Study on the Comparison of Development Efficiency between Inner and Outer Urban Circles and the Balanced Development Strategy of Marginal Areas : Analysis based on the county scale of Chongqing

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Abstract. The article takes 38 counties in Chongqing as the research object, conducts social and economic development data statistics and spatial analysis, and divides them into the core, inner circle and outer circle counties based on the theory of 'core-periphery' and the circle structure characteristics of municipal areas. The data envelopment analysis (DEA), exploratory spatial data analysis (ESDA) and geographically weighted regression (GWR) models are introduced to conduct a comparative analysis of the characteristics of the spatial patterns and factors affecting the development efficiency of the inner and outer circle counties in the municipal area, and to explore the differences in the development of the inner and outer circle counties, as well as the main development problems and strategies.

Keywords: urban circles; development disparities; peripheral areas; balanced development; ESDA

1. Introduction

The interaction between regional development differences at the geographic spatial level and unbalanced regional development policies has accelerated the emergence of the 'core-periphery' structure in regional space (Yang *et al*., 2023). In this regard, many scholars use qualitative, quantitative and other methods to carry out the regional unbalanced development research to demonstrate. Some studies have found that the 'core-periphery' feature is not only reflected in the regional economic differences but also manifested in the social elements such as the cultural divide (Savini *et al*., 2016). When identifying the core or peripheral areas of the region, the regional economic, demographic, political and knowledge levels should be considered and reflected in regional policymaking (Eder, 2019). Meanwhile, the spatial variation trend and distribution characteristics of socio-economic development inequality have also been increasingly concerned (Wei, 2015). Some studies have used the Theil Index (Wei *et al*., 2020), Reilly's Law of Retail Gravitation model (Rana, Routray and Younas, 2020) and Cluster Analysis (Shi, 2023) to reveal the internal development differences of the region and their dynamic evolutionary processes and spatial pattern. Research based on the Multi-dimensional Equality Development Index (MEDI), including economic vitality, innovation capacity, social convenience and inclusiveness, found that the

pattern of spatial inequality in China has shifted from 'coastal-inland inequality' to 'core-periphery inequality' (Yang *et al*., 2023). There is a prevalence of 'core-periphery' spatial development structure in provinces and large cities in China, the phenomenon is mainly produced by the combined effect of natural geographical spatial differentiation, socio-economic spatial organisation and regional spatial connection (Wang and Fan, 2019), and the significant 'core-periphery' structure can exacerbate provincial spatial polarisation and reduce local mobility (Wei *et al*., 2020). Multi-dimensional and multi-scale studies have been carried out on the 'core-periphery' structure within the region. Some scholars have focused on the temporal and spatial variation characteristics of the 'core-periphery' structure in the economic development process of counties within the Yellow River Basin, and used regression models to explore the driving mechanism of the evolution of the 'core-periphery' structure of counties on provincial boundary (Zhang *et al*.,2023). On the inter-provincial scale, the spatio-temporal pattern and formation mechanism of regional economic differences in the inter-provincial fringe areas were discussed (Xia *et al*., 2014; Yu *et al*., 2012). At the provincial and city scales, research often focuses on a typical provincial or municipal unit, specifically analysing the process of change, stage characteristics and internal mechanisms of districts from core to fringe (Yang *et al*., 2023), as well as analysing the spatial pattern of inequality in the provincial area through Spatial auto-correlation Models (Wei and Ye, 2009; Wei *et al*., 2020; Li, Ding and Liu, 2012), and applying multi-level regression model to explore the influencing factors for the formation of the provincial 'core-periphery' structure (Li, Miao and Ye, 2016), and using Geographically Weighted Regression (GWR) to explore the spatial heterogeneity of the factors affecting inequality in the provinces (Wei and Ye, 2009; Cao and Xu, 2018).

Research on the 'core-periphery' structure within regions has been ongoing and has produced rich results, but most of the existing studies have focused on inequality within developed regions in eastern China (Wei and Ye, 2004, 2009; Wei *et al*., 2020; Liao and Wei, 2012, 2015; Zhang, Tong and Liang, 2018), and there are less analyses of county economic differences in less developed western provinces (Zhou and Li, 2021). Therefore, a multidimensional division of analysing the development differences in typical western regions, tailoring regional development strategies according to the degree of marginalisation of the region, and helping marginalised regions to break through geographical constraints to form agglomeration advantages, which have strategic value for accurately improving the level of regional coordinated development (Eder, 2019). Chongqing is a typical city with a 'core-periphery' structure (Wang and Fan, 2019), although counties have made remarkable achievements in economic and social development in recent years, the development level of counties in the non-central urban area is lagging behind, and not only is there a clear gap with the top one hundred counties in the country, but also has no competitive advantage in the ranking of the top one hundred counties in the west. There is significant spatial dependence in the economic and social development of counties in the long term, that is, the economic growth of a district is significantly positively affected by the economic growth of

neighbouring counties. For Chongqing, this trend is even more pronounced, with significant positive spatial correlation in the economic growth of counties, significantly forming a high economic growth agglomeration area mainly consisting of the nine districts in Chongqing's central urban area, as well as a low economic growth agglomeration area mainly located in southeastern Chongqing and northeastern Chongqing. According to 'the Outline of the Fourteenth Five Year Plan and Vision for the 2035 Plan for the National Economic and Social Development of Chongqing Municipality', the ratio of per capita GDP between the 'one region' and the 'two clusters'[1] was 1.84:1 by 2020. Chongqing has markedly regional uneven development characteristics, forming an economic spatial pattern with the 'one region' as the core and the 'two clusters' as the periphery.

