

Article

Coordinated Development Evaluation of Population–Land–Industry in Counties of Western China: A Case Study of Shaanxi Province

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Abstract: The 14th Five-Year Plan of China proposes promoting urbanization construction, with counties as an important carrier. In order to evaluate the urbanization development level of counties in Western China, this study established an index system of population, land, and industry, constructed the coupling coordination model, selected Shaanxi Province as a representative case, and evaluated the comprehensive development level and its coordination degree of urbanization at the county level. The results show that: (1) there are two stages of urbanization in Western counties, namely “increment” and “quality improvement”; (2) county urbanization in Western China radiates from central cities, presenting the characteristics of a “core-edge” circle structure. Northern Shaanxi has significant spatial difference characteristics, the coordination and development level of the Guanzhong area are both in the lead, and Southern Shaanxi is still in the stage of weak level coordination; (3) unlike urbanization in metropolises, urbanization in Western counties is mainly driven by industrial agglomeration instead of land urbanization. However, population outflow is an obstacle to the urbanization of Western counties. The evaluation of the coordinated development of county urbanization can provide a theoretical basis and practical path for enhancing public service functions in counties, guiding urban–rural harmonious development.

Keywords: Western China; county urbanization; high-quality development; coupling coordination degree



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1. Introduction

China has entered the “high-quality development” stage, moving from the high-speed development stage it occupied in the past. The 14th Five-Year Plan of China emphasizes “promoting the development of county urbanization”. High-quality urbanization in counties is the key to high-quality development of the whole country [1]. A county comprises several central towns which are surrounded mainly by rural areas. Rural characteristics are the fundamental attribute of county. So, the urbanization of a county is essentially the process of rural space evolution [2]. Since the county is the most complete micro-unit in China's governance system, its administrative division includes the multi-level office organization of “county–street–village\community”, which involves the linkage and coordination between urban and rural areas in China [3]. County urbanization becomes the main battlefield to develop the rural economy and promote rural urbanization [2]. Therefore, strengthening the development of county urbanization is a feasible way to promote the national strategy of rural revitalization in the different urbanization modes and levels [4]. This is significant to the policy requirements of “supplementing shortcomings” and “strengthening the weaknesses” in China's 14th Five-Year Plan, so as to promote sustainable development [5]. However, reconstructing the mode of rural production and life through high-quality urbanization in the county is a key problem to be solved [6].

Coordinated development is the key feature of high-quality urbanization, which requires improvement in the total factor productivity (TFP) through coordinating production factors [6]. However, the growth rate of TFP in China's counties has fluctuated and even decreased in recent years [7,8], and the insufficient level of urbanization development in counties has become a shortcoming of the overall high-quality urbanization construction in China [9–12]. Thus, the key to constructing high-quality development in counties lies in the coordinated development. Studies on the coordinated development of urbanization paid most attention to development at the provincial level [13,14] or focused on urban agglomerations [15–20]. Several studies have explored urbanization at the county level, which mainly concentrated in Eastern China [9,18,21]. Lack of research at the county level makes it difficult to reflect on the characteristics and trends of counties' social and economic development clearly.

As it lagging economically, Western China has been the main area of labor outflow in the past. Population hollowing is the main manifestation and core cause of urbanization deficiency in Western counties of China [22]. It is reassuring that the population has demonstrated a tendency towards returning in recent years [12], which provides a population driving force for Western counties' urbanization. Population agglomeration in a county drives the innovation diffusion through the learning effect, and promotes innovation development [6]. At the same time, it drives capital flow into counties, and promotes industrial development [23]. Therefore, the study on the coordinated development of urbanization in Western counties has a realistic foundation and era significance. Shaanxi Province is located in the core area of the Guanzhong Plain urban agglomeration in the middle reaches of the Yellow River. Xi'an, the capital city of the province, is one of the nine national central cities in China, which has a strong radiation effect on its surrounding areas. This makes the development of county urbanization in Shaanxi Province have both Western characteristics and typical regional advantages [24]. The study on the coordinated development of county urbanization in Shaanxi Province can contribute to China's national strategies, both of "High-quality development of the Yellow River Basin" and "One Belt and One Road".

