Research in Economics and Management
ISSN 2470-4407 (Print) ISSN 2470-4393 (Online)
Vol. 8, No. 3, 2023
www.scholink.org/ojs/index.php/rem

Original Paper

Temporal and Spatial Evolution of Economic Quality Difference between North and South China

Tao Liu[1], Yifei Wang[1], & Kai Liu[1*]

[1] College of Resources and Environment, Henan University of Economics and Law, Zhengzhou, China

Received: July 11, 2023 Accepted: August 9, 2023 Online Published: August 23, 2023

doi:10.22158/rem.v8n3p111 URL: http://dx.doi.org/10.22158/rem.v8n3p111

Abstract

Based on the "Five development Concepts", this paper uses the entropy method to measure the economic quality of 336 prefecture-level regions and above in China from 1991 to 2020, and uses Dagum Gini coefficient, Kernel density estimation, spatial autocorrelation and standard deviation ellipse to explore the spatio-temporal evolution characteristics of North-South economic quality differences. The main conclusions are as follows: 1) From 1991 to 2020, the economic quality of the north and south continues to grow, and the spatial distribution pattern shows a relatively significant feature of "the south is relatively high, the north is relatively low" and "the coastal economic belt is relatively high, and the inland city is relatively low". 2) In the past 30 years, the relative difference between the north and south regions has fluctuated and decreased, while the absolute difference has increased. 3) The economic quality of southern cities has a more significant spatial agglomeration. HH agglomeration and LL agglomeration are dominant in the south, while LL agglomeration is more inclined in the north. 4) The economic mass center of gravity in the north and the south showed a migration trend of "northeast-north" and "northwest-southwest" respectively.

Keywords

North-South regional differences, spatial and temporal evolution, coordinated regional development, shift of center of gravity

1. Introduction

Since the reform and opening up, China's economic geography has changed dramatically, and regional differences have become more and more serious, and transformed from the imbalance between the east, central and west to the imbalance between the north and the south (Fan & Wang, 2019). In 2018, the central government issued the Opinions on Establishing a New Mechanism for More Effective Coordinated Regional Development, emphasizing "coordinating the new pattern of regional development

in the domestic east", west, central and southern north In 2018, the central government issued the "Opinions on Establishing a New Mechanism for More Effective Coordinated Regional Development", which emphasizes "coordinating the new pattern of regional development in the East, West and North and South of China", and formally proposes that coordinated regional development should pay attention to the gap between North and South. "The report of the 19th National Congress points out that the main contradiction of our society has been transformed into the contradiction between people's growing need for a better life and unbalanced and insufficient development", and the economy has shifted from the stage of high-speed growth to the stage of high-quality development. The new development pattern of the domestic cycle requires not only the cycle of the east and west, but also the cycle of the south and north. Excessive economic disparity between the north and the south will not only lead to unreasonable resource allocation and unequal development opportunities, but also jeopardize the harmonious development of society (Wu, Yang, & Li, 2011). This requires us to explore more comprehensively the spatial and temporal evolution characteristics of the economic quality of the South and the North, so as to lay the foundation for the in-depth promotion of coordinated regional development, integrated development of regional economic integration between the North and the South, and high-quality development strategies.

The evolutionary pattern of regional economic differences is one of the core issues of academic concern (Feng, Zeng, & Cui, 2015; Qin, 1997; Jian, Sachs, & Warner, 1996; Long, 1999; Zhao & Ying, 2014; Xu, Lu, & Su, 2005). Tracing the spatial and temporal evolution of regional economic disparities by scholars at home and abroad, we can see that the scale of foreign research has gradually changed from the large scale of international (Costas, & Dimitrios, 2010) and national (Leonid, 2002; Barro & Sala-i-Martin, 1991). to the small and medium microscopic scale of "provinces and regions" (Park & Lee, 2013; Masahisa & Dapeng, 2001), and the research methods have changed from the traditional regression analysis (Martin, Kerstin, &Fredrik, 2011; Thomas, 2015) to spatial measurement and statistical analysis (Sergio, 2001; Le, Ertur, & Baumont, 2003). Domestic scholars' research mainly focuses on the macroscopic scales of the three major regions in the East and West (Yang, 1994; Xu & Yang, 2001), the provincial level (Li, Wei, & Xu, 2001; Zhao, Zhang, & Jiang, 2019), and the microscopic scales of cities (Li, Wei, & Xu, 2001; Yan, Zhang, & Chen, 2019; Zeng, Yu, & Zuo, 2015)., counties (Li, Wei, & Xu, 2001; Zhou, Li, & Wu, 2014; Li & Qiao, 2001), and a specific region (Zhang & Zhang, n.d.; Zhang, Yu, & Zhang, 2018; Wang, Yuan, & Meng, 2014), using indicator analysis methods (e.g., Gini coefficient (Guo & Li, 2017), coefficient of variation (Li, Wei, & Xu, 2001; Yan, Zhang, & Chen, 2019; Zeng, Yu, & Zuo, 2015; Zhou, Li, & Wu, 2014; Li & Qiao, 2001; Zhang & Zhang, n.d.; Zhang, Yu, & Zhang, 2018; Wang, Yuan, & Meng, 2014; Guo & Li, 2017; Chen & Zhu, 2012), Thayer index (Guo & Li, 2017), standard deviation (Li, Bai, & Luo, 2011), etc.) and integrated spatial data analysis (e.g., spatial Markov model (Yan, Zhang, & Chen, 2019), exploratory spatial data analysis (Jin & Lu, 2009; Ren & Gu, 2018), kernel density function (Li, Shi, & Jin, 2013, etc.) to react to the spatial and temporal evolution characteristics of regional economic differences.

So far, studies on north-south differences have mainly focused on physical geography such as regional division (Zhang, 2008), natural climate (Li, Yan, & Wu, 2019), disaster prevention and control (Li, Yang, & Liu, 2015), and ecological protection (Zhang, 2019), but few studies on north-south economic differences have been conducted, and the existing studies have only used single indicators such as GDP per capital (Wu, 2001; Chen, 1999) or GDP (Li & Qin, 2002), without taking the approach of constructing a comprehensive indicator evaluation system In this paper, we focus on "innovation, coordination, coordination, and economic quality". In this paper, 16 comprehensive evaluation indicators are constructed from the five dimensions of "innovation, coordination, green, openness, and sharing", using year-by-year statistics of 336 prefecture-level and above regions from 1991 to 2020 to measure and analyze their economic quality levels, and analyze the regional differences between the north and the south and the spatial and temporal evolution characteristics from a more refined perspective. The analysis reveals the change of the economic center of gravity between the north and the south, and ultimately provides a reference for the structural optimization, spatial integration and high-quality development of China's regional economy.

