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Evaluation on developing level of urban agglomeration derived from resources exploration:Grey relational comprehensive evaluation

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ABSTRACT

Urban agglomeration derived from resources exploration is a sort of urban agglomeration formed in the urban agglomeration formation process and evolution process after resources-based cities based on resources exploration. It is limited in the angle of urban agglomeration development and has significant significance on regional scientific research. This paper has introduced basic principles of matter element evaluation model, based on which, this paper has made systematic evaluation on urban agglomeration derived from resources exploration in China and got the following conclusion that urban agglomeration with highlighting characteristics of old industrial bases gets higher development level and eastern urban agglomeration has higher education level than western regions in terms of such urban agglomeration development level.

KEYWORDS

Development level;
Grey relational comprehensive evaluation;
Urban agglomeration.

INTRODUCTION

Urban agglomeration derived from resources exploration is a sort of urban agglomeration formed in the urban agglomeration formation process and evolution process after resources-based cities based on resources exploration. It is limited in the angle of urban agglomeration development and has significant significance on regional scientific research.

This paper plans to measure and evaluate education level of urban agglomeration derived from resources exploration and makes the following arrangements: first part is research overview at home and abroad; second part is introduction of evaluation methods, third part is introduction of research methods, fourth part is discussion, and fifth part is analysis of evaluation results of urban agglomeration derived from resources exploration in China.

EVALUATION INDEXES OF DEVELOPMENT LEVEL OF URBAN AGGLOMERATION DERIVED FROM RESOURCES EXPLORATION IN THIS PAPER

Evaluation indexes involve mining cities, agglomeration degree of urban agglomeration, urbanization level and social economic development condition.

Evaluation and determination of agglomeration degree of urban agglomeration is symbolized by two indexes including gravity (gravity force) model and primacy ratio. Gravity model is important research content of urban spatial interaction and applied widely in

TABLE 1 : Evaluation indexes of urban agglomeration derived from resources exploration

	A. Evaluation Angle	B. Evaluation Indexes	C. Meanings of Indexes
Evaluation of Development Condition of Urban Agglomeration Derived from Resources Exploration	Resources-Based Cities	Number Proportion of Resources-Based Cities	Number of Resources-Based Cities/Total Urban Number of Urban Agglomeration
		Population Proportion of Resources-Based Cities	Population of Resources-Based Cities/Total Population of Urban Agglomeration
		Area Proportion of Resources-Based Cities	Construction Area of Resources-Based Cities/Construction Area of Urban Agglomeration
	Agglomeration Degree of Urban Agglomeration	Gravity Index	Average Gravity Index of Urban Agglomeration
		Primacy Ratio of Core Cities	Primate City Population/Second City Population
	Urbanization Level	Proportion of Non-Agricultural Output Value	Non-Agricultural Output Value/GDP
		Proportion of Non-Agricultural Population	Non-Agricultural Population/Total Population
		Urban Built-up Area Ratio	Built-Up Area of Urban Agglomeration/Total Area
	Social Economic Condition	GNP Per Capita	GDP Per Capita
		Industrial Structure	Value-Added of the Tertiary Industry/Urban GDP
		Employment Structure	Employees of the Secondary and Tertiary Industry/All Employees
		Urban Environment	Green Ratio of Built-Up Area
		Greenland Area	Greenland Area Per Capita
		Environmental Pollution Control	Percentage of Industrial Waste Water up to the Standards for Discharge
		Scientific and Technical Innovation	Expenditure of Scientific Research
		Scientific and Technical Staff	Scientific and Technical Staff Number
		Consumption Expenditure	Total Social Retail Sales of Consumer Goods
		Educational Expenditure	Total Educational Expenditure

geography as the earliest model in spatial economic research[62], which is used by Chinese scholars to take research of urban systematic spatial structure and urban agglomeration spatial structure[63] and is used by the author to take research of urban agglomeration economic spatial interaction (in 2008). Intercity gravity is one expression of intercity interattraction and is proportional to intercity interattraction and is inversely proportional to the distance between two cities in terms of urban spatial scope. Gravity inversely proportional to distance indicates that radiation effect of central city on outer city trends to decrease with increasing distance in urban agglomeration space. Intercity gravity is the index to measure the strength of interregional economic contact, which can not only reflect radiation and attraction ability to surrounding area of economic central city but also reflect reception degree of surrounding area to economic central radiation and attraction ability. Gravity model connotation is:

