Spatiotemporal Patterns and Dynamic Evolution of Rural Non-Agricultural Employment Levels: A Case Study of Qinghai Province (Postprint)

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Abstract

To accurately grasp the spatiotemporal patterns and dynamic evolution trends of rural non-agricultural employment levels in Qinghai Province at the county scale and promote common prosperity, this study employs panel data from 43 county-level units in Qinghai Province from 2010 to 2020. Using methods such as global trend analysis, standard deviational ellipse, and Moran's I index, it reveals the spatiotemporal evolution characteristics of rural non-agricultural employment levels in Qinghai Province, and further adopts Kernel density estimation and Markov chains to examine their dynamic evolution trends. The results indicate: (1) The rural non-agricultural employment level in Qinghai Province shows an overall fluctuating upward trend, which can be divided into a rapid growth stage and a slow growth stage based on growth rates. (2) In terms of spatial distribution patterns, the overall spatial distribution exhibits characteristics of "high in the east and west, low in the middle" and "high in the north, low in the south", with the spatial pattern showing a shift from an "east-west" distribution to a "northeast-southwest" orientation. (3) Regarding spatial correlation, rural non-agricultural employment levels exhibit significant positive spatial autocorrelation, with prominent patch characteristics of "high-high" agglomeration and "low-low" agglomeration. (4) In terms of distribution dynamic evolution, rural non-agricultural employment levels demonstrate a stable club convergence phenomenon, and there exists a "spatial spillover" effect in the development process of rural non-agricultural employment levels.

Full Text

Abstract

This study aims to comprehensively understand the spatiotemporal patterns and dynamic evolution of rural non-farm employment in Qinghai Province at

the county scale, thereby contributing to the realization of common prosperity. Based on panel data from 43 county-level units, we employ global trend analysis, standard deviation ellipse, and Moran's I index to reveal the spatiotemporal evolution characteristics of rural non-farm employment in Qinghai Province. Furthermore, kernel density estimation and Markov chain methods are used to examine its dynamic evolution trends. The results indicate that: (1) The overall level of rural non-farm employment exhibits a fluctuating upward trend, which can be divided into a rapid growth stage and a slow growth stage based on growth rates. (2) In terms of spatial distribution, the pattern shows "high in the east and west, low in the middle" and "high in the north, low in the south," with a noticeable shift from a "due east-due west" distribution toward a "northeast-southwest" orientation. (3) Regarding spatial correlation, rural non-farm employment demonstrates significant positive spatial autocorrelation, with prominent "high-high" and "low-low" clustering patterns. (4) In terms of distribution dynamics, rural non-farm employment exhibits stable club convergence, and the development process shows a "spatial spillover" effect.

Keywords: rural non-farm employment; common prosperity; spatiotemporal pattern; dynamic evolution; Qinghai Province

Introduction

The "three rural issues" (agriculture, rural areas, and farmers) are fundamental problems concerning national welfare and people's livelihood. The core of these issues lies with farmers, whose primary concern is income—specifically, low and difficult-to-increase incomes. At present, farmers find it challenging to achieve prosperity through agriculture alone, whether cultivating grain crops or cash crops. Consequently, more farmers are obtaining income through non-farm employment, which has gradually become an important channel for wealth creation. The 20th National Congress of the Communist Party of China emphasized developing rural characteristic industries and expanding channels for farmers to increase their income, consolidating and expanding poverty alleviation achievements, and enhancing the endogenous development momentum of former poverty-stricken areas and populations. Farmers' participation in non-farm employment can effectively counter the risk of returning to poverty and plays a crucial role in consolidating poverty alleviation achievements and achieving common prosperity.

In recent years, Qinghai Province has witnessed rapid development in its non-farm industries, particularly tourism. The prosperity of non-farm industries has driven substantial economic growth, expanded income channels for farmers, and increased rural non-farm employment income. However, it must be acknowledged that significant gaps remain between Qinghai Province and eastern coastal provinces in terms of rural non-farm employment. Therefore, improving rural non-farm employment levels has become a key measure for achieving high-quality development in Qinghai Province.

