



Study on Coordinated Development of Population-economy Space-time Pattern in Hehuang Area

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Abstract. Hehuang region is one of the regions with dense population distribution and strong economic vitality on the qinghai-tibet plateau. This paper quantitatively measures the process and characteristics of population and economy spatial-temporal pattern evolution and coordinated development in Hehuang Region of Qinghai province from 2010 to 2020 by using geographic concentration degree, inconsistency index and spatial autocorrelation analysis. The results showed that: (1) the spatial pattern of population and economy in Hehuang region of Qinghai province tended to be the same, with the distribution characteristics of “The highest in the middle, the second in the east, and the lowest in the north, the south and the West”centered on Xining. (2) there are differences in the distribution of population and economy among counties in Hehuang area. The inconsistency index is high around and low in the middle. (3) the inconsistency index of economic development of county population gradually approaches to 1, and tends to synergic development. Using qualitative and Quantitative analysis methods and combining with regional realities, this paper puts forward suggestions on promoting the coordinated development of population and economy.

Keywords: Hehuang area; population; economy; space-time pattern; coordinated development

1 INTRODUCTION

For a long time, the relationship between population and economy has been the focus of academic research and the core issue of regional sustainable development. Population is closely related to economy^[1]. In general, the development of regional economy promotes the gathering of population^[2], and the increasing population also drives the economic development forward. Population growth can lead to economic growth, and economic growth can also lead to population growth^[3-4]. Population affects economic change in the short term^[5], a long-term appropriate population growth is good for economic development^[6]. Therefore, there is a certain relationship between the spatial distribution of population and economic agglomeration. In the short term, there will be

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differences between the two, which will hinder the sustainable development of the region, but in the long term, it will show a coordinated development trend, to promote regional sustainable development.

At present, most studies on the distribution, development and synergy of population and economy are concentrated in the central and eastern regions of China. Foreign scholars have studied population and economic problems and their relationship from Latin, Bangladesh and Russia^[7-10], many scholars believe that population agglomeration is closely related to economic growth^[11-13]. Domestic scholars not only discuss the relationship between population and economy in China^[14-15], and the population and economic distribution, evolution and synergistic coupling in the Central Plains Economic Zone, Wu River River basin, Songnen Plain River basin, Chengdu-chongqing economic circle and Wei River River basin were explored^[16-19]. Most of the research areas are located in the eastern and central parts of the country, where the population and the economy are more developed, while there is less research on the relevant topics of the Tibetan plateau.

Hehuang area is located in the east of Qinghai province, its area is only 5.6% of the whole province, but it concentrates 70% of the population and economic gross of Qinghai province. This paper studies the spatial agglomeration and distribution characteristics of population and economy in each district and County of Hehuang region, probes into the evolution law of the spatial and temporal pattern of population and economy coordinated development in Hehuang region, and tentatively puts forward some reference suggestions, it is of practical significance to promote the coordinated development of population and economy in Hehuang region, so as to promote the sustainable development of Hehuang region and provide reference for other regions.

2 DATA AND RESEARCH METHODS

2.1 The profile of the study area

The Hehuang region is located at the junction of the eastern edge of the Tibetan Plateau and the Some Random Place Somewhere, between 100°E-103°E, 35°N-38°N (Figure 1). It is located in the upper reaches of the Yellow River basin, including Xining, Haidong, Haibei, Hainan and Huangnan State 5 states 18 district counties, an area of about 40,000 square kilometers. The cultivated land resource is relatively concentrated and the heat is sufficient, which is the main valley agriculture area in qinghai-tibet region. The region has a long history of human activities. It is a multi-ethnic area inhabited by Tibetans, Han Chinese, Hui and Monguor people. It has a long history of development, a relatively concentrated population and a high level of economic development. By 2020, the permanent population of Hehuang is 4.268 million and the GDP is 203.162-billion-yuan, accounting for 72 percent of Qinghai's population and 67.6 percent of its economic output.