DETERMINATION METHODS OF DEVELOPMENT LEVEL OF URBAN AGGLOMERATION DERIVED FROM RESOURCES EXPLORATION

Grey relational comprehensive evaluation and measurement principle

Grey theory becomes more and more mature in recent years, and grey comprehensive evaluation is widely applied in matter comprehensive evaluation and analysis. "Grey system" is a concept of control theory, and can divide the systems into "black" (have no idea about internal information) and "white" (have full information) in terms of color according to information mastering degree of human, and the system that has part information is called as grey system. Grey system is medium system between white system that has full information and black system that has no idea. Grey system theory possesses a great many advantages as the theory to research and treat complex system from incomplete information rather than to discuss from internal special rules of the system, make math processing of observation data at one level of the system and then achieve to higher level so as to understand internal change trend and mutual relation of the system.

Grey systematic theory mainly research the following aspects seen from recent condition: relational analysis of grey factors, grey modeling, grey prediction, grey decision, grey system analysis, grey system control and grey system optimization, etc[69]. Urban agglomeration system is a multiple-level, complex and fuzzy system, and index system of measured urban agglomeration designed in the former sections is made according to urban agglomeration theory, but such indexes are only of one measurement of urban agglomeration system in terms of development condition of urban agglomeration from certain dimension as one incomplete measurement, so grey theory shall meet the following basic requirements for system evaluation: information is incomplete, namely "grey". Hereto the author mainly wants to use the thought and methods of grey theory to make grey comprehensive evaluation of urban agglomeration system, and mainly use relational analysis of grey factors as mentioned above. Grey relational analysis refers to similar degree of two curves, while in urban agglomeration measurement, we adopt an ideal urban agglomeration (all measuring indexes are best), and then compute differences between each urban agglomeration and ideal urban agglomeration, and accordingly order them according to the differences, namely rank the urban agglomerations.

The largest advantages of grey relational analysis method is that it has no strict requirements for data volume, and can make analysis not matter the data is huge or little. Due to its math method is non-statistical method, which is more practical when the system data is little and the condition does not meet statistical requirements. Comprehensive evaluation procedure adopting grey relational analysis is as following:

Data teatment

m objects and n indexes consist of evaluated data matrix X

$$X=\begin{bmatrix} x_1(1) & x_1(2) & \dots & x_1(n) \\ x_2(1) & x_2(2) & \dots & x_2(n) \\ \dots & \dots & \dots & \dots \\ x_m(1) & x_m(2) & \dots & x_m(n) \end{bmatrix}=\begin{bmatrix} X_1 \\ X_2 \\ \dots \\ X_m \end{bmatrix} \quad (1)$$

$X_i(i=1,2,...m)$ refers to the i-th evaluated object, $x_i(j)(i=1,2,...m,\ j=1,2,...n)$ refers to the selected value at j index of the i-th object, and it consists of matrix of n indexes of m objects.

Take standardized or normalized treatment and remove dimension effect of measuring data of each object, and there are a great many methods to treat data, like extremum method, standardization method, point type and domain type, etc[69]. Given x_{ij} as source data, M_j as maximum value of the j-th index, m_j as minimum value of the j-th index, and as data after treatment, then:

Maximization data conversion: $\mu_{ij}=x_i(j)/M_j$ (2)

Minimization data conversion: $\mu_{ij}=1+m_j/M_j-x_i(j)/m_j$ (3)

Standardization data conversion: $\mu_{ij}=\dfrac{x_i(j)-\overline{x}_j}{\sigma_j}$ (4)

Structure reference sequence

Reference sequence is the optimal value of each index feature of evaluated matter, as to "cost target", smaller data is better; as to "benefit target", larger data is better.

$$X_0 = [x_0(1) \quad x_0(2) \quad \dots \quad x_0(n)] \tag{5}$$

Among which, $x_{0j}(j=1,2,...n)$ is the optimal value of the j-th index[70].