As the importance of rural non-farm employment becomes increasingly prominent, related research has grown substantially. Existing literature primarily focuses on two aspects: first, examining influencing factors of rural non-farm employment, including the expiration of the first round of subsidies for the Sloping Land Conversion Program [], gift expenditures [], digital inclusive finance [], rural industry integration [], agricultural infrastructure [], and individual and household characteristics []. Second, investigating the impacts of rural non-farm employment on household financing [], economic growth [], and other factors. However, most existing studies focus on the relationship between specific factors and rural non-farm employment, with limited research on the spatiotemporal characteristics of rural non-farm employment levels. Moreover, existing studies are mostly based on static perspectives, lacking exploration from dynamic viewpoints []. Against this background of common prosperity, what trends has rural non-farm employment in Qinghai Province experienced? What characteristics does it exhibit temporally and spatially? How can rural non-farm employment levels be improved? Answering these questions is crucial.

Based on this context, this study examines 43 counties in Qinghai Province, employing global trend analysis, standard deviation ellipse, and Moran's I index to reveal the spatiotemporal evolution characteristics of rural non-farm employment levels. Furthermore, kernel density estimation and Markov chain methods are used to explore dynamic evolution trends. The marginal contributions of this paper are mainly reflected in three aspects: (1) Innovative research object: Qinghai Province possesses typical characteristics including frontier location, economic underdevelopment, and ethnic cultural diversity, making its findings valuable for reference in similar regions. (2) Innovative research scale: This study is conducted at the county scale, enabling more accurate and detailed revelation of internal differences in rural non-farm employment levels within Qinghai Province. (3) Innovative research perspective: This paper explores spatiotemporal patterns and evolution trends of rural non-farm employment levels from both static and dynamic perspectives.

1. Materials and Methods

1.1 Study Area

Qinghai Province is located in the inland northwest of China, in the northeastern part of the Qinghai-Tibet Plateau. It has two prefecture-level cities and six autonomous prefectures, totaling 43 county-level administrative units. Qinghai's pastoral area is one of China's five major pastoral areas. While agriculture and animal husbandry are relatively developed in the province, they face severe limitations in expanding sources of income for farmers and herders due to complex terrain, high average altitude, and prominent ecological functions. In 2020, the per capita disposable income of rural residents in Qinghai Province was only 12,342 yuan, significantly lower than the national average of 17,131 yuan for rural residents.

1.2 Data Sources

This study's data primarily come from the *China County Statistical Yearbook*, *Qinghai Statistical Yearbook*, *Xining Statistical Yearbook*, and statistical bulletins of various prefectures and cities in Qinghai Province from 2010 to 2020. Due to unavailable data for Dachaidan Administrative Committee and Mangya City, the county sample size is 43. Based on the measurement method for rural non-farm employment levels by Fang et al. [], we calculated the rural non-farm employment levels for all counties in Qinghai Province.

1.3 Methods

1.3.1 Global Trend Analysis Global trend analysis reveals the spatial distribution patterns of variables within a study area through three-dimensional simulation surfaces, primarily showing the overall patterns of spatial data. It reflects the main characteristics of economic variables' changes across spatial regions. In a trend analysis diagram, each vertical bar represents the value (height) and location of a data point. These points are projected onto an orthogonal plane composed of east-west and north-south directions, where a best-fit line can be drawn through the projection points to simulate the trend in a specific direction [].

1.3.2 Standard Deviation Ellipse The standard deviation ellipse (SDE) analyzes the spatial distribution characteristics of economic phenomena through four basic elements: center, long axis, short axis, and rotation angle []. The long and short axes of the ellipse represent the dispersion degree of rural non-farm employment levels in Qinghai Province in the primary and secondary directions, respectively, while the rotation angle indicates changes in the main trend direction of rural non-farm employment levels.