Given this, this paper selects Chongqing as the research area, takes counties as the research unit, and divides them into three levels: core, inner circle and outer circle. Analyse the development efficiency of counties in Chongqing, as well as their spatial distribution characteristics and agglomeration patterns. Furthermore, it uses stepwise linear regression and geographically weighted regression models to quantitatively analyse the factors influencing the development efficiency of the counties and explores the spatial heterogeneity of their influencing effects. On this basis, a balanced development strategy for marginal counties is proposed, to provide a theoretical basis for the coordinated development among various circles in the city, and to enhance the overall inclusiveness of the city.

2. Overview of the Study Area, Data and Methods

2.1 Overview of the Study Area

Located in southwestern China, Chongqing is an important growth pole in the western region of China. It covers an area of 82,400 square kilometres and currently has 38 districts and counties under its jurisdiction, including 26 municipal districts, 8 counties and 4 autonomous counties. According to the Fourteenth Five-Year Development Programme of Chongqing, the economic spatial layout of Chongqing has a significant development pattern of circle structure. At the municipal scale, promoting the

[1] 'One Region' and 'Two Clusters': 'One Region' refers to the main urban metropolitan area of Chongqing, which includes nine counties in the central urban area and other twelve counties. Nine central urban counties including Yuzhong, Dadukou, Jiangbei, Shapingba, Jiulongpo, Nanan, Beibei, Yubei, and Banan. Other twelve counties including Fuling, Changshou, Jiangjin, Hechuan, Yongchuan, Nanchuan, Qijiang, Dazu, Bishan, Tongliang, Tongnan and Rongchang, with a permanent population of over 21.22 million in 2022. 'Two Clusters' refers to the town cluster of Three Gorges Reservoir Area in northeast Chongqing and the town cluster of Wuling Mountain Area in southeast Chongqing. The town cluster of Three Gorges Reservoir Area in northeastern Chongqing includes eleven counties, including Wanzhou, Liangping, Kaizhou, Chengkou, Fengdu, Dianjiang, Zhongxian, Yunyang, Fengjie, Wushan and Wuxi, with a permanent population of over 8.04 million in 2022. The town cluster of Wuling Mountain Area in southeast Chongqing includes six counties (autonomous counties), including Qianjiang, Wulong, Shizhu, Xiushan, Youyang, and Pengshui, with a permanent population of over 2.86 million in 2022.

coordinated development of 'one region' and 'two clusters', forming two basic circles, including the main urban metropolitan area and the peripheral counties. At the scale of the main urban metropolitan area, a pattern of gradual development is formed with the 9 central urban districts as the core to drive the tiered development of the new districts of the main urban area.

According to Friedmann's 'core-periphery' theory (Friedmann, 1966), there is a dominant 'core' in the regional development process, where production factors such as capital, technology, labour and production activities are concentrated. From the current development situation of Chongqing, the central urban area composed of nine districts constitutes the core circle. The various elements of the surrounding counties continue to flow out under the siphoning effect of the central urban area, which is gradually being at an unfavourable position in the process of economic development, forming the 'periphery'. According to the Fourteenth Five-Year Development Plan of Chongqing, the counties in the main urban new area are in the main circle of influence of the central urban area, and most of them border directly with one or more administrative districts in the central urban area, and are directly driven by the central urban area, and undertake the spillover of the functions and the industry of the central urban area. With the characteristics of 'the periphery near the core', they are divided into inner-circle counties. The town clusters in the Three Gorges Reservoir Area in the northeast of Chongqing and the Wuling Mountain Area in the southeast of Chongqing, which are developed relatively independently of the central urban area, have a certain spatial distance from the central urban area, do not border one or more administrative districts in the central urban area, and are subject to the limited radiation by the central urban area, and are gradually marginalised in the process of development to form a group of their own. The counties and districts contained in the 'two clusters' are classified as outer-circle counties.

Fig.1. Spatial distribution map of core, inner circle, and outer circle counties in Chongqing

2.2 Data

There is a substantial interactive correlation between the level of regional basic public services and the quality of economic and social development (Fang, 2012; Rana, Bhatti and e Saqib, 2017). Basic public service is one of the core factors directly or indirectly determining the state of economic and social development of a region (Holtz-Eakin and Schwartz, 1995), which plays an important role in promoting economic growth and significantly improving the social equity level (Liu, 2012). At the same time, the level of regional economic development also significantly affects the development of basic public services (Wang *et al*., 2023). Therefore, based on the empirical analysis of the interaction between basic public services and county economic development in Chongqing (Xiong, Yu and Wang, 2019), it is feasible and effective to use the financial expenditure and allocation efficiency of basic public service facilities as an indicator to measure the level of regional development in this paper.

This paper takes 38 districts and counties in Chongqing as the research object. The basic data of all the indexes come from the 2019-2023 Chongqing Municipal Statistical Yearbook, China County Statistical Yearbook (County and Municipal Volume), and 2022 Statistical Bulletin of the districts.

In terms of the selection of indicators for calculating efficiency, based on comparability and accessibility, this paper mainly selects three per capita indicators as input variables, including education expenditure, health expenditure, and social security and employment expenditure. In setting the output variables, the effectiveness of education, health care and social welfare services are taken into account. Adopting a series of representative indicators, including the ratio of students per full-time teacher in general secondary schools, and the ratio of students per full-time teacher in primary schools, which are used to assess the efficiency of the allocation of education resources. Four indicators have also been introduced, including the number of beds in medical and health care institutions per thousand people, the number of medical and health technicians per thousand people, the number of beds in adoptive social service institutions per thousand people and the number of industrial activity units per thousand people, to comprehensively reflect the coverage and effectiveness of public health services and welfare services. Together, these output indicators build a three-dimensional, multifaceted evaluation system to accurately measure the efficiency of financial expenditure and allocation of basic public services.