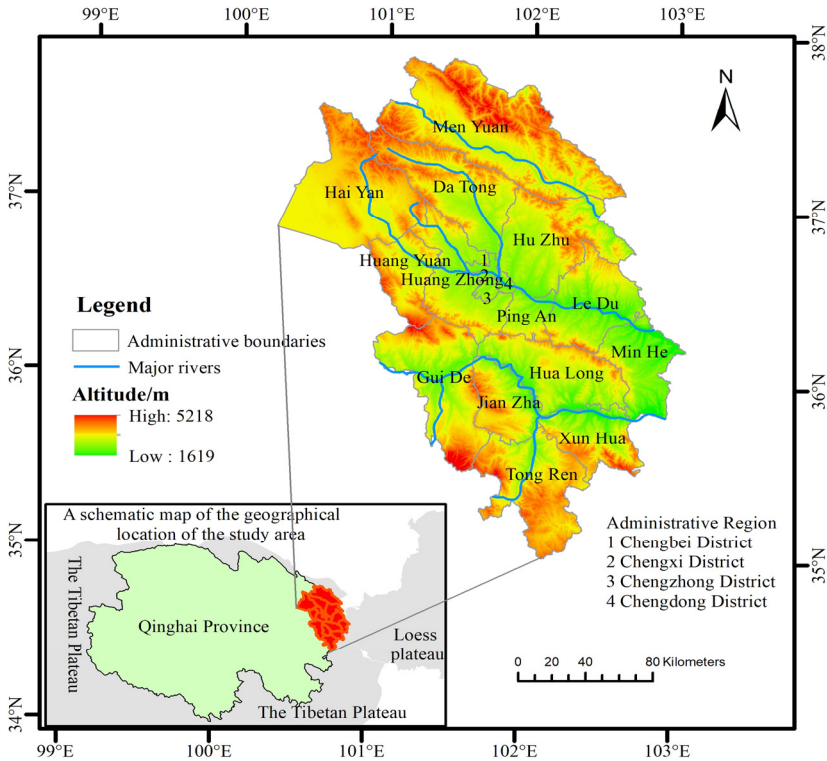


Fig. 1. Overview of the study area (Note: From the author’s own drawing)

2.2 Data sources

This article mainly based on the 2010-2020 Qinghai province Hehuang area each district and the county’s population and the economy and so on statistical data carries on the analysis, the population data are mainly derived from the data of the sixth and seventh population censuses, the statistical yearbooks and statistical bulletins of each district and county, the economic data mainly came from the statistical yearbook of Chinese counties, the Statistical Yearbook of Qinghai Province and Xining Province, and the statistical bulletins of cities, districts and counties. In the cartographic data, the vector data sources of the county boundaries in Hehuang area are the National Geographic Information Resources Catalog Service System, and the elevation data come from the geospatial data cloud.

2.3 Methods

In this paper, from the area and county scale of Hehuang area, the comprehensive application of geographic concentration, inconsistency index and spatial autocorrelation analysis¹⁶. By using SPSS, ArcGIS and Geoda Software, this paper analyzes the evolu-

tion process and characteristics of the spatial-temporal pattern of population and economy coordinated development by collecting the data of population, GDP and administrative area of each county and city from 2010 to 2020.

Geographic concentration.

The degree of geographical concentration is considered synthetically with the factors of population, economy and area, and the degree of geographical concentration of population and economy is introduced to measure the degree of population and economy concentration in certain spatial scope in Hehuang area. The formula is:

$$R_{pit} = \frac{p_{it} / \sum_{n=i}^n p_{it}}{S_{it} / \sum_{n=1}^n S_{it}}, \quad R_{Git} = \frac{G_{it} / \sum_{n=i}^n G_{it}}{S_{it} / \sum_{n=1}^n S_{it}} \quad (1)$$

In the formula, R_{pit} and R_{Git} denote the population geographic concentration degree and the economic geographic concentration degree of "i" area in "t" period, P_{it} , G_{it} and S_{it} represent the population, GDP and area of "i" region, respectively, "n" represents the number of units and Σ represents the sum of geographic elements in the whole region.

The index of population-economy inconsistency.