1.3.3 Spatial Correlation Spatial autocorrelation includes global and local autocorrelation. The global Moran's I index can examine the spatial agglomeration degree of rural non-farm employment levels during the study period, while the local Moran's I index can more intuitively depict the spatial dependence and heterogeneity of local units. The calculation formulas are:

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

where x_i and x_j represent the rural non-farm employment levels of county i and county j, respectively; $\bar{x}$ is the mean rural non-farm employment level of all counties in Qinghai Province in a given year; n is the number of county units; and w_{ij} is the spatial weight matrix. This study constructs the weight matrix based on the adjacency principle. The global Moran's I index ranges between $[-1, 1]$. Specifically, a global Moran's I greater than 0 indicates positive spatial

autocorrelation, less than 0 indicates negative spatial autocorrelation, and equal to 0 indicates no spatial correlation [].

For the local Moran's I index, when $I_i > 0$, it indicates similar spatial clustering (high-high or low-low); when $I_i < 0$, it indicates dissimilar spatial clustering (high-low or low-high).

1.3.4 Kernel Density Estimation Kernel density estimation reveals the geographical distribution characteristics of economic phenomena by examining data distribution patterns []. This study uses non-parametric kernel density estimation to compare kernel density curves across different years, exploring the dynamic evolution characteristics of rural non-farm employment levels in Qinghai Province. The specific calculation formula is:

$$f(x) = \frac{1}{nh} \sum_{i=1}^{n} K\left(\frac{x_i - x}{h}\right)$$

where $f(x)$ is the kernel density estimate; n is the number of county units; x_i is the rural non-farm employment level of county i; x is the mean rural non-farm employment level of all counties in Qinghai Province in a given year; $K(\cdot)$ is the kernel function; and h is the bandwidth.

1.3.5 Markov Chain Markov chain is a random process with discrete time and states. Continuous data are discretized into k types, and the distribution and changes of corresponding types are calculated. Transitions between attribute types at different times can be represented using a $k \times k$ probability matrix []. Thus, we can construct a Markov transition probability matrix to describe the dynamic evolution characteristics of rural non-farm employment levels in Qinghai Province. The specific calculation formula is:

$$m_{ij} = \frac{n_{ij}}{n_i}$$

where m_{ij} is the probability of a region belonging to type i at time t transitioning to type j at time $t+1$; n_{ij} is the total number of regions transitioning from type i at time t to type j at time $t+1$; and n_i is the total number of regions belonging to type i at all time t during the entire study period.

The spatial Markov chain method introduces the concept of "spatial lag" into the Markov analysis process []. The spatial Markov chain transition probability matrix uses the spatial lag of a region in the initial year as a condition, decomposing the traditional transition probability matrix into k $k \times k$ Markov transition probability matrices. In the kth conditional matrix, element m_{ij}^k represents the probability that region a transitions from state type i at time t to state type j at time $t+1$ under the condition that its spatial lag type is k. The

spatial lag value of region a is the weighted average of attribute values of its spatial neighboring regions []. The specific formula is:

$$\text{lag}_a = \sum_{b=1}^{n} Y_b W_{ab}$$

where lag_a is the spatial lag value of region a; W_{ab} is the spatial weight matrix representing the spatial relationship between region a and region b; Y_b is the attribute value of region b; and n is the total number of regions.

2. Results

2.1 Temporal Characteristics Analysis

From 2010 to 2020, the overall rural non-farm employment level in Qinghai Province showed a fluctuating upward trend, with the fluctuation amplitude gradually decreasing over time. The evolution can be roughly divided into two stages (Fig. [Figure 1: see original paper]):

(1) Rapid growth stage (2010–2015): During this stage, rural non-farm employment levels increased from 39.54% to 44.05%, with an average annual growth rate of 1.13%. The possible reason is that the implementation of the first round of household registration system reform in Qinghai Province in 2010 provided favorable conditions for rural labor to engage in non-farm employment. Additionally, Qinghai Province successively introduced a series of policies to strengthen labor transfer in agricultural and pastoral areas, which gradually increased rural non-farm employment levels.