Table 1
Input and Output Variables for the financial expenditure and allocation of Basic Public Services

Input Variables	Output Variables
Education Expenditure	Number of full-time teachers in general secondary

	schools / Number of students in general secondary schools
	Number of full-time teachers in primary schools / Number of pupils in primary schools
Health Expenditure	Number of beds in medical and health care institutions per thousand people
	Number of medical and health technicians per thousand people
Social Security and Employment Expenditures	Number of beds in adoptive social services institutions per thousand people
	Number of industrial activity units per thousand people

2.3 Methodology

2.3.1 Data Envelopment Analysis (DEA)

DEA is a non-parametric method for efficiency evaluation that can be applied to Decision-Making Units (DMU) with multiple inputs and multiple outputs. This paper adopted the DEA-BCC model in STATA software to measure the efficiency of financial expenditure and allocation of basic public services in each district and county of Chongqing, and used it as a quantitative value to measure the level of regional economic and social development. The model formula is as follows (Charnes, Cooper, and Rhodes, 1978; Liu *et al*., 2020):

$$(BC^2)\begin{cases} \min \theta \\ s.t.\sum_{j=1}^{n}\lambda_j x_{jm} + s_i^- = \theta x_0, i = 1,2,...,m \\ \sum_{j=1}^{n}\lambda_j y_{js} - s_r^+ = y_0, r = 1,2,...,s \\ \sum_{j=1}^{n}\lambda_j = 1, \lambda_j \geq 0 \\ s_i^- \geq 0 \\ s_r^+ \geq 0 \end{cases}$$

Where: $\theta(0<\theta\leq 1)$ is the combined efficiency of decision-making units; n is the number of decision-making units; λ_j is the weighting variable; x_{jm} represents the inputs of the m^{th} indicator of the j^{th} unit, and y_{js} represents the outputs of the s^{th} indicator of the j^{th} unit. s_i^- and s_r^+ are slack variables for the m input variables and s output variables, respectively.

2.3.2 Stepwise Regression Model

Stepwise regression equations were created using the Statistical Package for the Social Sciences (SPSS) to extractive analyse the key factors in the independent variables. Using the optimal model R^2 to explain the coefficients of the model, which represents the overall significance. The standardised coefficients explain the positive and negative correlation with efficiency. Using the sig. to explain the significance of the independent variable on efficiency. The factors that are the main drivers of district and county development efficiency were analysed in this paper, where the various development indicators were the independent variables and the efficiency values were the dependent variables. The model formula is as follows (Paudel and Thapa, 2004):

$$\gamma = b_0 + b_1 x_1 + b_2 x_2 + ... + b_n x_n$$

Where： y is the efficiency value of the dependent variable, b_0 is the intercept, b_1， b_2,..., b_n are the coefficients of the explanatory variables x_1, x_2,...,x_n respectively.

2.3.3 Exploratory Spatial Data Analysis (ESDA)

This paper applied ESDA to measure the spatial correlation of counties in Chongqing. Used the description and visualisation of district and county distribution patterns to detect spatial clustering and spatial anomalies. Took Global Moran's *I* index to analyse the global spatial auto-correlation characteristics of the distribution of counties, and clarified the spatial clustering relationships of the analysed units, that is, high-high clustering, low-low clustering, low-high outliers, high-low outliers or insignificant features. Used hotspot analysis tools to analyse local areas where spatial （1） ıg of high or low development efficiency units were clustered in space. The m nula is as follows (Liu, Hu and Li, 2014):

$$I_i = \frac{n}{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\left(x_i - \bar{x}\right)}{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \qquad (2)$$

$$Z(I_i) = \frac{I_i - E(I_i)}{\sqrt{VAR(I_i)}}$$

Where: I_i represents the overall trend in spatial correlation across the study area; x_i represents the development efficiency at location *i*. W_{ij} is the spatial weight value between elements *i* and *j*, and the neighbourhood matrix is used here. The neighbourhood matrix defines a binary symmetric spatial weight matrix W_{ij} to express the spatial neighbourhood of *n* positions, when *i* and *j* are neighbouring, the element of spatial weight matrix W_{ij}=1, otherwise W_{ij}=0. The value of Moran's *I* is generally in the range of [-1,1], I>0 indicates a positive correlation, and the closer the value tends to be to 1, which indicates that the spatial agglomeration of the research units with the same level of economic development is more significant; I<0 indicates a negative correlation, and the closer the value is to -1, which indicates that the spatial agglomeration of the research units with the different level of economic development is more significant. I=0

means that the regional units are independent of each other, spatially uncorrelated, and randomly distributed.

2.3.4 Geographically Weighted Regression (GWR)

GWR is a spatial regression model based on the idea of local smoothness. Embedding the geographic location of the data in the regression equation can effectively estimate the data with spatial auto-correlation as well as reflect the spatial non-stationarity of the parameters in different regions, which makes the spatial location of the different parameters change, and the results are more in line with reality. This paper used it to study the spatial heterogeneity of the factors affecting the development efficiency of counties in Chongqing. The model formula is as follows (Wei and Ye, 2009):

$$y_i = \beta_0(u_i, v_i) + \sum_{k=1}^{p} \beta_k(u_i, v_i) x_{ik} + \varepsilon_i$$

Where: y_i is the value of the dependent variable of sampling point i; β_0 is the intercept, (u_i, v_i) is the coordinate of sampling point i, β_0 (u_i, v_i) is the constant term of sampling point i; β_k (u_i, v_i) is the coefficient of the k^{th} independent variable of sampling point i; x_{ik} is the k^{th} independent variable of sampling point i; ε_i is the random error term.