The index is calculated on the basis of the concentration of population and economic geography, which can reflect the spatial difference of each region and show the status of the inconsistency of population and economy:

$$C_{it} = \frac{R_{pit}}{R_{Git}} \quad (2)$$

In the formula, C_{it} , R_{pit} and R_{Git} denote respectively the index of population-economy inconsistency, population-geography concentration and economy-geography concentration in "i" area in "t" period. From the inconsistency index connotation, C_{it} greater than 1 indicates that the population agglomeration is higher than the economic agglomeration, less than 1 indicates that the population agglomeration is lower than the economic agglomeration, and close to 1 indicates that the population and the economic agglomeration are basically consistent.

Spatial autocorrelation analysis.

In order to further explore the relationship between population and economic spatial distribution and its changing process, this paper introduces the Global Moran Index I and the local index of spatial relationship (Lisa) to further analyze.

The Global Moran Index I Formula Is:

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^n \sum_{j=1}^n w_{ij} \sum_{i=1}^n (x_i - \bar{x})^2}, \quad \bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \tag{3}$$

In the formula, “I” is the MOLAIN index, “n” is the number of study area units, x_i and x_j are the attributes of area "i" and area "j" respectively, and W_{ij} is the adjacent weight of space units. MOLAIN index is between [-1,1], less than 0 means negative correlation, equal to 0 means non-correlation, greater than 0 means positive correlation, the closer its absolute value is to 1 means the closer the relationship between spatial units.

The Local Moran Index I (Lisa) Formula Is:

$$I_i = \frac{n(x_i - \bar{x}) \sum_j w_{ij} (x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2}, \quad \bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \tag{4}$$

In formula (4), each variable has the same meaning as the previous formula (3). I_i value is the spatial aggregation of the similar values (high or low) around the regional unit, and negative value is the spatial aggregation of the non-similar values.

3 RESULTS AND FINDINGS

Based on the formula (1), the population and economic geographical concentration of Hehuang area in Qinghai province from 2010 to 2020 is calculated, using ARCGIS10.2 software to process the population and economic geographic concentration in 2010, 2013, 2017 and 2020, and divide them manually according to Jenks method and data characteristics, map the spatial distribution of population and economy.

3.1 The evolution of the spatio-temporal pattern of population

According to the spatial pattern of population concentration (Figure 2), the geographical concentration of population in Hehuang area is the highest in the middle, the second in the east, and the lowest in the south, the north and the west. Specifically, the geographical concentration of population is relatively high in the four urban areas of Xi-ning, all larger than 10, and significantly higher than the other areas of Hehuang region. The geographical concentration of population in the eastern Hehuang region ranges from 1-2 to 2-10, including Ping'an District, Datong Hui and Tu Autonomous County and Huzhu Tu Autonomous County, and from 0.5-1 for Huangyuan County and

Xunhua Salar Autonomous County, Jianzha County, Guide County, Tongren and Menyuan Hui Autonomous County in the north-south and the West all have concentrations of less than 0.5. From 2010 to 2020, Chengxi District, Chengdong District and Chengbei District, the three districts of Hehuang Prefecture, had a large increase in population concentration. The geographical concentration of the population of the other districts and counties basically showed a small fluctuation or declining trend, while that of Haiyan County, which had the smallest concentration, dropped from 0.0757 to 0.0603, it can be seen that there are obvious differences in the evolution of population geographical concentration degree between different districts and counties in Hehuang area. On the whole, from 2010 to 2020, there was no significant change in the pattern of geographical concentration of population in Hehuang region, which was mainly reflected in the increase of concentration of Chengxi District, Chengdong District and Cheng District, Ledu District and other districts and counties, and the decline in the concentration of districts and counties such as city centre, Huangyuan County, Ping'an District and Minhe Hui and Tu Autonomous County.