(2) Slow growth stage (2016–2020): During this stage, rural non-farm employment levels increased from 44.05% to 45.61%, with an average annual growth rate of only 0.31%. Although the second round of household registration system reform and related transfer employment policies continued to be effectively implemented, considering Qinghai Province's positioning based on its "three largest" provincial conditions and its pursuit of sustainable high-quality economic development, the province's economic structure has been continuously adjusted to adapt to ecological development laws. Non-farm employment activities not suited to ecological development patterns have been restricted, resulting in slow growth in rural non-farm employment levels during this stage.

2.2 Spatial Characteristics Analysis

2.2.1 Spatial Pattern Characteristics To reveal the spatial distribution pattern of rural non-farm employment levels at the county scale in Qinghai Province, this study uses trend analysis to plot three-dimensional perspective diagrams (Fig. [Figure 2: see original paper]) using the rural non-farm employment levels of each county in 2010, 2015, and 2020 as height attribute values. From the shape of the trend curves at the three time points, the trend curves in

the east-west direction all show a "U-shaped" characteristic of being high in the east and west but low in the middle, indicating that rural non-farm employment levels in the eastern and western regions of Qinghai Province are higher than in the central region. In the north-south direction, the curves show a smooth declining characteristic from north to south, indicating that a north-high-south-low distribution pattern of rural non-farm employment levels formed in Qinghai Province during the study period.

The possible reasons are that the northeastern part of Qinghai Province has flat terrain, lower altitude, and hosts many large enterprises, making its economy relatively developed and able to provide more non-farm employment opportunities, thus resulting in higher rural non-farm employment levels. Counties near the Qaidam Basin in the northwest have abundant natural resources, and the rapid development of industries such as petrochemical, salt lake chemical, and coal chemical industries has attracted large numbers of rural laborers, promoting local rural non-farm employment development. In contrast, most counties in the central and southern regions are located in the Three-River-Source area, with high altitude, sparse population, and prominent ecological protection functions, which have constrained local rural non-farm employment development to some extent.

To further characterize the evolution of the spatial pattern of rural non-farm employment levels at the county scale in Qinghai Province, this study uses standard deviation ellipse for quantitative identification (Table). From the rotation angle perspective, the standard deviation ellipse rotation angle of rural non-farm employment levels in Qinghai Province changed from 73.59° to 85.53°, indicating that the spatial pattern shifted from a "due east-due west" distribution to a "northeast-southwest" orientation. From the shape of the standard deviation ellipse, the average shape index (ratio of short semi-axis to long semi-axis) decreased from 2010 to 2015 and slightly increased in 2020, indicating that during the study period, rural non-farm employment levels in Qinghai Province showed a trend of first dispersing and then concentrating. From the perspective of centroid distribution, the centroid of rural non-farm employment levels in Qinghai Province fluctuated between 100.71°E–100.98°E and 36.14°N–36.40°N, with small movement amplitude and a slight shift toward the southwest.

2.2.2 Spatial Correlation Characteristics To investigate the spatial correlation of rural non-farm employment levels in Qinghai Province, this study uses ArcGIS 10.2 software to calculate the global Moran's I index, significance level P-value, and standardized statistic Z-value for rural non-farm employment levels from 2010 to 2020 (Table). The calculation results show that the global Moran's I index fluctuated between 0.627 and 0.722 during the study period, all significant at the 1% level, indicating that rural non-farm employment levels in Qinghai Province are not randomly distributed but exhibit significant positive spatial autocorrelation, showing spatial agglomeration distribution characteristics.

Through formula (2), we calculated the local Moran's I index for rural non-farm employment levels in Qinghai Province. Table shows that rural non-farm employment levels in Qinghai Province have significant spatial agglomeration effects, mainly manifested as "high-high" and "low-low" spatial clustering types. Specifically, "high-high" type counties have spillover effects in improving rural non-farm employment levels and can drive the development of surrounding counties' rural non-farm employment levels. In contrast, "low-low" type counties have low rural non-farm employment levels, and their surrounding counties also have low levels, unable to play a driving role.