3. Result

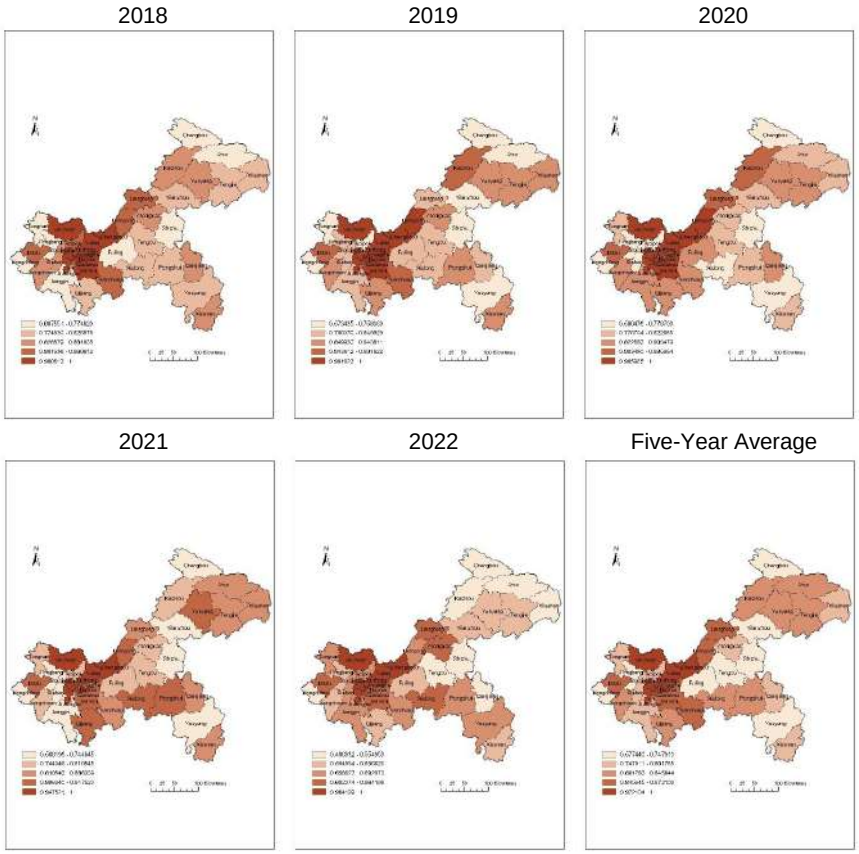
3.1 Spatial Patterns of Development Efficiency

3.1.1 Spatial Distribution Patterns

The spatial distribution of development efficiency in Chongqing's districts and counties were markedly geographically differentiated. The overall development efficiency in the western, northeastern, and southeastern of Chongqing was low. During the study period, areas with less development efficiency had shifted, with the least efficient zones formed in 2018 in western Chongqing, consisting of Tongnan, Tongliang, Rongchang, and Jiangjin districts, which gradually shifted to the least efficient zones in northeastern Chongqing, consisting of Chengkou, Wuxi, Wushan, and Kaizhou counties, and the lowest in southeastern Chongqing, consisting of Shizhu, Fengdu, and Qianjiang counties. From the perspective of circle division, the low-value areas of development efficiency were shifted from the inner circle to the outer circle, and in 2022, there were as many as seven low-value areas of development efficiency in the outer circle of Chongqing, accounting for more than 40 percent of the total.

An analysis of the average development efficiency of the districts and counties in Chongqing found that Yubei, Yuzhong, Shapingba, Nanan and Jiulongpo districts in the central urban area, as well as Hechuan and Changshou districts, which are directly neighbouring the central urban area, had better development efficiency. While Fengdu,

Chengkou and Wanzhou districts in the northeastern part of Chongqing, Shizhu and Youyang counties in the southeastern part of Chongqing, Rongchang and Tongliang



districts in the western part of Chongqing and Fuling districts in the central part of Chongqing had poorer development efficiency, of which Chengkou, Wanzhou, Shizhu, Youyang, and Rongchang district are all located in the municipal boundary area. From the point of view of circle division, the development efficiency of the core circle of Chongqing had been higher, with a stronger radiating and driving role. The number of counties with low development efficiency in the outer circle was significantly higher than that in the inner circle. This showed that the inner circle of counties are being radiated and driven by the central urban area, and the overall level of economic and social development presented a good trend, while the outer circle counties are relatively disadvantaged in terms of spatial distance, subject to the location of the marginalisation of the city, the urbanisation process and the construction of basic public facilities had lagged behind for a long time, the level of economic and social development was relatively low, in the process of economic development, they were in a crisis of being continuous marginalised.

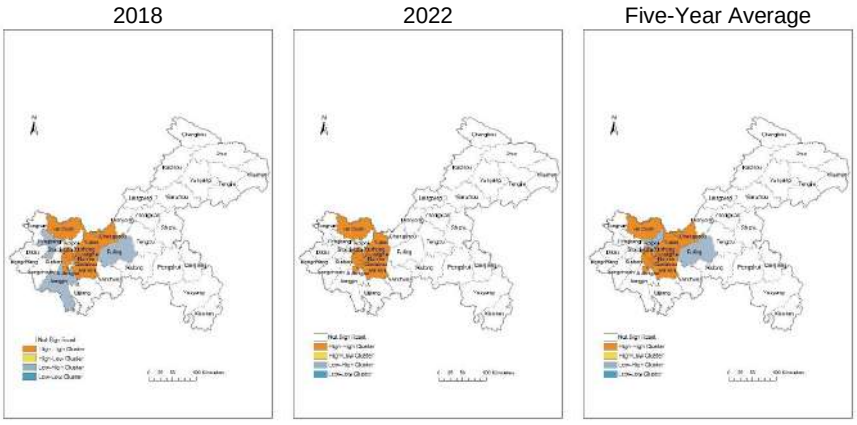
Fig.2. Spatial distribution characteristics of development efficiency of counties in Chongqing during the period 2018-2023.