2. Method

2.1 Entropy Value Method

The entropy method is a method of determining the weights of various indicators based on the magnitude of the information provided by their data (Lin, 1997). The specific calculation methods are as follows:

(1) Normalization of the original data:

$$\text{Positive indicators: } Y_{ij} = \frac{Y_{ij} - \min\{X_{ij}\}}{\max\{X_{ij}\} - \min\{X_{ij}\}} \tag{1}$$

$$\text{Negative indicators: } Y_{ij} = \frac{\max\{X_{ij}\} - X_{ij}}{\max\{X_{ij}\} - \min\{X_{ij}\}} \tag{2}$$

(2) Calculate the share of the j indicator for the i municipality:

$$Z_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{m} Y_{ij}} \tag{3}$$

(3) Calculate the information entropy of each index:

$$P_{ij} = -k\sum_{i=1}^{m}\left(Z_{ij} \times \ln Z_{ij}\right), k = \frac{1}{\ln m} \tag{4}$$

(4) Determination of indicator weights:

$$F_i = \frac{1 - P_i}{\sum_{i=1}^{m}\left(1 - P_j\right)} \tag{5}$$

(5) Calculate the level of economic development of the i municipality

$$W_i = \sum_{i=1}^{n} F_j Y_{ij} \quad (6)$$

Where: Y_{ij} is the standardized data value; X_{ij} represents the data value of the j indicator in the i municipality; max{X_{ij}} and min{X_{ij}} represent the maximum and minimum values of the j indicator in the i municipality, respectively; Z_{ij} represents the weight of the j indicator in the i municipality; i = 1~m, j = 1~n; Pj is the information entropy of each indicator; F_i is the weight of each indicator; W_i is the economic development level of the i municipality.

Table 1. Comprehensive Measurement Index of High Quality Development Level

Objectives	Dimension	Indicators	Explanation of Indicators	Indicator Properties
Economic quality level	Innovation	Education Investment Intensity	Share of education expenditures in fiscal expenditures (%)	+
		Investment intensity in science and technology	Share of science and technology expenditures in fiscal expenditures (%)	+
		Number of patents granted per 10,000 people	Number of patents granted per 10,000 people (pieces)	+
	Coordination	Degree of industrial advancement	Value added of tertiary industry/GDP (%)	+
		Registered Urban Unemployment Rate	Urban registered unemployment rate (%)	-
		Engel Coefficient	Proportion of residents' food expenditure to total personal consumption expenditure	-
	Green	Sewage treatment rate	Urban domestic sewage treatment rate (%)	+
		Garbage Harmless Disposal Rate	Harmless treatment rate of domestic garbage (%)	+
		Electricity consumption per unit of GDP	Electricity consumption of the whole society/GDP (kWh/yuan)	-
		Industrial wastewater emission per unit GDP	Industrial wastewater emission/GDP (ton/yuan)	-
	Openness	Trade Dependence	Total import and export/GDP (%)	+
		Intensity of foreign investment utilization	Actual amount of foreign capital utilized/GDP (%)	+
		GDP per capital	GDP per capital (Yuan)	+
	Sharing	Nighttime lighting value	Average of annual nighttime lighting values by city	+
		Teacher-student ratio of primary and secondary schools	Number of teachers/students in	+

	Number of physicians per 10,000 people	primary and secondary schools (%) Number of physicians per 10,000 people (person)	+

2.2 Dagum Gini Coefficient Decomposition Method

The Dagum Gini coefficient enables effective analysis of intra- and inter-regional differences (Sun, Liu, & Chen, 2021) and is calculated as follows:

$$G = \frac{\sum_{j=1}^{k}\sum_{h=1}^{k}\sum_{i=1}^{n_j}\sum_{r=1}^{n_k}\left|y_{ji}-y_{hr}\right|}{2n^2\overline{Y}} \tag{7}$$

$$G_w = \sum_{j=1}^{k} G_{jj} p_j s_j \tag{8}$$

$$G_{\mathrm{nb}} = \sum_{j=2}^{k}\sum_{h=2}^{j-1} G_{jh}\left(p_j s_h - p_h s_j\right) D_{jh} \tag{9}$$

$$G_{\mathrm{t}} = \sum_{j=2}^{k}\sum_{h=2}^{j-1} G_{jh}\left(p_j s_h - p_h s_j\right)\left(1 - D_{jh}\right) \tag{10}$$

In this paper, 336 regions at prefecture level and above are studied. k represents the number of regions, here both northern and southern regions are included, i.e., k=2, and n denotes the number of cities. $\mathrm{y}_{ji}(y_{hr})$ denotes the economic quality level of cities within region j(h). $\overline{Y}$ denotes the average of the economic quality level of cities. The Gini coefficients are divided into hypervariable density G_t, intra-regional variation G_{w}, and inter-regional variation G_{nb}.

2.3 Spatial Autocorrelation

Global spatial autocorrelation is usually expressed by Moran's I, which can reflect the overall spatial agglomeration level of economic development of north and south cities in China and takes the value of [-1, 1].

$$GlobalMoran's = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\left(y_i-\overline{y}\right)\left(y_i-\overline{y}\right)}{\left(\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\right)\sum_{i=1}^{n} W_{ij}\left(y_i-\overline{y}\right)^2} \tag{11}$$

Where: n is the number of study units, y denotes the value of the level of high-quality economic development of the prefecture-level city, and W_{ij} is the spatial weight of the spatial location relationship between cities i and j.

Local spatial autocorrelation is usually expressed by LISA diagram, which can reflect the degree of correlation between the study units and their neighboring units in the study area. The calculation formula is as follows:

$$LocalMoran'sI = \frac{n\left(y_i-\overline{y}\right)\sum_{j=1}^{m} W_{ij}\left(y_i-\overline{y}\right)}{\sum_{i=1}^{n}\left(y_i-\overline{y}\right)^2} \tag{12}$$

Where: m is is the number of cities adjacent to city i. Other variables are the same as above.

2.4 Standard Deviation Ellipse

The standard deviation ellipse (SDE) analysis method can be used to reveal the diffusion direction and dispersion degree of spatial elements, and has a good explanation effect on the spatial distribution of geographical elements, and can also be used to characterize the spatial concentration area, direction and center location of elements (Bai, Zhao, & Zhang, 2021).