Specifically, "high-high" type counties were mainly concentrated in 9 counties in northeastern Qinghai Province in 2010, including Ping'an District, Huzhu Tu Autonomous County, Hualong Hui Autonomous County, Chengdong District, Chengzhong District, Chengxi District, Chengbei District, Huangzhong District, and Huangyuan County. In 2015, Datong Hui and Tu Autonomous County was added. In 2020, the composition remained the same as in 2015. "Low-low" type counties were concentrated in 12 counties in central and southern Qinghai Province in 2010, including Maqin County, Baima County, Gande County, Dari County, Jiuzhi County, Maduo County, Tongde County, Xinghai County, Yushu City, Nangqian County, Qumalai County, and Zaduo County. In 2015, Nangqian County and Zaduo County were removed, while Henan Mongolian Autonomous County was added. In 2020, based on 2015, Henan Mongolian Autonomous County and Yushu City were removed, while Dulan County and Chengduo County were added. Overall, the number of "low-low" type counties remained relatively stable, though the distribution varied slightly across years.

2.3 Dynamic Evolution Analysis

2.3.1 Kernel Density Estimation Analysis To examine the dynamic evolution trend of rural non-farm employment levels in Qinghai Province from an overall perspective, this study uses Eviews10.0 software to conduct kernel density estimation for rural non-farm employment levels in 2010, 2015, and 2020 (Fig. [Figure 3: see original paper]). From the location perspective, the center of the kernel density curve shows a clear rightward shift, indicating that the overall rural non-farm employment level of all counties in Qinghai Province has improved. In recent years, the rapid development of the tourism industry and effective implementation of employment policies have created favorable non-farm employment opportunities for rural laborers, driving the development of rural non-farm employment.

From the shape perspective, the kernel density curve shows a unimodal, left-skewed distribution characteristic in all three years, indicating a convergence trend in rural non-farm employment levels in Qinghai Province, with obvious low-value agglomeration characteristics. From the peak change perspective, the peak height of the kernel density curve shows a declining trend, indicating that regional differences in rural non-farm employment levels in Qinghai Province have narrowed.

2.3.2 Traditional Markov Chain Analysis To further explain the probability of transitions in rural non-farm employment levels in Qinghai Province, this study uses traditional Markov chain to calculate the transition probability matrix. Based on the standard quantile method and drawing on relevant research [], rural non-farm employment levels of counties in Qinghai Province from 2010 to 2020 are divided into four types: Type I (low level, 0–25%), Type II (medium-low level, 25–50%), Type III (medium-high level, 50–75%), and Type IV (high level, 75–100%). Based on this classification, we calculated the traditional Markov transition probability matrix for rural non-farm employment levels in Qinghai Province (Table).

As shown in Table , the diagonal elements represent the probability of counties maintaining their original type during the study period, while off-diagonal elements represent the probability of transitions between different county types. Specifically, the values on the main diagonal are all greater than those on the off-diagonal, with probabilities of maintaining the original level for Types I, II, III, and IV being 0.875, 0.750, 0.750, and 0.875, respectively, while the maximum probability value on the off-diagonal is only 0.250. This indicates that rural non-farm employment levels in Qinghai Province exhibit different degrees of club convergence phenomena, with relatively stable convergence clubs. The small probability of transitions between different county types suggests an obvious solidification phenomenon in the differences in rural non-farm employment levels across Qinghai Province. Additionally, the probabilities of Type II transitioning to Types III and IV are 0.125 and 0.125, respectively, while the probability of Type I transitioning to Type IV is only 0.125, indicating that transitions in rural non-farm employment levels in Qinghai Province have phased characteristics, and achieving leapfrog growth is difficult. The main reasons are that counties in Qinghai Province have obvious differences in terrain conditions, resource distribution, and economic development levels, and counties with lower rural non-farm employment levels are heavily influenced by path dependence, making substantial short-term growth difficult.