Further using the global spatial auto-correlation tool（Global Moran's *I*）in ArcGIS *10.2* to analyse the spatial pattern of the development efficiency of Chongqing counties. The Global Moran's *I* index of the development efficiency of counties in Chongqing in each year of the study period was *0.3340*, *0.1528*, *0.2813*, *0.1086*, *0.4577*, and the *Z*-value of the normal statistic was *5.29*, *2.65*, *4.55*, *1.99*, *7.08*, respectively. The Global Moran's *I* index of the spatial distribution of the average development efficiency of Chongqing counties during the study period was *0.3265*, and the *Z*-value of the normal statistic was *5.19*. The index values were all positive and passed the test of significance at the level of *0.05*, indicating that the distribution of development efficiency of Chongqing counties had always had obvious global spatial auto-correlation characteristics. Despite fluctuations, counties with comparable development efficiency had always been highly agglomerated in space, and reached the highest value in 2022. At the same time, there had always been a significant difference in development efficiency between inner-circle counties and core-circle counties, but the gap was gradually decreasing.

Comparison of the results of the spatial clustering and outlier at the beginning and end of the study period showed that， in 2018, the central urban area (except Beibei district), Changshou district, and Hechuan district were high-high clusters, while Tongliang district, Jiangjin district, and Fuling district were low-high anomalies. In 2022, the central urban area (except Beibei district) and Hechuan district were high-high clusters, and the other areas were not significant. This indicated that: 1) counties exhibiting high-high clustering of development efficiency were always concentrated and contiguous, but the scale was shrinking. 2) Tongliang, Jiangjin and Fuling districts had gradually reached almost the same level of development efficiency as their neighbouring counties at the end of the study period.

From the analysis of the average development efficiency of the counties in Chongqing, the central urban area (except Beibei district), Changshou and Hechuan district were high-high clusters, and had formed a trend of taking the central urban area as the core to drive the continuous development of surrounding counties in the north. Beibei and Fuling district were low-high anomalies, forming two major 'depressions' around the central urban area, and facing the risk of marginalisation around the core circle.

Fig.3. Spatial clustering and outliers of development efficiency of counties in Chongqing at the beginning and end of the study period.

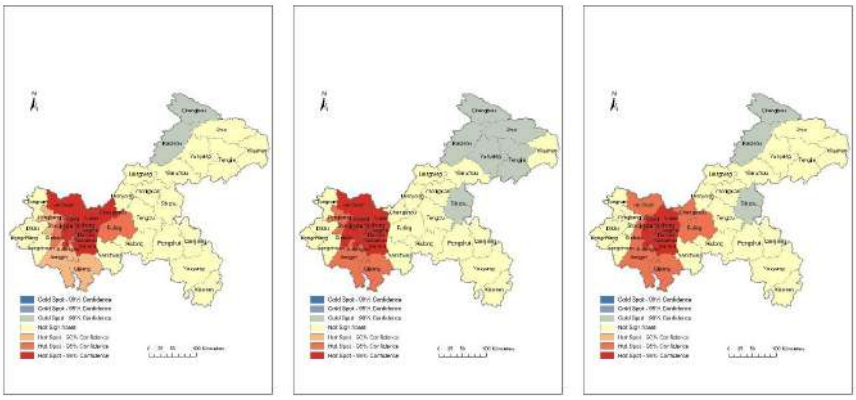


3.1.2 Spatial Agglomeration Patterns

Using the hotspot analysis tool to carry out local spatial auto-correlation analysis, the results showed that in 2018, the high value of the development efficiency of the counties in Chongqing was mainly concentrated in the hot spot area composed of the central urban area, Hechuan and Changshou district, and the Tongliang, Bishan, Jiangjin, Qijiang as well as Fuling district immediately adjacent to the central urban area had become secondary hot spots. The low value of the development efficiency was mainly concentrated in the cold spot area composed of the Chengkou and Kaizhou districts. By 2022, the high value of development efficiency of counties in Chongqing was mainly concentrated in the hotspot area composed of the central urban area, Hechuan, and Bishan districts. The hotspot area was basically unchanged, and was still centred on the nine districts of the central urban area, and its surrounding counties, Chanshou district, had insufficient development efficiency, and became non-significant, while Bishan district, with significant improvement in its development efficiency, integrated into the hotspot area, and Tongliang, Jiangjin, and Qijiang district, which were adjacent to the central urban area, form a sub-hotspot area. The Fuling district was non-significant. The scope of the low value of development efficiency of counties in Chongqing further expanded, adding Wuxi, Yunyang, Fengjie and Shizhu county based on Chengkou and Kaizhou district, forming a large-scale cold spot area in the northeast of Chongqing. In terms of circle division, the development efficiency of the core circle had always been

at the high values, the secondary hotspot area composed of counties and districts in the inner circle had shrunk. The cold spot area composed of some counties and districts in the outer circle had significantly expanded, and the number of counties with low values of development efficiency had increased significantly. This indicates the emergence of a 'periphery of the core' character of the inner circle districts, and the marginalization of counties and districts in the outer circle was becoming increasingly serious.