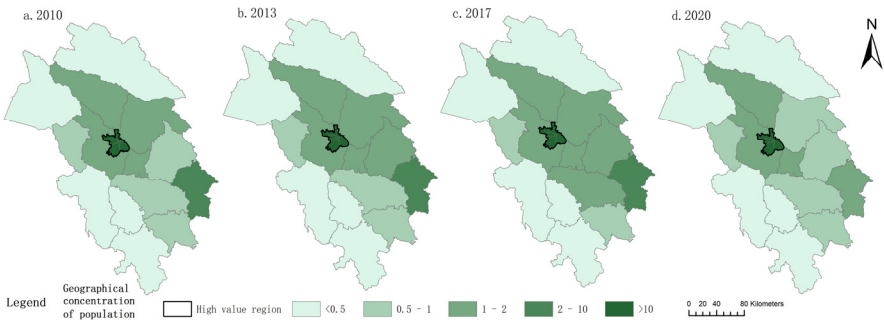


Fig. 2. Evolution pattern of population geographic concentration degree in Hehuang area from 2010 to 2020 (Note: From the author's own drawing)

3.2 The evolution of economic space-time pattern

As shown in Figure 3, the distribution pattern of the concentration degree of economic geography in Hehuang area is similar to that of population geography. More specifically, Xining city remains the most geographically concentrated, with Chengxi District having the highest concentration. The economic geography concentration degree of each district and county in the east is high, mostly between 0.5-1 and 1-2. South, north and west of Menyuan Hui Autonomous County, Haiyan County, Huangyuan County, Guide County, Tongren City and other districts and counties in the lowest geographical concentration, at less than 0.5. In terms of time, the concentration of economic geography in Xining's urban areas is on the rise, chengxi, Chengdong District, Chengbei District and Chengzhong increased from 100.9119, 37.3765, 34.1603 and 21.8126 in 2010 to 139.0485, 42.0143, 5.0539 and 26.3984 in 2020 respectively. The economic and geographical concentration of most districts and counties in the vicinity of Xining city decreased, with Datong Hui and Tu Autonomous County, Huangzhong and Huzhu Tu Autonomous County dropping from 1.3912, 1.7746 and 0.7398 in 2010 to 0.7615,

1.3701 and 0.6838 in 2020 respectively. Most districts and counties in the East Rose. The economic geographical concentration in the western regions of the north and south mostly declined, for example, from 0.6023 to 0.3359 in Huangyuan County and from 0.2547 to 0.0871 in Haiyan County. It can be seen that there are significant differences in the degree of concentration of economic geography among different districts and counties in Hehuang region. There are significant differences among different districts and counties. Due to its own conditions, regional advantages and political advantages, the main urban areas of Xining, China, have, the concentration of economic geography is high and rising, and the economic agglomeration continues to strengthen.

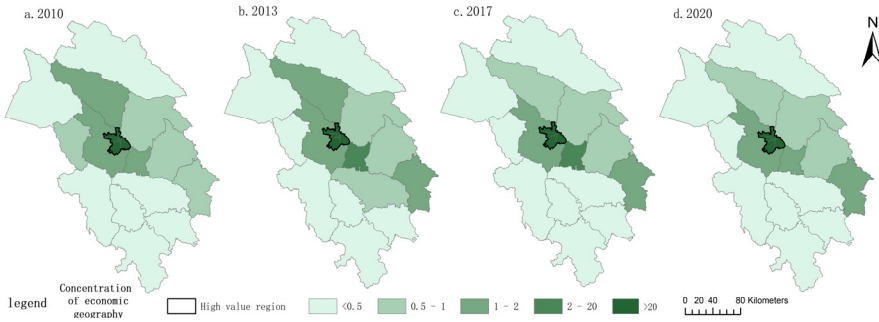


Fig. 3. the evolution pattern of concentration degree of economic geography in Hehuang region from 2010 to 2020 (Note: From the author’s own drawing)

3.3 Analysis of the population-economy inconsistency index

From 2010 to 2020, the distribution of population and economy in Hehuang area has changed, but whether the evolution of population and economy space-time pattern is coordinated or not is further analyzed by the index of population-economy inconsistency. According to the formula (2), the inconsistency index between population and economy of each district and county in Hehuang area is calculated and divided into four types: $0 < C_{it} < 0.8$ is the economic leading type, the degree of population agglomeration is lower than the degree of economic agglomeration; $0.8 < C_{it} < 1.2$ is the coordinated type of population and economy, the degree of population agglomeration is basically consistent with the degree of economic agglomeration, and is in the relative coordinated state; $1.2 < C_{it} < 2$ is the advanced type of population, the degree of population agglomeration is higher than that of economy agglomeration; $C_{it} > 2$ is a highly concentrated type of population, and the degree of population agglomeration is much higher than the degree of economic agglomeration. The spatial distribution pattern of population and economy discordance index in Hehuang area in these years was obtained (Figure 4).