2.3.3 Spatial Markov Chain Analysis The traditional Markov chain transition probability matrix treats each region as an independent unit, failing to consider the influence of surrounding regions' types on their transitions. Therefore, based on the traditional Markov matrix, this study incorporates spatial factors into the research framework and analyzes the impact of different neighborhood types on rural non-farm employment level transitions by constructing a spatial Markov matrix (Table).

The results show that: (1) Spatial factors have a significant impact on club convergence changes in rural non-farm employment levels in Qinghai Province. When ignoring spatial factors, the probability of Type II maintaining its original level is 0.750 (Table). When considering spatial factors, the probabilities of Type II maintaining its original level under neighborhood Types I, II, III, and IV are 0.667, 0.800, 0.667, and 1.000, respectively. (2) After considering spatial

factors, rural non-farm employment levels in Qinghai Province still exhibit stable club convergence characteristics. The probability values on the diagonal are all higher than those in other positions, except that under neighborhood Type I, the probability of Type I maintaining its original state equals its transition probability to Type II. (3) In the process of rural non-farm employment level development, there is usually a spatial spillover effect. If adjacent to counties with high rural non-farm employment levels, the probability of a county's type transitioning upward increases, while the probability of transitioning downward decreases. Conversely, if adjacent to counties with low rural non-farm employment levels, the probability of transitioning upward decreases, while the probability of transitioning downward increases, indicating that neighboring counties have a positive spatial spillover effect on the county []. Specifically, the transition probability of Type III to Type IV is 0.111 when adjacent to Type I counties, increases to 0.250 when adjacent to Type III counties, and decreases to 0 when adjacent to Type IV counties. This indicates that medium-high level counties have positive spillover effects on their neighboring counties' rural non-farm employment level improvements. The reason may be that medium-high level counties have demonstration effects in resource utilization and industrial development, which can radiate and drive neighboring counties.

3. Discussion

This study explores the spatiotemporal characteristics of rural non-farm employment levels in Qinghai Province at the county scale. In terms of temporal characteristics, rural non-farm employment levels in Qinghai Province showed a trend of rapid development followed by slow development during the study period, with 2015 as the turning point. The formation of the rapid development stage may be related to Qinghai Province's implementation of household registration reform and active promotion of employment, which is supported by existing research []. In recent years, the overall growth rate of rural non-farm employment levels in Qinghai Province has slowed down, possibly because the province has gradually intensified ecological environmental protection, adhered to ecological priority, and restricted non-farm employment activities not suited to ecological development laws. In view of this, Qinghai Province should continue to promote green economic development, optimize industrial structure, and promote high-quality development of rural non-farm employment.

This study finds that spatial factors play an important role in the development process of rural non-farm employment, which is consistent with the research conclusions of Ma et al. [] and Fang et al. []. At the same time, differences in terrain conditions, resource endowments, and economic development levels also affect the spatial distribution of rural non-farm employment levels []. Therefore, in terms of spatial evolution, the spatial differentiation of rural non-farm employment levels in Qinghai Province is obvious. Although the spatial distribution pattern of "high in the east and west, low in the middle" and "high in the north, low in the south" has improved, no fundamental change has occurred. Further-

more, Ma et al. [] only examined the spatial differentiation of rural non-farm employment levels without considering possible spatial spillover effects between adjacent counties. This study effectively addresses this issue from a dynamic perspective, while also expanding the research perspective on rural non-farm employment levels to some extent.

Considering that there is a positive spatial spillover effect between adjacent counties in Qinghai Province, this effect can be fully utilized to drive the development of rural non-farm employment in surrounding counties. "Low-low" type counties are mostly distributed in the central and southern parts of Qinghai Province, where ecological protection functions are prominent. For these counties, while strengthening ecological civilization construction, they should actively explore effective paths to transform "lucid waters and lush mountains" into "mountains of gold and silver," such as vigorously developing eco-tourism. Using tourism as a driver, they can promote the rapid development of related industries such as local hotels, commerce, and retail, further enhancing the absorptive capacity of non-farm industries for rural labor. Additionally, local governments should take strengthening rural laborers' awareness of non-farm employment and improving their non-farm employment capabilities as entry points, actively encouraging rural laborers to engage in non-farm employment, organizing employment training and industrial training activities, and enhancing their employability through employment assistance and skills training.