Compute grey degree of incidence

Grey degree of incidence $\xi_i(k)$ is the distance between the i-th evaluated object and the optimal (ideal) object, with expression as follows:

$$\xi_i(k) = \frac{\min_i \min_k |X_0(k) - X_i(k)| + \delta \max_i \max_k |X_0(k) - X_i(k)|}{|X_0(k) - X_i(k)| + \delta \max_i \max_k |X_0(k) - X_i(k)|} \tag{6}$$

$\min_i \min_k |X_0(k) - X_i(k)|$ and $\max_i \max_k |X_0(k) - X_i(k)|$ are the minimum absolute difference and the maximum absolute difference respectively. $\xi_i(k)$ is also called as grey absolute degree of incidence GADI, coefficient $\delta \in [0,1]$ generally adopts 0.5, and is to reduce effects of extremum on final determination result.

Build up matrix of grey degree of incidence:

$$E = \begin{bmatrix} \xi_1(1) & \xi_1(2) & \dots & \xi_1(n) \\ \xi_2(1) & \xi_2(2) & \dots & \xi_2(n) \\ \dots & \dots & \dots & \dots \\ \xi_m(1) & \xi_m(2) & \dots & \xi_m(n) \end{bmatrix} \tag{7}$$

Determine index weights and compute weighted degree of incidence

Determine weight vector of each index in final evaluation:

$$W = [\omega_1 \quad \omega_2 \quad \dots \quad \omega_n]^T \tag{8}$$

Among which, $\sum_{i=1}^{n} \omega_i = 1$

Computation model of grey comprehensive evaluation is:

$$R = \begin{pmatrix} r_1 \\ r_2 \\ \dots \\ r_m \end{pmatrix} = EW = \begin{bmatrix} \xi_1(1) & \xi_1(2) & \dots & \xi_1(n) \\ \xi_2(1) & \xi_2(2) & \dots & \xi_2(n) \\ \dots & \dots & \dots & \dots \\ \xi_m(1) & \xi_m(2) & \dots & \xi_m(n) \end{bmatrix} * \begin{pmatrix} \omega_1 \\ \omega_2 \\ \dots \\ \omega_n \end{pmatrix} \tag{9}$$

Rank

According to computation result of formula (9), rank the evaluated objects, and then grey comprehensive evaluation is finished.

Measurement of development level of urban agglomeration derived from resources exploration in china

Adopt two methods based on the evaluation methods of urban agglomeration derived from resources exploration as mentioned above, collect and compute statistical index measuring value of each urban agglomeration according to related data of Chinese City Statistical Yearbook 2007 and statistical yearbook of each related provinces and cities, and measure development condition of each urban agglomeration derived from resources exploration, with measuring value of each index referring to the appendix.

Index measuring value scope and grading standard

We build up grading standard and measuring value scope of each in the quartile computing method in statistics according to evaluation index system of urban agglomeration derived from resources exploration and measuring value scope of each index built up in TABLE 2. Moreover, we divide development condition of urban agglomeration derived from resources exploration into four stages according to definition standard of urban agglomeration of Chinese and foreign scholars: formation stage, primary development stage, stable development stage and mature stage[1].

Distribution of development stage of urban agglomeration derived from resources exploration in china

We compute the statuses of each urban agglomeration in each index according to TABLE 3 above and source data of current condition of urban agglomeration derived from resources exploration in China.

Measurement of grey relational evaluation method

We make standardized treatment of source data of urban agglomeration derived from resources exploration in China according to the following formula:

$$\mu_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \tag{10}$$

Then, compute with formula (3.29) to get matrix of

TABLE 2 : Evaluation index system and standards of development level of urban agglomeration derived from resources exploration