Through the observation and analysis of the inconsistency index of population and economy in Hehuang area, we can find that the inconsistency index of population and economy in Hehuang area has changed from 2010 to 2020, and its distribution has spatial difference, the spatial distribution of population is higher than that of economy,

which shows that the distribution and development of population and economy in Hehuang area are not coordinated. Specifically, the leading economies in 2010 are the City West District, Chengbei District, Haiyan County and Jainca County, and the leading economies in 2020 are the city Central District, Chengxi District, Chengbei District, Ping'an District and Haiyan County, it is more concentrated in Xining's urban areas, which indicates that the urban economic agglomeration capacity is higher than the population agglomeration capacity. In 2010, Chengdong District, Chengzhong, Datong Hui and Tu Autonomous County, Huangzhong, Ping'an District, Guide County, by 2020, there will be Chengdong District, Huangzhong, Ledu District, Tongren and Jainca County, mainly in the neighboring and southern districts of Xining city in central China, population agglomeration and economic agglomeration basically coordinate. The population concentrated type and the population advanced type are mostly located in the northern, southern and eastern parts of Hehuang area, and there are always more districts and counties of this type than other types from 2010 to 2020, it shows that the economic development of most regions in Hehuang area lags behind the population agglomeration. From 2010 to 2020, the inconsistency index of most districts and counties, such as Chengdong District, Chengbei District and Tongren City of Ledu District, gradually approached one, indicating that the difference between population and economic agglomeration in Hehuang region was narrowing, the future of population and economy may present a trend of coordinated and balanced development.

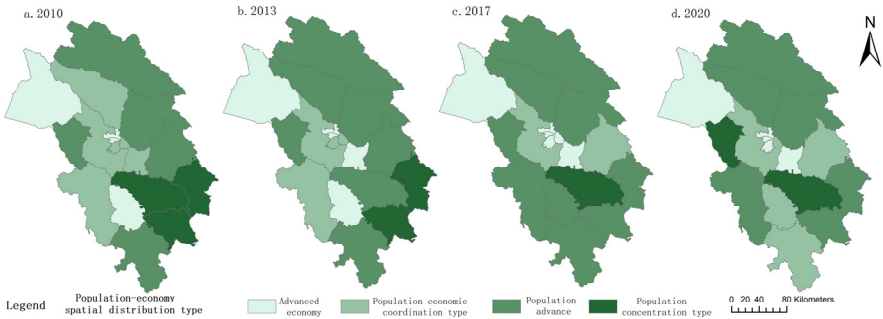


Fig. 4. the spatial distribution pattern of population-economy inconsistency index in Hehuang area from 2010 to 2020 (Note: From the author's own drawing)

3.4 Spatial autocorrelation analysis of the inconsistency between population and economy

The spatial autocorrelation analysis is introduced to further explain the spatial relationship and changing trend of the discordance between population and economy in Hehuang area. Based on the calculation formula (3), the Moran index I of discordance between population and economic distribution in Hehuang area in 2010 and 2020 is 0.320 and 0.171 ($P \leq 0.05$ by Z test), all of them are positive, which shows that the inconsistency index of population and economy in Hehuang area is positive spatial autocorrelation and has obvious spatial agglomeration. However, the value of Moran index

It shows a downward trend, which indicates that the difference between population and economy in Hehuang area is gradually reduced, and the population and economy may develop in synergy. According to the Moran scatterplots in 2010 and 2020(Figure 5), most districts and counties in Hehuang area were located in the first and third quadrants in 2010 and 2020, “High-high” and “Low-low” clustering characteristics are more obvious, indicating that the population and economic distribution in Hehuang region of the spatial difference is large. But in 2020, the districts and counties in Hehuang area are distributed evenly in each quadrant, which shows that the spatial agglomeration effect is weakened and the distribution of population and economy tends to cooperate.