The standard deviation ellipse center coordinates formula is:

$$\left(\overline{X},\overline{Y}\right)=\left\{\frac{\sum_{i=1}^{n}x_iA_i}{\sum_{i=1}^{n}A_i},\frac{\sum_{i=1}^{n}y_iA_i}{\sum_{i=1}^{n}A_i}\right\} \tag{13}$$

Standard deviation elliptical azimuth equation:

$$\tan\theta=\frac{\sum_{i=1}^{n}A_i^2\Delta X_i^{\,2}-\sum_{i=1}^{n}A_i^2\Delta Y_i^2+\sqrt{\left[\sum_{i=1}^{n}A_i^2\Delta X_i^{\,2}-\sum_{i=1}^{n}A_i^2\Delta Y_i^2\right]^2+4\left[\sum_{i=1}^{n}A_i^2\Delta X_i^{\,2}\Delta Y_i^2\right]^2}}{2\sum_{i=1}^{n}A_i^2\Delta X_i^{\,2}\Delta Y_i^2} \tag{14}$$

3. Result

3.1 Analysis of the Differences in the Spatial and Temporal Distribution of Economic Quality between North and South

China's economic quality as a whole showed a substantial growth from 1991 to 2020, with a total growth rate of 49.62%, including 44.89% in the north and 52.54% in the south. As can be seen from Figure 1: In the spatial dimension, economic quality in both the north and the south shows a decreasing trend from east to west. High level cities, only Shenzhen, Dongguan and Suzhou in the southern region in 1995, developed to 20 by 2020, accounting for 83.33% of the number of high level cities, much higher than the proportion in the north; higher level cities are mainly distributed around high level cities, concentrated in the Yangtze River Delta and Pearl River Delta regions in the south, and in the Shandong Peninsula region in the north; low level cities contract from east to west, and by In 2020, they will be mainly concentrated in the southeast and the northern regions of Gansu and Qinghai. The overall spatial distribution pattern of the north-south economy shows a more significant "relatively high in the south, relatively low in the north", "higher in the coastal economic zone, lower inland cities". In addition, cities with faster growth in economic quality are mainly in the central and southeastern regions, with growth rates above 20%; cities with economic growth rates below 5% are mainly in the northeast, mid-west and southwest regions; the high level economy is first concentrated in the "North, Shanghai and Guangzhou" and its surrounding areas, and then spreads inland.

From Figure 2, we can see that: in the time dimension: the proportion of the economic quality development level of each group in the north and the south at the same time. As can be seen from Figure 2, the economic level of the South and the North has been improving year by year, and the proportion of cities at low level has dropped sharply, from 61.67% and 69.23% in 1991 to 5% and 7.05% in 2020

respectively, and the proportion of low level cities in the South is higher than that in the North until 2017; the proportion of lower level cities in the South and the North is growing faster, and both show an "S" The proportion of higher level cities was relatively stable at the beginning, and began to grow rapidly after 2002 and 2006 in the south and north respectively, and the growth rate in the south was greater than that in the north; high level cities appeared in the south in 1991, and began to rise steadily after 1999, and there were already 20 high level cities in the north by 2020. The high level cities in the north appeared in 2007 and also showed an upward trend after their appearance, growing to 4 by 2020. In terms of the evolution of the overall urban economic level, the cities in the north and the south show a fluctuating growth characteristic of "low level - lower level - higher level".

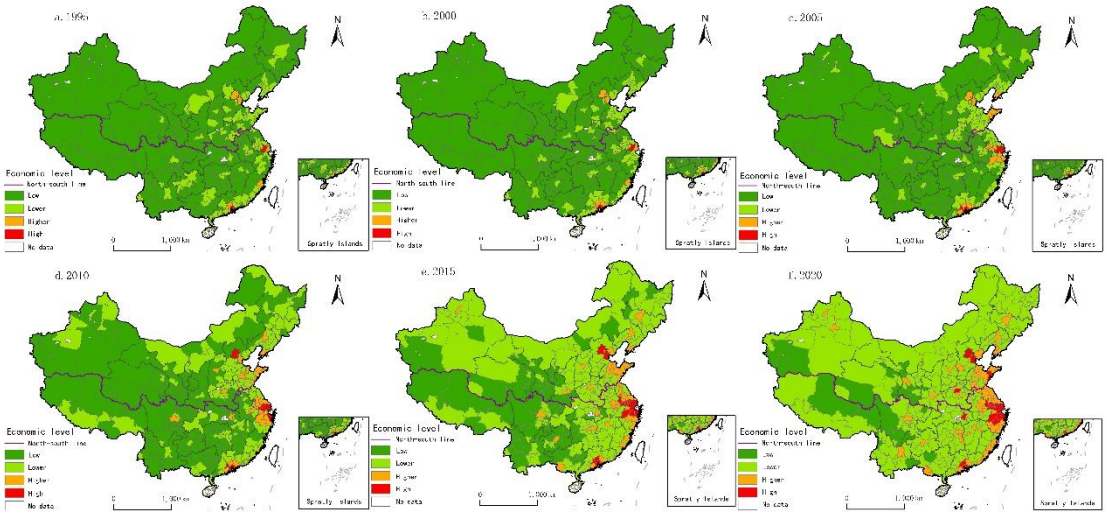

Figure 1. Spatial Distribution of Economic Level of Chinese Cities from 1995 to 2020

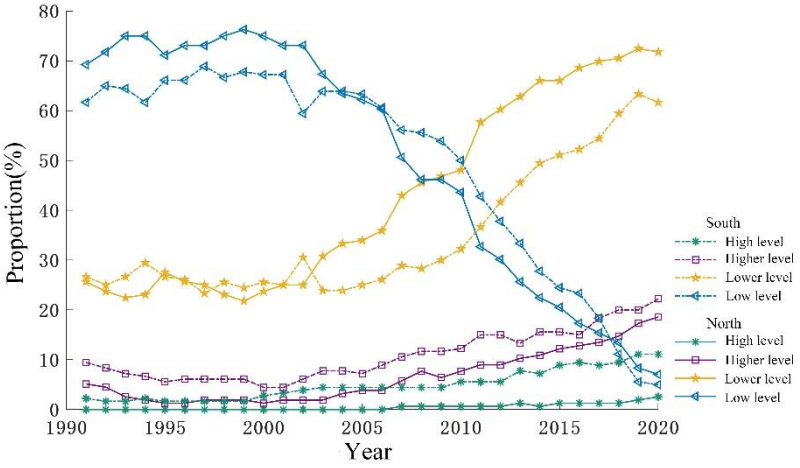

Figure 2. Proportion of Different Types of Cities in the North and South from 1991 to 2020

3.2 Analysis of Regional Differences in Economic Quality Between North and South

The Dagum Gini coefficient is used to reflect the overall regional differences in economic levels between the North and the South, and is decomposed according to the two major economic regions, South and North, to reveal the main sources of regional disparities (Table 2).

The Gini coefficient of the national economic quality ranges from 0.316 to 0.3915, with a decreasing trend during the study period. Specifically, the Gini coefficient fluctuated down from 1991-2000 and 2003-2020, and briefly increased between 2000-2003, and was greater than 0.31 in all years, indicating that although the gap in economic quality between prefecture-level and above regions nationwide has narrowed, the imbalance is still evident. Therefore, we should accelerate the balanced development of economic quality nationwide and narrow the economic differences between regions.