Measuring Angle	Measuring Index	Formation Stage	Primary Development Stage	Stable Development Stage	Mature Stage
Resources-Based Cities	Number Proportion of Resources-Based Cities	[0, 0.26]	[0.26,0.35]	[0.35,0.41]	[0.41,0.51]
	Population Proportion of Resources-Based Cities	[0.11, 0.1722]	[0.1723,0.2345]	[0.2345,0.3512]	[0.3513,0.4329]
	Area Proportion of Resources-Based Cities	[0.1032,0.205]	[0.205,0.3124]	[0.3125,0.3895]	[0.3896,0.5402]
Agglomeration Degree of Urban Agglomeration	Gravity Index	[5,17]	[17.01,35]	[36,80]	[81,130]
	Primacy Ratio of Core Cities	[1.3,1.5]	[1.51,1.65]	[1.66,2.35]	[2.36,3.7]
Urbanization Level	Proportion of Non-Agricultural Output Value	[69,79]	[79.1,82]	[82.1,85.4]	[85.45,90]
	Proportion of Non-Agricultural Population	[0.25,0.3304]	[0.3305,0.4025]	[0.4026,0.49]	[0.491,0.75]
	Urban Built-up Area Ratio	[0.0040,0.0078	[0.0079,0.001]	[0.0011,0.013]	[0.0131,0.018]
Social Economic Condition	GNP Per Capita	[1,1.3]	[1.3,1.78]	[1.78,2.3]	[2.3,3.7]
	Industrial Structure	[27,32.3]	[32.3,35]	[35,37.3]	[37.4,39]
	Employment Structure	[0.935,0.96]	[0.96,0.978]	[0.978,0.989]	[0.989,0.994]
	Urban Environment	[27,30.8]	[30.8,34]	[34,36.3]	[36.3,40]
	Greenland Area	[14,26]	[26,32]	[32,38]	[38,42]
	Environmental Pollution Control	[15000,30000]	[30000,48000]	[48000,73000]	[73000,150000]
	Scientific and Technical Innovation	[4500,11000]	[11000,14000]	[14000,23000]	[23000,29000]
	Scientific and Technical Staff	[10000,26900]	[26900,31500]	[31500,50000]	[50000,7100]
	Scientific and Technical Staff	[1200,1450]	[1450,2000]	[2000,3600]	[3600,6700]
	Educational Expenditure	[15,35]	[35,55]	[55,75]	[75,90]

grey degree of incidence of each urban agglomeration. Weight of each index and weight adopted in extensional evaluation is same (TABLE 3).

Compute grey comprehensive evaluation value of each urban agglomeration and rank them to get TABLE 4, which gives comprehensive evaluation results of grey comprehensive evaluation model of development level of each city and analyzes development level of urban

TABLE 3 : Distribution of development stage of urban agglomeration derived from resources exploration in china

	Central Liaoning Urban Agglomeration	Harbin-Daqing-Qiqihar Urban Agglomeration	Central Jilin Urban Agglomeration	Shandong Peninsula Urban Agglomeration	Jianghuai Urban Agglomeration	Wuhan Urban Agglomeration	Urban Agglomeration in the Central Plains	Chengdu-Chongqing Urban Agglomeration	Guanzhong Urban Agglomeration	Beijing-Tianjin-Tangshan Urban Agglomeration
Number Proportion of Resources-Based Cities	4	1	3	1	3	1	2	1	3	2
Population Proportion of Resources-Based Cities	4	1	2	1	2	1	4	4	3	3
Area Proportion of Resources-Based Cities	4	1	2	1	2	1	3	4	2	4
Gravity Index	3	1	1	1	2	3	4	2	4	4
Primacy Ratio of Urban Agglomeration	4	4	2	1	3	4	2	1	3	1
Proportion of Non-Agricultural Output Value	4	1	1	4	3	2	3	1	4	3
Proportion of Non-Agricultural Population	4	2	3	3	1	2	4	1	1	4
Urban Built-up Area Ratio	3	1	1	4	2	3	4	2	2	4
GNP Per Capita	4	3	3	4	1	2	2	1	1	4
Industrial Structure	4	1	2	4	1	3	1	4	2	3
Employment Structure	3	1	1	4	2	1	4	4	4	4
Urban Environment	1	1	2	3	4	4	4	2	1	3
Greenland Area	3	4	2	1	2	3	4	1	1	4
Environmental Pollution Control	1	1	1	2	4	2	3	3	1	2
Scientific and Technical Innovation	3	2	1	1	2	3	4	3	4	3
Scientific and Technical Staff	1	2	1	3	1	2	4	4	4	3
Consumption Expenditure	4	2	1	1	3	3	4	2	4	4
Educational Expenditure	2	3	2	2	4	4	1	3	1	4

Data Source: Computed by the author

agglomeration.