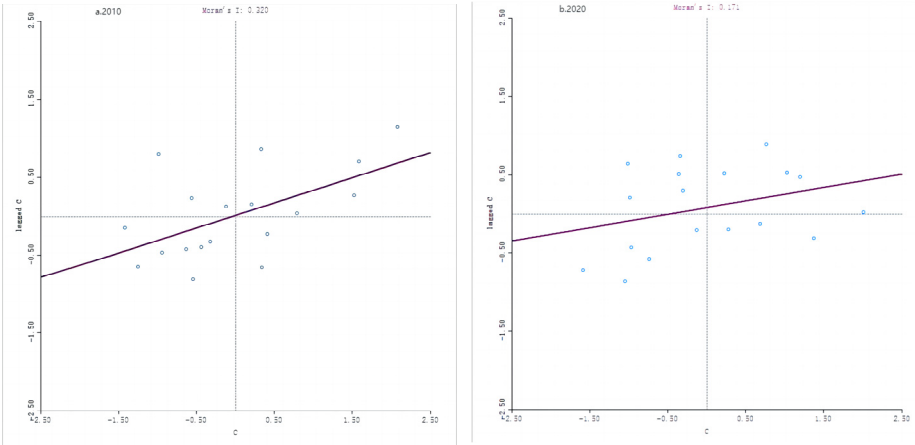


Fig. 5. Moran scatter plot of the population-economy discordance index of Hehuang region in 2010 and 2020 (Note: From the author’s own drawing)

In order to better understand the spatial distribution and changes of population and economy in Hehuang area, a local Lisa cluster map of population and economy in Hehuang area from 2010 to 2020 was drawn (figure 6). At least 12 of the 18 districts and counties in Hehuang area show no obvious characteristics in each year, which reflects the weak relationship between population and economy in these districts and counties. The other districts and counties are obviously “High-high” agglomeration and “Low-low” agglomeration. In 2010, Ledu District, Minhe Hui and Tu Autonomous County and Xunhua Salar Autonomous County counties in the eastern part of Hehuang prefecture showed a “High-high” concentration distribution, and they were of advanced population type and highly concentrated population type Urban District and Huangzhong district are “Low-low” agglomeration, population and economy coordination type. In 2013, Minhe Hui and Tu Autonomous County and Xunhua Salar Autonomous County formed a “High-high” concentration, while the city center was a “Low-low” concentration, and Jainca County after 2013 was a “Low-high” concentration. In 2017, “High-high” clusters remained unchanged, while “Low-low” clusters increased, all located in Xining’s urban areas. By 2020, Minhe Hui and Tu Autonomous County and Guide County will be clustered in a “High-high” pattern, while Xunhua Salar Autonomous

County will change from a "High-high" pattern to a non-significant one, and the demographic and economic inconsistency will decrease. Midtown and Chengdong District are "Low-low". Generally speaking, the "High-high" agglomeration mainly lies in Minhe Hui and Tu Autonomous County and Xunhua Salar Autonomous County, which are located in the southeast of Hehuang area. "Low-low" clusters are mostly located in the main urban areas of Xining. These areas have good basic conditions and advantages in economic development. The degree of economic agglomeration is higher than that of population agglomeration. Therefore, it can be found that there are differences in the spatial distribution of population and economy in Hehuang area.

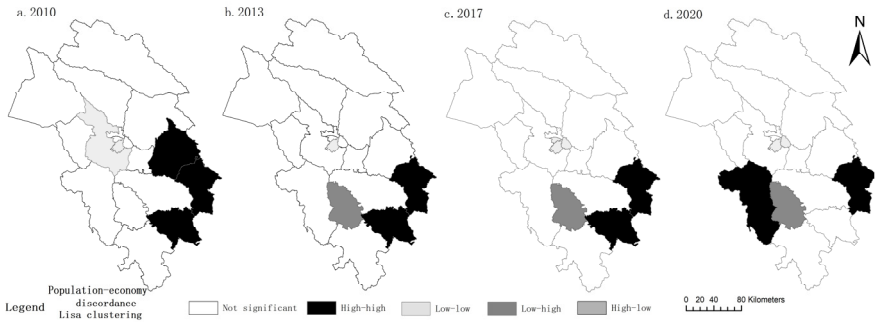


Fig. 6. Lisa aggregation map of population-economy inconsistency index in Hehuang area
(Note: From the author's own drawing)