Table 2 shows the evolution trend of the intra-regional Gini coefficient difference between the South and the North. The Gini coefficient of the northern economy ranges from 0.2297 to 0.3462 with a mean value of 0.2458, and the Gini coefficient of the southern economy ranges from 0.3643 to 0.4328 with a mean value of 0.3922, and both have a general fluctuating downward trend, and both have a similar trend of change. The intra-regional differences in the South are higher than those in the North during the study period, indicating that the degree of economic quality coordination is better in the North than in the South. Therefore, the South needs to take into account the overall coordinated development more while considering the improvement of economic quality of each city. In terms of the inter-regional differences between the North and the South, the inter-regional Gini coefficient ranges from 0.3712 to 0.3916, and the inter-regional differences show a fluctuation of falling, then growing and then falling again, with an overall downward trend.

According to Table 2, it can be seen that the sources of contribution to the difference in economic quality between the north and the south are stable, and the intra-north difference is the main source of difference during the study period, with an average contribution of 50.72% for 30 years and little change between years. The contribution of inter-north-south differences is in the second place, with a rising trend, from 12.41% in 1991 to 25.19% in 2020, indicating that inter-north-south differences are a secondary source of overall differences, and their contribution to overall differences is increasing; the contribution of super-variable density to overall differences is the smallest and decreasing, indicating that the cross-over problem between north and south regions has a The contribution of super-variable density to the overall difference is the smallest and tends to decrease, indicating that the cross-over problem between north and south regions has little influence on the overall regional difference.

Table 2. Economic Differences between North and South and Their Contribution Rates

Year	Total G	G_w	G_{nb}	G_t	Within-group differences		Differences between groups	Contribution /%		
					South	North		G_w	G_{nb}	G_t
1991	0.3915	0.1981	0.0486	0.1448	0.4196	0.3462	0.3916	50.60	12.41	36.99
1992	0.3631	0.1839	0.0502	0.1290	0.3995	0.3045	0.3628	50.65	13.83	35.53
1993	0.3455	0.1753	0.0516	0.1186	0.3901	0.2745	0.3447	50.74	14.93	34.33
1994	0.3492	0.1773	0.0601	0.1118	0.3991	0.2661	0.3485	50.77	17.21	32.02
1995	0.3329	0.1692	0.0521	0.1116	0.3814	0.2564	0.3316	50.83	15.65	33.52
1996	0.3296	0.1676	0.0506	0.1114	0.3798	0.2512	0.3282	50.85	15.35	33.80
1997	0.3334	0.1695	0.0475	0.1164	0.3852	0.2541	0.3318	50.84	14.25	34.91
1998	0.3323	0.1688	0.0447	0.1188	0.3868	0.2493	0.3308	50.80	13.45	35.75
1999	0.3347	0.1702	0.0486	0.1159	0.3917	0.2465	0.3329	50.85	14.52	34.63
2000	0.3325	0.1692	0.0497	0.1136	0.3908	0.2424	0.3306	50.89	14.95	34.17
2001	0.3493	0.1778	0.0547	0.1168	0.4101	0.2531	0.3475	50.90	15.66	33.44
2002	0.3603	0.1832	0.0598	0.1173	0.4172	0.2669	0.3590	50.85	16.60	32.56
2003	0.3754	0.1909	0.0656	0.1189	0.4318	0.2799	0.3744	50.85	17.47	31.67
2004	0.3660	0.1860	0.0546	0.1254	0.4255	0.2707	0.3647	50.82	14.92	34.26
2005	0.3559	0.1806	0.0493	0.1260	0.4137	0.2641	0.3550	50.74	13.85	35.40
2006	0.3603	0.1828	0.0515	0.1260	0.4173	0.2688	0.3595	50.74	14.29	34.97

2007	0.3473	0.1761	0.0495	0.1217	0.4038	0.2572	0.3465	50.71	14.25	35.04
2008	0.3402	0.1724	0.0451	0.1227	0.3969	0.2511	0.3396	50.68	13.26	36.07
2009	0.3324	0.1686	0.0469	0.1169	0.3911	0.2400	0.3316	50.72	14.11	35.17
2010	0.3350	0.1698	0.0523	0.1129	0.3922	0.2417	0.3347	50.69	15.61	33.70
2011	0.3361	0.1705	0.0539	0.1117	0.3912	0.2463	0.3355	50.73	16.04	33.23
2012	0.3239	0.1643	0.0524	0.1072	0.3782	0.2362	0.3232	50.73	16.18	33.10
2013	0.3426	0.1739	0.0626	0.1061	0.3993	0.2464	0.3422	50.76	18.27	30.97
2014	0.3182	0.1612	0.0582	0.0988	0.3668	0.2358	0.3183	50.66	18.29	31.05
2015	0.3194	0.1617	0.0657	0.092	0.3683	0.2324	0.3201	50.63	20.57	28.80
2016	0.3164	0.1601	0.0663	0.09	0.3643	0.2306	0.3172	50.60	20.95	28.45
2017	0.3177	0.1609	0.0676	0.0892	0.3659	0.2316	0.3184	50.65	21.28	28.08
2018	0.3236	0.1635	0.0777	0.0824	0.3721	0.2297	0.3254	50.53	24.01	25.46
2019	0.3201	0.1615	0.0785	0.0801	0.3652	0.2307	0.3225	50.45	24.52	25.02
2020	0.3283	0.1653	0.0827	0.0803	0.3708	0.2398	0.3316	50.35	25.19	24.46

Note. G is the overall Gini coefficient; G_w is the intra-regional variation of Gini coefficient; G_{nb} is the inter-regional variation of Gini coefficient; G_t is the hyper-variance density of Gini coefficient.

3.3 Analysis of the Differences in the Spatial Pattern of Economic Quality between North and South

3.3.1 Global Spatial Correlation Analysis

The global indices, standard deviation statistics, and significance level values for a total of 336 municipal units in the south and north from 1991 to 2020 were calculated using Equation (9) and ArcGIS 10.8 software, respectively, to reveal the global spatial correlation between the north and south economies. The calculation results are detailed in Figure 3.