Comparison analysis of extensional evaluation and grey comprehensive evaluation

Analysis of measuring results of two evaluation methods

Measuring results of extensional evaluation and grey relational comprehensive evaluation of urban agglomeration derived from resources exploration in China indicate significant differences between developments of each urban agglomeration.

Firstly, we specified that urban agglomeration constructed is at senior stage of urban agglomeration development. Central Liaoning, Beijing-Tianjin-Tangshan, Central Plains and Guanzhong urban agglomeration are at mature stage of urban agglomeration development, which is indicated by measuring results in view of extensional matter element evaluation model; combined with results of grey relational comprehensive evaluation, the above four urban agglomeration are in the front rank of urban agglomerations, which indicates that final measuring results of two evaluation and measuring models is consistent internally although they are taken from different angles.

TABLE 4 : Grey comprehensive evaluation mark and rank of urban agglomeration derived from resources exploration in china

Urban Agglomeration	Grey Comprehensive Evaluation Mark	Rank
Central Liaoning	0.792772	1
Harbin-Daqing-Qiqihar	0.587723	10
Central Jilin	0.597757	9
Shandong Peninsula	0.67846	5
Jianghuai	0.612792	8
Wuhan	0.644869	7
Central Plains	0.761384	2
Chengdu-Chongqing	0.646675	6
Guanzhong	0.71089	4
Beijing-Tianjin-Tangshan	0.758736	3

Secondly, part urban agglomerations under construction brought forward recently are at formation and rapid development stage. Wuhan, Central Jilin and Jianghuai urban agglomerations are at the middle reaches, and results of model measurement also indicates their development are still under primary development stage, which is related with the bringing forward time of constructing urban agglomeration, accordingly, regional policy makes short term effects on development of urban agglomeration, so measuring results indicate that all these urban agglomeration are under middle development stage, and these regional government ought to make suitable regional development policies according to development stage.

Lastly, resources-based cities get different status in these urban agglomerations, and it makes measuring results mainly reflect effect of resources exploration in urban agglomeration. As to ten urban agglomerations derived from resources exploration brought forward by us, due to different number of resources-based cities contained and different economic status of each resources-based cities, each urban agglomeration can be divided as typical and atypical agglomeration, as mentioned in Chapter II, which is also indicated by measuring results.

Therefore, measuring results of measuring model indicate that measuring index system of urban agglomeration derived from resources exploration is more suitable for evaluation of development condition of these urban agglomerations.

Advantages of combination of extensional evaluation and grey comprehensive evaluation

Seen from analysis of measurement of urban agglomeration derived from resources exploration in the discussion of 3.2.3 and 33, we can find that extensional evaluation model to evaluate urban agglomeration derived from resources exploration can effectively evaluate development stage of each urban agglomeration, and evaluation results are consistent with actual condition, while grey comprehensive evaluation results can rank the grade of matters in extensional evaluation as supplement of extensional evaluation, so combination of the two methods can supplement each other in comprehensive evaluation and rank of matters. Evaluation results can be considered as references to guide practical work.

CONCLUSION

This paper builds up measuring index system of development level of urban agglomeration derived from resources exploration according to the features of urban agglomeration derived from resources exploration, brings into multiple-index extensional element evaluation measuring model and grey relational analysis model, and finishes comprehensive measurement, rank and evaluation of ten urban agglomerations derived from resources exploration in China based on social and economic data of urban agglomerations in China in 2006. Research results indicate that comprehensive application of the two measuring methods can supplement each other; urban agglomeration development stages differ greatly, and grey comprehensive evaluation realizes rank of urban agglomeration at the same stage, measurement and evaluation results offers scientific references for understanding local urban agglomeration development condition in different urban agglomeration regions.

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