Analysing the spatial clustering characteristics of the average development efficiency of each district and county in Chongqing during the study period, it was found that the hotspot areas were mainly the nine districts in the central urban area and their direct neighbouring counties, of which only Nanchuan district was insignificant. Chengkou and Kaizhou district in northeastern Chongqing, and Shizhu county in southeastern Chongqing constituted the cold spot areas. The distribution pattern of circles was



significant, with the nine districts in the central urban area as the core circle with high development efficiency, the inner circle counties directly neighbouring the nine districts in the central urban area with high development efficiency, while other outer circle counties had low development efficiency.

2018 2022 Five-Year Average

Fig.4. Spatial agglomeration characteristics of development efficiency of counties in Chongqing at the beginning and end of the study period.

By calculating the average development efficiency of the core circle, inner circle and outer circle counties each year, it was found that the core circle had always maintained a significantly high level of development efficiency, and the fluctuations of the development efficiency had tended to be stable. The overall development efficiency of the inner circle and outer circle was generally on a downward trend, and the development efficiency of the inner circle is always higher than that of the outer circle. In 2022, the development efficiency of both the inner and outer circles decreased

considerably, with the outer circle experiencing a significantly larger decrease than the inner circle, while the core circle showed a slight increase. This suggested that the vulnerability of the peripheral counties was higher when dealing with major risk challenges, with the inner counties being more resilient to risk than the outer counties.

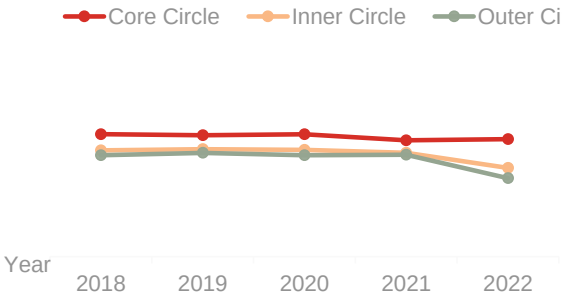


Fig.5. Changes in the overall development efficiency of counties in the core circle, inner circle, and outer circle of Chongqing during the period 2018-2023.

3.2 Analysis of Influencing Factors

3.2.1 Independent Variable Selection

Existing studies have shown that the development efficiency of cities and towns in China is affected by various factors, including economy, population, land, industry, and income (Sun Wang and Sun, 2013; Li *et al*., 2019; Yin, Wang and Duan, 2021; You, Jiang and Li, 2022; Luo, Cai and Wen, 2022). Therefore, this paper selects 20 indicators as independent variables from five dimensions: economic development level, population agglomeration capacity, built-up area development conditions, industry agglomeration capacity and residents' income level. Taking the efficiency value of financial expenditure and allocation of basic public services as the dependent variable to explore the factors affecting the differences in the development efficiency of counties.

Table 2
Development indicators and variables classification of counties in Chongqing

Development Indicators	Variables Classification
Level of Economic Development	• Gross regional product (10,000 yuan). • Gross regional product per capita (yuan). • Average land output value (10,000 yuan/square kilometer). • Per capita tax revenue (10,000 yuan). • General public budget revenue at district and county level (yuan).
Population Agglomeration	• Permanent population (10,000 people). • Population density (person/hectare).

Capacity	• Share of county population in total city population (%).
Development Conditions of Built-Up Areas	• Built-up area (square kilometers). • Built-up population density (10,000 people/square kilometer). • Land urbanisation rate (%). • Population urbanisation rate (%).
Industrial Aggregation Capacity	• Total industrial output value (100 million yuan). • Number of industrial enterprises above designated size. • Share of industrial output value in the city's secondary industry output value(%).
Level of Residents' Income	• Per capita investment in social fixed assets (yuan). • Per capita disposable income of rural permanent residents (yuan). • Per capita disposable income of urban permanent residents (yuan). • Per capita savings deposit balance of residents (yuan).

3.2.2 Stepwise Regression Analysis of Influencing Factors

The variables were processed in SPSS *20.0* using the stepwise regression model. The calculation results showed that three explanatory variables passed the significance test and covariance diagnosis, that is, the influencing factors of the development efficiency of counties in Chongqing were mainly related to the per capita tax revenue, the urbanisation rate of the population and the per capita balance of residents' savings deposits, which were respectively related to economic development level, development conditions of built-up areas and residents' income levels. All three indicators had a positive impact on the development efficiency of counties. In terms of the intensity of the effect, the balance of per capita residents' savings deposits > per capita tax revenue > population urbanisation rate, indicated that the level of residents' income had the strongest impact on the development efficiency of counties.

Table 3
Stepwise regression modelling results

Variable	Standard Coefficient	Sig.
Population Urbanisation Rate	0.486	0.027
Per Capita Tax Revenue	0.571	0.006
Per Capita Residential Savings Balance	0.509	0.027
R^2	0.363	

3.2.3 Analysis of Spatial Heterogeneity of Influencing Factors

To explore the spatial differences in the effects of the above three significant influencing factors, the GWR model was used to further analyse the spatial heterogeneity in the intensity of the effects of the influences. The results of the GWR model showed that:

(1) Tax revenue per capita.