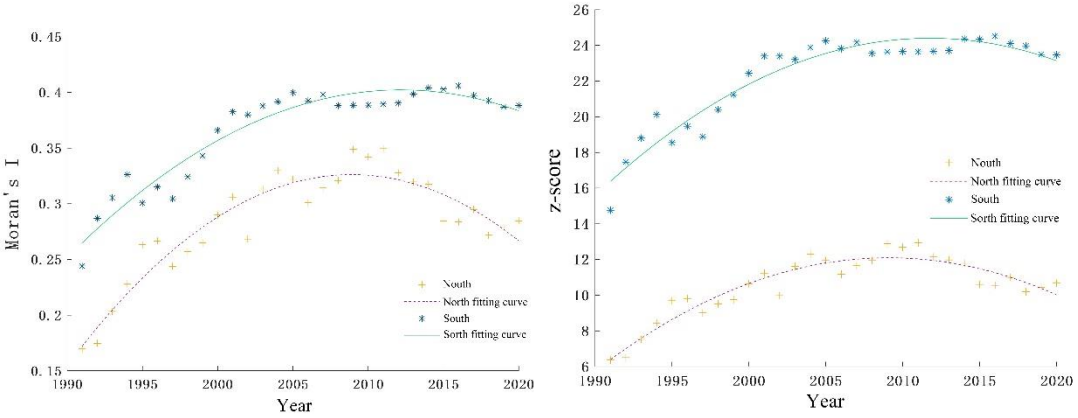

Figure 3. Global spatial autocorrelation between the North and South economies from 1991 to 2020

From Figure 3, it can be seen that the Moran's I indexes of the economic levels of the South and North are all positive, and the standard deviation statistics Z values are all greater than the critical value of 2.58 for the 99% confidence interval of the normal distribution, indicating that the probability of the composite score of the national municipal economic development levels being randomly distributed is below 1%, and they all pass the significance test. This indicates that the spatial distribution of economic levels in the South and North during 1991-2020 has a strong positive spatial correlation and significant spatial agglomeration, that is, areas with higher economic levels have higher economic levels in their neighboring areas, and areas with lower economic levels have lower economic quality levels in their neighboring areas, and areas with similar economic levels tend to be agglomerated in spatial distribution. The Moran index in the south is larger than that in the north, which indicates that the economy of the southern municipalities has stronger correlation and more significant spatial agglomeration than that of the northern municipalities; the Moran index in the south shows a trend of first growth and then stabilization, while the north shows an inverted "U" trend, which indicates that during the period of 1991-2020 The spatial agglomeration of the northern municipalities first strengthened and then weakened after 2009, while the spatial agglomeration of the southern municipalities first strengthened rapidly and then stabilized after 2003.

3.3.2 Local Spatial Correlation Analysis

The global Moran's I index cannot reflect the spatial clustering characteristics of local areas. In order to further study the local clustering characteristics of economic quality level of cities in South and North, six time points of 1995, 2000, 2005, 2010, 2015 and 2020 were selected due to space limitation, and the LISA clustering map of economic quality level of cities in South and North (Figure 4) and the local spatial clustering The clustering statistics table (Table 3).

As can be seen from Table 3, the economic development of the South is dominated by HH agglomeration and LL agglomeration, and the North is dominated by LL agglomeration, and the number of cities in spatial autocorrelation (HH, HL, LH and LL agglomeration) is larger in the South than in the North at all

six time points, indicating that the agglomeration trend of economic development is larger in the South than in the North. In the period 1995-2020, the proportion of the number of cities in HH agglomeration in the north After reaching a peak of 8.97% in 2005, it gradually decreased to 1.92% (2020), and the number of cities with LL agglomeration gradually increased to 32.69% after reaching a trough of 21.15% in 2005; the overall number of cities with HH agglomeration and LL agglomeration in the south is in a stable situation without much fluctuation, indicating that the spatial agglomeration trend among cities in the south is more stable The spatial agglomeration among cities in the north is more inclined to LL agglomeration over time.

It can be seen from Figure 4 that the HH agglomeration cities in the north and the south have similar spatial distribution patterns, i.e., they are distributed in the coastal city cluster, the Yangtze River Delta city cluster and the Pearl River Delta city cluster in the south, and the Shandong Peninsula city cluster in the north. the LL agglomeration is mainly distributed in the central, western and northeastern regions in the north, and in the central and southwestern regions in the south. The HL agglomeration and LH agglomeration in the north and the south are fewer in number, and are mainly scattered around the HH agglomeration and LL agglomeration. The insignificant area in the north is much larger than that in the south, further supporting that the balance of economic levels is stronger in the north than in the south.

Table 3. North-south Economic Level Local Spatial Agglomeration Statistical Table

LISA Cluster	1995		2000		2005		2010		2015	
	South	North	South	North	South	North	South	North	South	North
	Specific Gravity /% Significant Local Spatial Agglomeration Patterns（p≤0.05）									
High-High Clustering	24.44	3.21	23.89	3.21	21.11	8.97	21.11	7.05	23.89	5.77
High-Low Clustering	6.67	3.85	5.56	2.56	4.44	3.85	3.89	2.56	3.33	2.56
Low-high clustering	8.33	0.64	7.78	0.00	12.22	0.64	13.33	0.64	15.00	1.28
Low-Low Clustering	31.67	23.08	37.22	21.79	36.67	21.15	36.67	21.15	36.11	28.85
	Non-significant local spatial agglomeration pattern（p≥0.05）									
Insignificant	28.89	69.23	25.56	72.44	25.56	65.38	25	68.59	21.67	61.54

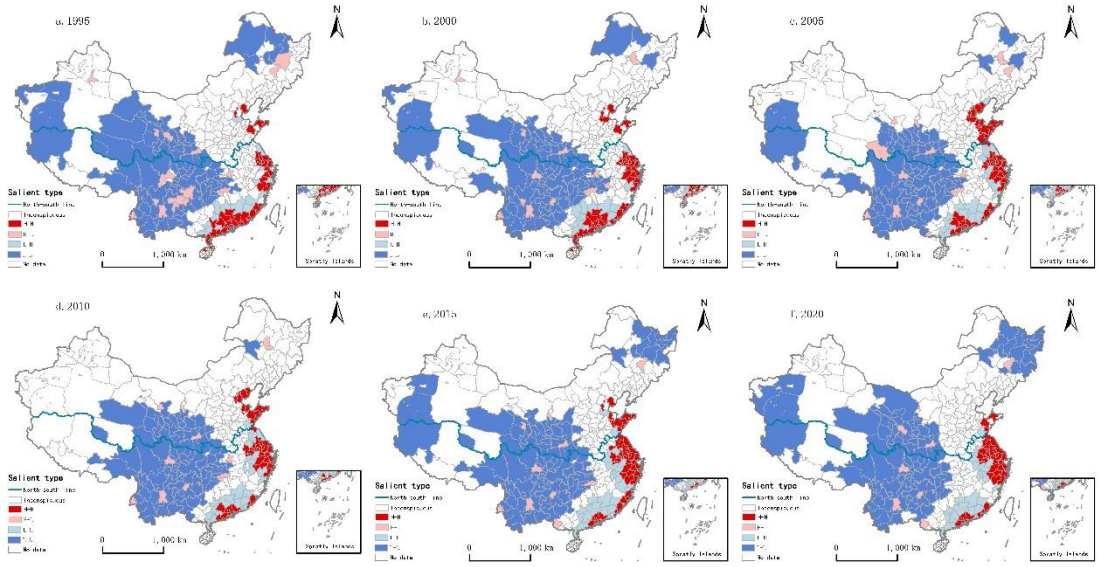

Figure 4. LISA Agglomeration Map of Economic Quality Level of North and South Cities