Urbanization is a complicated dynamic process, which involves the dynamic adaptive coordination of multi-subject relationships [12,25,26]. Population, land, and industry are considered to be the most important subjects in the process of urbanization. Population is the core, land is the spatial carrier, and industry is the development foundation [27]. The coordination of their relationship determines the quality of urbanization [28]. Urbanization is primarily the process of a population gathering into cities [29]. The measurement of population agglomeration is essential in the evaluation of urbanization development level. Furthermore, the interaction of population agglomeration, land urbanization, and industrial agglomeration has a positive impact on the improvement of urbanization [30–32].

Different from the urbanization in metropolises, urbanization at the county level is quite distinctive. Firstly, restricted by the protection of agricultural land policies, county-level urbanization cannot develop through the exploitation and utilization of land [33–35], but is mainly driven by population and industrial agglomeration [36], which is obviously different from the concomitant characteristics of extensive land expansion in metropolises [33]. Secondly, due to the lack of product factors agglomeration, urbanization in a county depends on the influence of location factors, ecological conditions, resource endowment, etc. [9]; in particular, the radiation capacity of the central city has a significant impact on the urbanization of its surrounding counties. Third, rural regions usually lack infrastructure, a concrete problem given the geographical dispersion and the social, economic, and daily opportunity divide between rural and urban areas. The inequality of public resources makes it difficult for the elements to gather spontaneously, as in cities, and makes them more dependent on policy inclination [10]. China's counties' industrial agglomeration largely depends on the government's planning for economic development. This is particularly prominent in Western counties. In recent years, there were government plans to move the large-scale manufacturing industry to small towns in the central and western regions, and guide industries to form clusters in the counties through

financial inclination. In addition, population agglomeration in the county is affected by the construction of production and living public facilities. Through the construction of public facilities, it could form a high-quality production, living, and ecological space in the county which should strengthen the attraction to the agricultural transfer population. All in all, the construction of public facilities assists the county population, industry, and other factors, and then enhances the county's economy and urbanization. Therefore, the coordinated development of county urbanization needs to be solved from the point of view of both the urbanization development mechanism [24,37] and the county attributes. That is, countermeasures should be considered based on the particularity of county-level urbanization problems.

This study took Shaanxi Province, a typical province in Western China, as the representative case. Based on the data of China's County Statistical Yearbook (County Volume), and taking into the account the particularities of county's situation, we constructed an evaluation index system of county urbanization via the multi-index method. Based on this, we clarified the coordinated development mechanism of population, land, and industry urbanization at the county level, and identified the temporal, spatial, and coupling characteristics and driving forces of county urbanization. The results should provide ideas and directions for the development and construction of high-quality urbanization in Western counties during the "14th Five-Year Plan" period. This paper is divided into five sections. The first section introduces the significance and literature review of this study. The second section presents the materials and methods, introducing the study area, data sources, indicators, and models. The third section shows the results of this paper. The fourth section summarizes the main research conclusions. The fifth section discusses the research results combined with the practical background and points out the improvement strategies and the shortcomings of this study.

