvious.

(2) From a spatial perspective, the economic resilience of China's three major urban agglomerations illustrates a spatial distribution pattern of a core-edge structure, with the central cities being the most resilient, the geographically adjacent cities being the second and the peripheral cities being the least. Cities with high economic resilience are mainly the central cities of the three major urban agglomerations, mainly cities at sub-provincial level or above, while cities with medium economic resilience and cities with high economic resilience are in geographical proximity, while cities with low economic resilience are mainly located in the peripheral areas of their respective urban agglomerations.

(3) In terms of influencing factors, the rate of university students has a significantly positive impact on the increase of economic resilience, while foreign direct investment, urban construction and urbanization rate as well as urban GDP growth rate have less impact on the impact of economic resilience, therefore, economic agglomeration has uncertainty on the increase of economic resilience.

5.2 Suggestions for countermeasures

(1) Reduce the level gap of economic resilience among the major urban agglomerations and give full play to the core cities' radiation-driven role and continuously enhance the surrounding cities' ability to undertake transfers, so as to enhance the economic resilience of the city agglomerations as a whole.

(2) Strengthen the economic linkages between core-fringe cities and enhance the synergistic ability to enhance economic resilience among cities within these urban agglomerations.

(3) These three major city agglomerations should pay more attention to both inter- and outer-city agglomeration’s economic resilience of the three major urban agglomerations in China.

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