3.3.3 Analysis of the Differences in Spatial Evolutionary Trends of Economic Quality between North and South

From 1991 to 2020, the economic center of gravity in the south as a whole shows a "northeast-north" migration trend, while the economic center of gravity in the north as a whole shows a "west-northwest" migration trend. The economic center of gravity in the south is located in Hengyang City, Hunan Province from 1991 to 2000. The southern economic center of gravity was located in Hengyang City, Hunan Province from 1991 to 2000, Zhuzhou City from 2001 to 2004 and 2014 to 2020, and Pingxiang City, Jiangxi Province from 2005 to 2013, which is relatively concentrated from 1991 to 2000 and 2014 to 2020. The northern economic center of gravity was located in Baoding, Hebei Province during 1991, in Datong, Shanxi Province during 1992 as well as 2005-2013, in Xinzhou City during 1993-2004, and in Shuozhou City during 2014-2020, with a relative concentration of the northern economic center of gravity during 1999-2004 and 2007-2013. During the 30 years under study, the southern economic center of gravity generally moved 88.83 km to the northeast and the northern economic center of gravity generally moved 105.67 km to the northwest, and the distance between the northern and southern economic centers of gravity decreased, indicating that the economic differentiation between the two regions in the north and the south has been reduced.

As can be seen from Figure 5, the oval area of the standard deviation of the southern economy shows a fluctuating trend of increase during 1991-2020, with an overall increase of 95,600 km2 during the 30-year period, the long axis increasing by 12.44 km and the short axis decreasing by 6.99 km, which indicates that the spatial distribution range of the southern economy spreads in the "northeast-southwest" direction and in the "southeast-southwest" direction. This indicates that the spatial distribution range of the southern economy spreads in the "northeast-southwest" direction and contracts in the "southeast-

northwest" direction; the standard deviation ellipse area of the northern economy shows a fluctuating trend of increase over the 30 years, with an increase of 124,900 km2, an increase of 29.03 km in the long axis and a decrease of 1.74 km in the short axis, indicating that the spatial distribution range of the northern economy is in the "east-west" direction. This indicates that the spatial distribution of the northern economy spreads sharply in the "east-west" direction and contracts slightly in the "south-north" direction.

From the shape index, the shape index of the economic ellipse in both the north and the south decreases during the study period, from 0.71 and 0.61 to 0.66 and 0.55 respectively, with a tendency of flattening; the shape index of the southern ellipse is larger than that of the north, indicating that the spatial distribution of the southern economy is more homogeneous than that of the north. In terms of rotation angle, the rotation angle of the southern economic ellipse is relatively stable overall; the rotation angle of the northern economic ellipse is fluctuating and rising, and the standard deviation ellipse is rotating in the counterclockwise direction, indicating that the "northeast-southwest" pattern of the northern economy is strengthening.

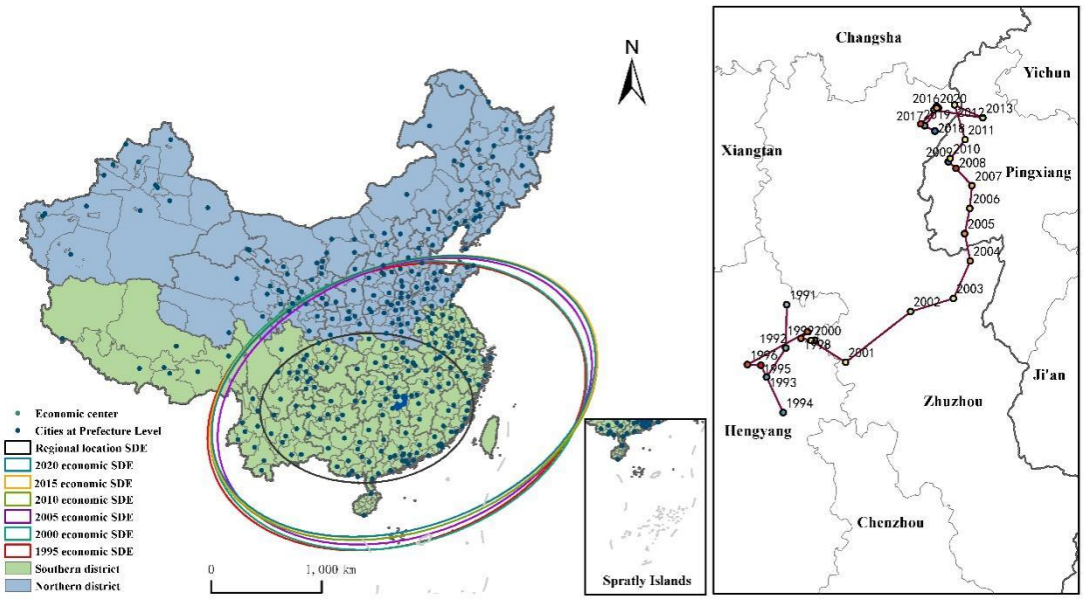

Figure 5. Ellipse and Center of Gravity of Standard Deviation of Southern Economic Distribution