Counties in northwestern Qinghai Province should make full use of their abundant local resources, taking resource-based cities such as Golmud and Delingha as development models, practicing green development concepts, and developing industries focused on salt and alkali chemical industry, new energy, new materials, plateau equipment manufacturing, and characteristic biology according to local conditions, thereby promoting the improvement of local rural non-farm employment levels.

4. Conclusions and Recommendations

4.1 Conclusions

From 2010 to 2020, rural non-farm employment levels in Qinghai Province showed an overall fluctuating upward trend, with 2010–2015 as the rapid growth stage and 2016–2020 as the slow growth stage. Different periods have different evolution characteristics, which are closely related to economic development models, household registration reform systems, and employment policies.

During the study period, rural non-farm employment levels in Qinghai Province exhibited spatial distribution characteristics of "high in the east and west, low in the middle" and "high in the north, low in the south." The spatial pattern showed a shift from a "due east-due west" distribution toward a "northeast-southwest" orientation.

Neighboring counties have similar resource endowments and non-farm industry

development concepts, and there are interactive effects in employment policy formulation and implementation, resulting in significant positive spatial autocorrelation in rural non-farm employment levels in Qinghai Province. The "high-high" and "low-low" agglomeration patterns are prominent.

Rural non-farm employment levels in Qinghai Province show a convergence trend, with narrowing gaps between counties. There exists stable club convergence in rural non-farm employment levels. Due to factors such as resource endowments and economic development levels, transition probabilities between county types are small, and achieving large-scale leapfrog transitions is difficult. Spatial factors play an important role in the transition process of rural non-farm employment levels in Qinghai Province. The "spatial spillover" effect between neighboring counties is obvious, and the spillover effect shows heterogeneity under different county type backgrounds.

4.2 Recommendations

Based on the above conclusions, Qinghai Province is divided into three regions according to spatial distribution patterns: northeastern, central and southern, and northwestern. The following recommendations are proposed to improve rural non-farm employment levels in Qinghai Province:

"High-high" type counties are mostly distributed in northeastern Qinghai Province. For these counties, industrial cooperation and labor collaboration can be strengthened to enhance economic ties with surrounding counties, fully leveraging their positive spatial spillover effects to radiate and drive improvements in neighboring counties' rural non-farm employment levels. Meanwhile, Qinghai Province should build county-level economic cooperation platforms, break down communication barriers between counties, and establish effective communication and interaction channels to maximize the positive spatial spillover effects of rural non-farm employment levels.

"Low-low" type counties are mostly distributed in the central and southern parts of Qinghai Province, where ecological protection functions are prominent. For these counties, while strengthening ecological civilization construction, they should actively explore effective paths to transform "lucid waters and lush mountains" into "mountains of gold and silver," such as vigorously developing ecotourism. Using tourism as a driver, they can promote the rapid development of related industries such as local hotels, commerce, and retail, further enhancing the absorptive capacity of non-farm industries for rural labor. Additionally, local governments should take strengthening rural laborers' awareness of non-farm employment and improving their non-farm employment capabilities as entry points, actively encouraging rural laborers to engage in non-farm employment, organizing employment training and industrial training activities, and enhancing their employability through employment assistance and skills training.

Counties in northwestern Qinghai Province should make full use of their abundant local resources, taking resource-based cities such as Golmud and Delingha

as development models, practicing green development concepts, and developing industries focused on salt and alkali chemical industry, new energy, new materials, plateau equipment manufacturing, and characteristic biology according to local conditions, thereby promoting the improvement of local rural non-farm employment levels.

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Note: Figure translations are in progress. See original paper for figures.