The per capita tax revenue was positively correlated with the development efficiency of counties, that is, the higher the per capita tax revenue, the higher the development efficiency of the counties. The regression coefficient of per capita tax revenue showed the distribution characteristic of gradually increasing from west to east, and the regression coefficient fluctuated a lot, which indicated that its influence effect on the development efficiency of counties in Chongqing had strong spatial heterogeneity. In terms of inner and outer circles, the regression coefficients of the factors in the outer circle of the eastern area were larger, that is, the per capita tax factor had a more significant impact on the development efficiency of the counties located in the periphery. The per capita tax reflected the industrial tax contribution capacity and economic development level of counties, the higher the per capita tax, the stronger the industrial development, the stronger the tax contribution capacity and the relatively higher the development efficiency of counties. In the long-term development of outer-circle counties, they had been constrained by the unbalanced development strategy at the policy level. At the same time, their development emerged with a lot of problems, including weak industrial foundations, unclear advantageous industries, imperfect industrial systems, as well as limited location conditions, insufficient construction of production factors, slow improvement of the investment environment and so on. The cumulative cycle of all kinds of problems, emerged from the lack of development impetus, which had influenced the improvement of the economic development level of the outer-circle counties.

(2) Population urbanisation rate

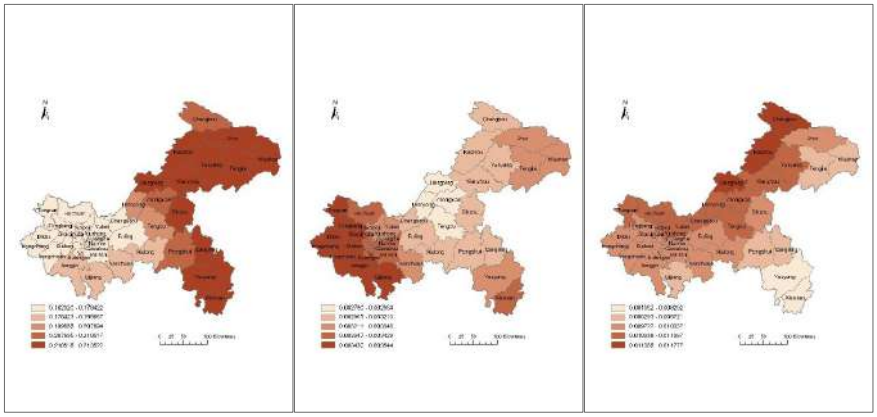
The population urbanisation rate had a positive impact on the development efficiency of counties. The regression coefficient of the population urbanisation rate showed a spatial distribution characteristic of gradually decreasing and then gradually increasing from west to east, and the spatial heterogeneity was relatively obvious. From the perspective of inner and outer circle division, the regression coefficients of inner circle counties in the west were larger, that is, the population urbanisation rate had a greater impact on the development efficiency of counties located on the edge of the core in the west. The population urbanisation rate reflected the changes in the urban and rural population structure and the development level of built-up areas in the counties. Counties located at the edge of the core were subject to the obvious siphoning effect of the core circle counties, and the phenomenon of the population moving to the central urban area in pursuit of higher levels of public services and higher quality employment opportunities was obvious, while the level of their urban construction was insufficient, making it difficult to attract the transfer of surplus rural labour to the cities, and the

development elements were insufficiently concentrated, resulting in the overall development efficiency of the counties being relatively low.

(3) Per capita residential savings deposit balance

There is a positive correlation between per capita savings deposit balance and development efficiency of district and county. The regression coefficients of per capita savings deposit balance showed a spatial distribution characteristic of decreasing from north to south. In terms of inner and outer circles, the regression coefficients of the factor were larger in the outer circle counties in the northeast area that were located in municipal border areas, which meant that the development efficiency of these counties was closely related to the per capita savings deposits balance. The per capita savings deposits balance reflected the level of residents' income. Chengkou, Kaizhou, and Liangping districts had poor local production conditions, and limited sources of income for residents, mainly relying on agricultural production and migrant work, the income level was low, making the overall development efficiency of the counties relatively low.

Fig.6. Spatial heterogeneity of influencing factors of tax revenue per capita, population urbanisation rate, per capita residential savings deposit balance.



4. Strategy

The classical theory of urban geography holds that the core and the periphery are interdependent, jointly constructing a complete spatial system, the development process of which has evolved from unrelated, isolated development to unbalanced development, and from unbalanced to interrelated balanced development (Lu *et al.*,2016). Based on the efficiency differences between the inner circle counties and outer circle counties in Chongqing, the city is in the stage of unbalanced development. To optimise the

economic spatial pattern of Chongqing, and to promote the formation of an interlinked balanced development pattern in counties of each circle, combined with the differences in the influencing factors of the development efficiency of each district and county, the following suggestions are put forward for the development of the inner circle counties and the outer circle counties, respectively.

4.1 Inner-Circle Counties

The factors affecting the development efficiency of inner circle counties are mainly the population urbanisation rate in the indicators of built-up area development condition. As a result, raising the urbanisation level of built-up areas, enhancing the attractiveness of counties, and promoting population concentration and development are the keys to raising the development efficiency of inner-circle counties.

On the one hand, inner circle counties need to comprehensively improve their soft and hard capabilities based on the diverse needs of various types of populations. At the hardware level, through the phased promotion of urban construction and renewal, the quality of the spatial environment in built-up areas should be optimised, and good housing, transport and other living conditions should be provided; and the efficiency, quality and satisfaction of public services should be upgraded in key areas, such as education, medical care and housing, so as to create conditions to attract the outgoing population back to the county. Second, reforms and innovations in the population system, community governance, and employment policies at the software level should be implemented to jointly promote the citizenship of the agricultural transfer population and the inward migrant population. By deepening the reform of the household registration system and relaxing the restrictions on urban settlement, it will guide the rural population and the migrant population from outside to gather in counties in an orderly manner. At the same time, to enhance community governance capacity, improve the quality of residents through organising community education, cultural and sports activities, and so on., and promote greater interaction among residents, to foster social integration among different groups of citizens. As well as implementing a proactive employment policy, optimising the environment for innovation and entrepreneurship, creating more high-quality jobs within counties, supporting the expansion of employment, and promoting high-quality development of the population.