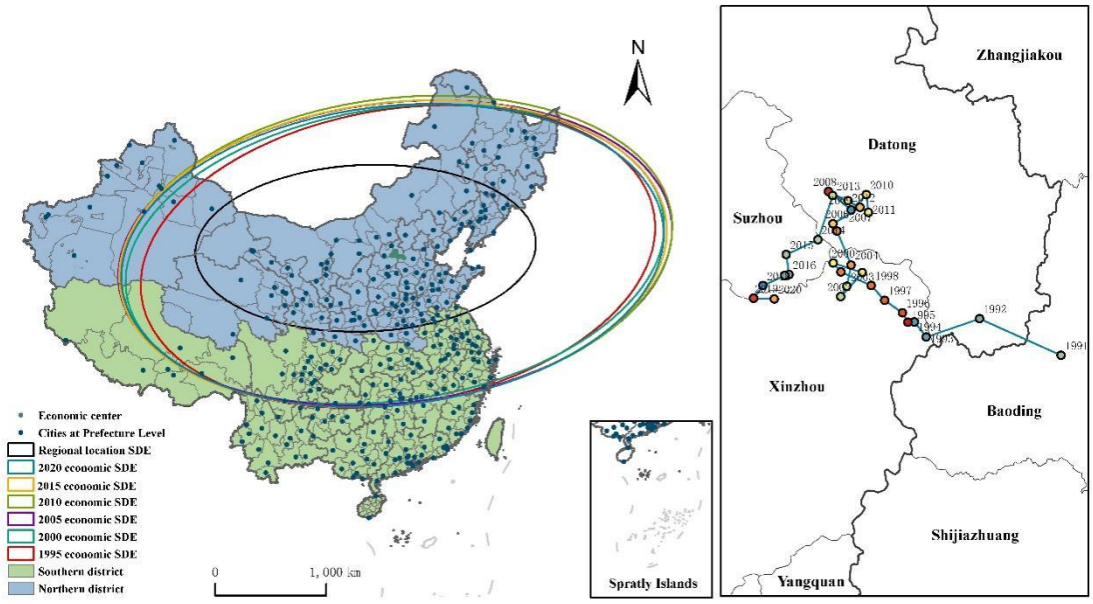

Figure 6. Ellipse and Center of Gravity of Standard Deviation of Northern Economic Distribution

4. Discussion and Conclusion

4.1 Discussion

In recent years, "North-South disparity" has become a hot term and has attracted widespread attention in academic circles. The study on the spatial and temporal evolution characteristics of North-South economic disparity in this paper can provide a reference for policy-making on North-South coordination, regional development and high-quality development. There are still shortcomings in this paper, which need to be further improved in the future: as this paper involves more years and regions, it is relatively difficult to obtain data, so only 16 indicators are selected, and the indicators are not perfect; the regions (regions, autonomous regions, leagues) with more missing data are obtained according to the provincial data, and the data obtained in this way are assigned according to the average proportion of the data of each region in the existing years to the provincial level, and the data obtained in this way have some errors with the actual situation. Due to the limitation of space, we only explored the spatial and temporal evolution of the economic differences between the north and the south, and we can explore the influencing factors behind them in the follow-up study.

4.2 Conclusion

This paper takes 336 prefecture-level and above regions across China as the research unit, and uses year-by-year statistics from 1991 to 2020 to study the spatial and temporal evolutionary characteristics of high-quality economic differences between the South and the North using the entropy method, Dagum Gini coefficient, Kernel density estimation, exploratory spatial data analysis, and standard deviation ellipses. The main findings are as follows:

In terms of spatial and temporal distribution, the overall economic level of the North and South shows a substantial growth from 1991 to 2020, and the overall spatial distribution pattern shows a more significant "relatively higher in the South, relatively lower in the North" and "higher in the coastal economic zone, lower inland cities" characteristics. The number of high level cities in the south has increased much more than that in the north, and is mainly concentrated in the Yangtze River Delta and Pearl River Delta regions, while the north is concentrated in Shandong Peninsula, and the higher level cities are mainly distributed around the high level cities, and the low level region is contracted from east to west.

The Gini coefficients within the regions of both the South and the North show a fluctuating downward trend, and both have similar trends of change. The intra-regional differences in the South are higher than those in the North during the study period, indicating that the degree of coordination of economic quality in the North is better than that in the South, and the inter-regional differences show fluctuations of falling, then growing and then falling again, with an overall downward trend, and the relative differences mainly come from the intra-regional differences in the North and South.

In terms of spatial agglomeration, the Moran index of economic level in the South is larger than that in the North during 1991-2020, indicating that the South's economy has a stronger correlation and more significant spatial agglomeration than the North. The southern economy is dominated by HH agglomeration and LL agglomeration, and the number of cities in spatial autocorrelation (HH, HL, LH and LL agglomeration) is larger in the south than in the north, i.e., the agglomeration trend of the southern economy is larger than that of the northern cities, and the north is more inclined to LL agglomeration. The HH agglomeration in the south is mainly distributed in the Yangtze River Delta city cluster and the Pearl River Delta city cluster, and the LL agglomeration in the north is mainly distributed in the northeast and the central and western regions, and in the south is mainly distributed in the central and southeastern regions.

From the spatial evolution trend, the economic center of gravity in the south has an overall "northeast-north" migration trend from 1991 to 2020, while the economic center of gravity in the north has an overall "northwest-southwest" migration trend, with the center of gravity in the south generally tilting to the northeast and the center of gravity in the north generally tilting to the northwest. The center of gravity in the south is tilted to the northeast and the center of gravity in the north is tilted to the northwest. The spatial distribution of the southern economy spreads in the "northeast-southwest" direction and contracts in the "southeast-northwest" direction, while the northern economy spreads dramatically in the "east-west" direction and in the "south-north" direction. "The shape index of the economic ellipse decreases in both the north and the south, and is always larger in the south than in the north, indicating that the spatial distribution of the southern economy is more homogeneous than that of the north.

References

Bai, B., Zhao, Z. Q., & Zhang, P. (2021). The trend and layout of regional economic spatial integration in North and South China. *Economic Geography*, *41*(2), 1-10.

Barro, R. J., & Sala-i-Martin, X. (1991). Convergence Across States and Regions. *Brookings Papers on Economic Activity*, *1991*(1), 107-182. https://doi.org/10.2307/2534639

Chen, P. Y., & Zhu, X. G. (2012). Regional economic disparities in China based on different scales. *Acta Geographica Sinica*, *67*(8), 1085-1097.

Chen, Z. (1999). The difference of development between North and South in eastern and central China. *Geographical Research*, *18*(1), 80-87.

Costas, S., & Dimitrios, A. (2010). Testing for Convergence Across the Greek Regions. *Regional Studies*, *32*(6), 537-546. https://doi.org/10.1080/00343409850119102

Fan, J., & Wang, Y. F. (2019). The Change of China's Economic Geography Pattern and regional Coordinated Development in the New Era. *Economic Geography*, *39*(1), 1-7.

Feng, C. C., Zeng, Z. R., & Cui, N. N. (2015). Spatial and temporal evolution of regional economic disparities in China since 2000. *Geographical Research*, *34*(2), 234-246.

Guo, Y. Y., & Li, L. (2017). Factors influencing regional economic disparities in western inland provinces: A case study of Chongqing. *Geographical Research*, *36*(5), 926-944.

Jian, T. L., Sachs, J. D., & Warner, A. M. (1996). Trends in regional inequality in China. *China Economic Review*, *7*(1), 1-21. https://doi.org/10.1016/S1043-951X(96)90017-6

Jin, C., & Lu, Y. Q. (2009). The evolution of economic spatial pattern based on county unit in Jiangsu Province. *Acta Geographica Sinica*, *64*(6), 713-724.