4 CONCLUSIONS

Population and economy are two main indicators of regional development. It is important to study the consistency and synergy between them. This paper analyzes the spatial and temporal pattern of coordinated development of population and economy in Hehuang region from 2010 to 2020, and draws the following conclusions:

(1) there is a certain relationship between the population and the concentration degree of economic geography in Hehuang area. The spatial distribution pattern of population and economic agglomeration in all districts and counties shows the pattern of "The highest in the middle, the second in the east, and the lowest in the south, the north and the West". From the perspective of spatio-temporal evolution, the increase in population and economic geographical concentration is evident in Xining's urban areas. Most of the surrounding and marginal districts and counties show a downward trend, showing a phenomenon of regional economic concentration, it reflects the unbalanced distribution of population and economy in Hehuang area.

(2) the distribution of population and economy in Hehuang area is not completely consistent, and the coordinated development of population and economy is poor. Specifically, Xining's main urban population and economic inconsistency index is less than 1, mainly in the economic leading type, most of the northern and southern districts and counties are more than 1, mainly in the population leading type, showing the trend of high around, low in the middle. At the same time, the discordance index of population

and economy in Hehuang area has obvious spatial characteristics of “High-high” and “Low-low”.

(3) the population-economy inconsistency index of more than half of the counties in Hehuang area tended to be 1, and the Moran index I showed a downward trend, this indicates that the population and economy in Hehuang area may develop in synergy in the future.

5 DISCUSSION

Hehuang region has the advantage of connecting the east and the west, which is the important growth pole to promote the economic development of the west. Based on the existing conditions and unique advantages of Hehuang area, we should formulate appropriate development strategies to promote the coordinated development of population and economy.

(1) in general, Hehuang area, as a key development zone in the east of Qinghai province, should improve its economic development level and quality, optimize the urban-rural pattern and construction land structure, to build the urban space suitable for population, economy and natural resources carrying capacity, cultivate the economic development axis and emerging cities, and make them become the core areas of green and high-quality development.

(2) to implement different development strategies according to the development of the population and economy of each sector. Xining's main urban areas, where the population and economy are highly concentrated, should give full play to their regional advantages, develop new and high-tech industries and give full play to the vitality of the market economy so that the population and economy are concentrated in an efficient manner. For the eastern region with a relatively large agricultural and animal husbandry sector, it is necessary to rationally implement the cultivated land protection system, improve the scientific and technological level of agriculture and animal husbandry and crop quality, develop the characteristics and ecological economy of agriculture and animal husbandry, and promote the transformation of the agricultural population to non-agriculture. For the marginal counties with lower economic development level in the north-south West, we should ensure the infrastructure and public services, actively develop the local characteristic resources, improve the supply capacity of ecological products, improve the industrial structure and carry out ecological migration.

(3) according to local conditions, bring into play the main advantages, promote inter-regional cooperation, and promote the formation of the Hehuang region with different characteristics, complementary regional patterns. It is necessary to improve the mechanism of inter-regional economic cooperation, strengthen the relationship between the central cities and the peripheral areas in Hehuang region, promote the free movement of population and factors of production, and strengthen and give full play to Xining's radiation capacity. According to the different function orientation, depending on the different superior resources of each district and county, develop the local characteristic economy and service, distribute the industrial division reasonably, promote the regional superiority complementary, improve the integration degree of Hehuang area, to guide

the coordinated development of the economy and population of each district and county.

The limitation of this paper is that several years from 2010 to 2020 are selected for analysis, and the space-time evolution law of more detailed time periods is to be studied. In the area of district and county, the spatial differentiation of functions, population mobility and separation of occupation and residence in each district and county need further consideration and research. The Quantitative analysis approach to the drivers of the spatio-temporal distribution of population and economy is more traditional. Because of the difficulty in obtaining data, the indicators are relatively simple and not considered in a detailed and comprehensive manner, it can't be explored from the vertical, and it is necessary to establish a more perfect evaluation system, from many aspects, multi-level, multi-angle in-depth study.

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