On the other hand, take the initiative to collaborate with the integration of the Chongqing metropolitan area and strengthen the joint development with the core circle, thus effectively curbing the continuous loss of population in inner circle counties. Narrow the gap with the central urban area by upgrading public services and establishing a mechanism for the common construction and sharing of public service facilities, to achieve the sharing and accessibility of public resources. Strengthening transport and information links with the central urban area, so that residents of the counties can more conveniently enjoy high-quality resources as well as employment opportunities in the central urban area, and attracting the population of the central urban

area with the unique ecological and cultural resources of the counties, and promoting the reverse flow of population. Enhance industrial collaboration between inner-circle districts and the central urban area, forming industrial linkage effects, create more local employment opportunities, reduce the out-migration of residents due to employment, and at the same time, attract industrial spillover and talent overflow from the central urban area, to jointly improve the development efficiency of inner-circle counties.

4.2 Outer-Circle Counties

The development efficiency of outer-circle counties is mainly affected by the per capita tax revenue in the indicator of the level of economic development, while some outer-circle counties are also affected by the per capita residents' savings balance in the indicator of the level of residents' income. It can be found that promoting economic growth and increasing residents' income is the core driving force to enhance the development efficiency of Chongqing outer-circle counties.

On the one hand, the outer circle counties should focus on optimising their development environment and gathering internal forces for development. Firstly, according to the comparative advantages of their resources, they should guide the transformation and upgrading of traditional industries and cultivate competitive leading industries. At the same time, increases financial expenditure on innovation, stimulates the vitality of scientific and technological innovation, actively cultivates emerging industries, forms a diversified, high-value-added industrial system, improves product value-added and labour productivity, and drives tax growth. Secondly, optimize the allocation of public services and infrastructure, improve the investment and living environment, attract talent, technology and capital pouring in, and in the spatial planning of each level, strengthen the layout of the outer circle counties of transportation, information and other infrastructure, promote the interconnection of counties of each circle, shorten the spatial and temporal distance between the outer circle and the core circle, and improve the flow efficiency of resources between counties to support the Economic growth.

On the other hand, make full use of the positive edge effect of interaction and borrow development momentum. Firstly, based on regional synergy policy, using the radiation-driven role of the core circle and the inner circle to undertake the transfer of industries and technological overflow, and take the initiative to buttress its advantageous industries, develop supporting industries, and form an upstream and downstream linkage, division and collaboration of the industrial system. Secondly, given the weak economic foundation of the outer circle counties, which are at a disadvantage in regional competition, it is possible to establish a cooperation mechanism, build a group development mode, focus on cultivating group-level growth poles, and promote in-depth cooperation between counties in the form of co-built industrial parks, tourism zones, and logistic hubs, to form a secondary interrelated development mode in the outer circled districts and enhance the overall competitiveness.

5. Conclusion

Under the guidance of the 'core-periphery' theory, interpret policy documents and identify the uneven development of counties at the level of the regional development strategy of Chongqing, and divide them into three circles, including the core, the periphery of the core, and the periphery. Using the DEA model to measure the development efficiency of counties, and analyze the spatial distribution characteristics of the development efficiency of counties in Chongqing through the spatial auto-correlation method, identify the hot spots, cold spots and outliers of the development efficiency at the end of the study period, and analyze the spatial variations of the development efficiency of counties in different circles. A total of 20 variables in 5 dimensions, including economic development level, population agglomeration capacity, built-up area development conditions, industrial agglomeration capacity and living standard of residents, are selected to study the spatial heterogeneity of factors affecting the development efficiency of the counties of Chongqing and the effect level of the factors by applying the stepwise regression model and the GWR model, and to discuss the development strategies of the counties in different circles of Chongqing. The main findings are as follows:

（1）During the study period, the development efficiency of counties in the core circle of Chongqing has remained consistently high value, and the development efficiency of counties in the inner circle as a whole has continued to be higher than that of counties in the outer circle. Some inner-circle counties
have large differences in development efficiency with core-circle districts and counties in the process of development, and face the risk of marginalisation around the core circle. The area of low development efficiency in outer-circle counties is expanding significantly, and the characteristics of marginalisation are increasing.

（2）Tax per capita, population urbanisation rate and per capita savings deposit balance are the main factors influencing the development efficiency of counties in Chongqing, and their effects are spatially heterogeneous and positively correlated with the development efficiency. The development efficiency of counties in the inner circle is mainly affected by the population urbanisation rate, especially in Tongnan, Tongliang, Dazu, Bishan, Rongchang, Yongchuan, Jiangjin and Qijiang. The development efficiency of outer circle counties is mainly affected by per capita tax revenue, with the outer circle counties represented by Liangping, Kaizhou and Chengkou simultaneously significantly affected by per capita residential savings balances.

（3）Inner-circle counties need to optimise urban space and public services to retain population, and realise population agglomeration through population management, community governance and employment policy innovation. Also, strengthen collaboration with the core circle, share resources, smooth traffic and information, and cooperate with industrial development to mitigate the impact of siphoning and curb the outflow of population, as well as to stimulate economic vitality and efficiency through

the convergence of human capital. The outer circle should focus on building a competitive industrial system to accelerate economic growth, improve infrastructure, optimise the investment environment, participate in the division of labour under the framework of regional coordination, undertake industrial transfers, and develop complementary industries; deepen cooperation between counties to form a development model of clusters, cultivate growth poles, and drive economic growth in the region.

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