Le, G. J., Ertur, C., & Baumont, C. (2003). A Spatial Econometric Analysis of Convergence across European Regions, 1980-1995. *European Regional Growth*, *228*(47), 99-129. https://doi.org/10.1007/978-3-662-07136-6_4

Leonid, F. (2002). Regional Inequality and Regional Polarization in Russia, 1990-99. *World Development*, *30*(3), 443-456. https://doi.org/10.1007/978-3-662-07136-6_4

Li, S. S., Yan J. P., & Wu, Y. Q. (2019). Changes of heating pattern in the northern and southern regions of Qinling-Huaihe River and influencing factors. *Acta Geographica Sinica*, *74*(9), 1866-1877.

Li, B., Shi, P. J., & Jin, S. T. (2013). Spatial evolution of economic disparities in Gansu Province and its adjacent areas. *Economic Geography*, *33*(4), 40-47.

Li, E. L., & Qin, C. L. (2002). A study on regional economic differences between North and South China. *Geography and Territorial Research*, *18*(4), 76-78.

Li, J. B., Bai, Y. P., & Luo, J. (2011). Spatial analysis of the change of county economic difference in Gansu Province. *Economic Geography*, *31*(3), 390-395.

Li, Q., Wei, J. F., &Xu, B. (2001). Evolution and Driving Mechanism of Multi-scale Pattern of Regional Economic Development in China from 2000 to 2018. *Economic Geography*, *41*(12), 12-21.

Li, S. S., Yang, S. N., & Liu, X. F. (2015). Temporal and spatial variation of extreme precipitation in Northern and southern Qinling-Huaihe River during 1960-2013 and influencing factors. *Progress in Geography*, *34*(3), 354-363.

Li, X. J., & Qiao, J. J. (2001). Spatial analysis of inter-county economic disparities in China in the 1990s. *Acta Geographica Sinica*, *68*(2), 136-145.

Lin, X. Q. (1997). On the unity of entropy, environment and development. *Journal of Nanchang University (Social Science Edition)*, *35*(3), 19-24.

Long, G. Y. (1999). China's Changing Regional Disparities during the Reform Period. *Economic Geography*, *75*(1), 59-70. https://doi.org/10.2307/144462

Martin, H., Kerstin, E., &Fredrik, N. G. (2011). Trends and cycles in regional economic growth How spatial differences shaped the Swedish growth experience from 1860-2009. *Explorations in Economic History*, *48*(4), 538-555. https://doi.org/10.1016/j.eeh.2011.07.001

Masahisa, F., & Dapeng, H. (2001). Regional disparity in China 1985-1994: The effects of globalization and economic liberalization. *The Annals of Regional Science*, *35*(1), 3-37. https://doi.org/10.1007/s001680000020

Park, H. C., & Lee, J. H. (2013). A Study on the Analysis of Regional Disparity and Competitiveness on Employment in Korea. *Journal of the Korea Academia-Industrial cooperation Society*, *14*(5), 2207-2214. https://doi.org/10.5762/KAIS.2013.14.5.2207

Qin, C. L. (1997). *Research on Regional Economic Differences in China* (pp. 3-8). Beijing: China Economics Press.

Ren, Y., & Gu, G. F. (2018). Spatio-temporal characteristics and influencing factors of county economic disparities in Northeast China. *Areal Research and Development*, *37*(4), 25-31.

Sergio, J. R. (2001). Spatial Empirics for Economic Growth and Convergence. *Geographical Analysis*, *33*(3), 195-214. https://doi.org/10.1111/j.1538-4632.2001.tb00444.x

Sun, X., Liu, L. G., & Chen, J. (2021). Regional differences, dynamic evolution and influencing factors of tourism economic quality in three provinces of Northeast China. *Science of Geography*, *41*(5), 832-841.

Thomas, P. L. (2015). Intraprovincial Disparities in China: Fujian Province, 1978-1995. *Economic Geography*, *74*(4),405-432. https://doi.org/10.1111/j.1944-8287.1998.tb00023.x

Wang, H. Q., Yuan, J. D., & Meng, X. J. (2014). Spatial and temporal characteristics of tourism economic differences among three provinces in Northeast China. *Scientia Geographica Sinica*, *34*(2), 163-169.

Wu, A. Z., Yang, K. Z., & Li, G. G. (2011). A review of the changes of regional economic disparities in China. *Economic Geography*, *31*(5), 705-711.

Wu, D. T. (2001). On the difference between the North and the South of China's economic growth. *Geographical Research*, *20*(2), 238-246.

Xu, J. H., Lu, F., & Su, F. L. (2005). Spatial and temporal scale analysis of regional economic disparities in China. *Geographical Research*, *23*(1), 57-68.

Xu, J., & Yang, Y. C. (2001). The Spatial Evolution of economic globalization in Western China under the Belt and Road Initiative. *Economic Geography*, *41*(7), 20-30.

Yan, T., Zhang, X. P., & Chen, H. (2019). The Evolution of Regional economic Disparities of prefecture-level cities and above in China from 2001 to 2016. *Economic Geography*, *39*(12), 11-20.

Yang, K. Z. (1994). Research on the Variation of regional economic disparities in China. *Economic Research Journal*, *40*(12), 28-33+12.

Zeng, H., Yu, R. X., & Zuo, Y. F. (2015). The evolution of urban economic pattern and its influencing factors in the Yangtze River Economic Belt. *Economic Geography*, *35*(5), 25-31.

Zhang, B. P. (2019). Ten scientific issues in the study of South-North transition zone in China. *Progress in Geography*, *38*(3), 305-311. https://doi.org/10.1111/j.1944-8287.1998.tb00023.x

Zhang, D. (2008). *Study on Ecogeographic Regional System in China* (pp. 3-8). Beijing: The Commercial Press.

Zhang, K. Y., & Zhang, Y. (n.d.). The evolution of regional economic disparities in the Yellow River Basin under different spatial scales. *Economic Geography*, *40*(7), 1-11.

Zhang, X. B., Yu, W., & Zhang, Y. L. (2018). Spatio-temporal differentiation and influencing factors of economic growth in the Beijing-Tianjin-Hebei region. *Acta Geographica Sinica*, *73*(10), 1985-2000.

Zhao, C. G., & Ying, H. (2014). Research on regional economic differences and its application. *BioTechnology: An Indian Journal*, *10*(9), 446-461.

Zhao, L. P., Zhang, H. Y., & Jiang, S. L. (2019). Study on the spatial difference and structural optimization strategy of regional economic development in Hunan Province. *Economic Geography*, *39*(8), 29-35+43.

Zhou, Y., Li, N., & Wu, W. X. (2014). Spatio-temporal pattern of county economic development in China from 1982 to 2010. *Progress in Geography*, *33*(1), 102-113.