2. Materials and Methods

2.1. Overview of the Study Area

Shaanxi Province is located in the central region of China and the middle reaches of the Yellow River, and is adjacent to Shanxi and Henan in the East, Ningxia and Gansu in the West, Sichuan, Chongqing and Hubei in the South, and Inner Mongolia in the North (Figure 1). It has a total area of 205,600 square kilometers, and is one of the five Northwest provinces in China. There are 10 prefecture level cities, 29 municipal districts, 6 county-level cities, and 73 counties in Shaanxi. By the end of 2019, its permanent resident population was 38.7621 million, of which the urban population was 23.0363 million, accounting for 59.43% in total. Although Shaanxi Province belongs to the Northwest region geographically, it is located on the HU line precisely (Hu Huanyong, a Chinese geographer, put forward a contrast line to divide China's population density in 1935. This line is roughly a 45-degree basic straight line from Fuhui, Heilongjiang Province to Tengchong, Yunnan Province. There are 96% of the population living in 36% of the land in the southeast of the line, with plains, water network, hills, karst and Danxia landforms as the main geographical structure, taking farming as the economic basis since ancient times; the population density in the northwest of the line is very low, which is the world of grassland, desert and snow plateau, and the paradise of nomads since ancient times. Therefore, two distinct natural and cultural regions are delineated.)—that is, part of Shaanxi is on the west side of HU line and another part on the east side. Furthermore, the core area of Shaanxi belongs to the Guanzhong Plain urban agglomeration, which is the key urbanization area in China's development strategy of national main functional areas. Xi'an, the capital city of Shaanxi, is one of nine national central cities with strong population agglomeration ability, and has a strong radiating and driving effect on its surrounding areas. Meanwhile, Xi'an is also one of the key cities in the "One Belt One Road" strategy. These factors make the county urbanization in Shaanxi Province not only have the Western characteristics, but also have regional advantages different from other Western regions. Studies on high-quality urbanization development in Shaanxi counties should contribute to China's national strategies both in the national main

functional areas, the high-quality development of the Yellow River Basin, and “One Belt and One Road”.



Figure 1. The location of Shaanxi Province. These maps are standard maps from the standard map service website of National Geomatics Center of China; map approval numbers are GS (2019) 1694 and ShaanS (2018)006.

2.2. Data Sources

We utilized data from the China County Statistical Yearbook, and some missing data were filled by data from the Shaanxi Statistical Yearbook or Local Statistical Bulletin. We selected 87 districts and counties in Shaanxi Province as the research object, including 73 administrative counties, 6 county-level cities, and 8 suburban counties/districts. The sample basically covers all of the county-level small towns in Shaanxi Province, which are distributed in Northern Shaanxi (23 districts/counties), the Guanzhong Area (38 districts/counties), and Southern Shaanxi (26 districts/counties).

The measurement index of the China County Statistical Yearbook had changed since 2014. Therefore, based on the principle of proximity, quantification, and availability, we chose county data from 2014 to 2019. As China’s “12th Five-Year Plan (2011–2015)” and “13th Five-Year Plan (2016–2020)” constitute the separation period between high-speed urbanization and high-quality urbanization, even the data used in this study cannot cover the whole period of 12th and 13th Five-Year Plan, but it still could reflect the changeable rule of the two Five-Year Plan periods sufficiently.

2.3. Construction of County Urbanization Index System

There are two methods to construct the index system of urbanization: the single index method and the multi-index method [38–40]. The single index method mainly uses land area, population size and other factors which were closely related to urbanization characteristics as the single dimension indicators [41,42]. The multi-index method seeks to construct an index system, combined with the availability and measurability of data [43,44]. The single index method is usually used to measure simple concepts. However, as urbanization

is a complex process, it can only be explained through a multi-dimensional measurement index accurately. The use of the multi-index method should include the development of a theoretical framework, the selection of variables, multivariate analysis, missing data interpolation, data standardization, weighting and aggregation, and robustness analysis [45]. This study gradually analyzes the process of county urbanization according to this method. Previous studies achieved good results in measuring the level of regional urbanization development through the comprehensive index method from the population, economic and social factors, residential structure, distance, and other indicators [3]. The entropy weight method based on multi-index synthesis can effectively alleviate the disadvantages of the single index method to subjective weighting evaluation. Through combining this with the particularities of a county, following the principle of quantification and availability, we constructed an index system reflecting the urbanization level of population, land, and industry in the county by using the multi-index method (Table 1).

As demonstrated above, the main dimensions to measure the development level of initial urbanization are population urbanization, land urbanization, and industrial urbanization. The index system measures the comprehensive urbanization development level of counties through the urbanization level of subsystems which include population, land, and industry. Each subsystem indicator can be divided into two dimensions (scale and structure). Each subsystem includes 3–5 specific indicators. There are positive and negative indicators. The positive indicators refer to the indicator contributing to urbanization, and the larger its value is, the higher the urbanization development level is. The negative indicators refer to the change in the indicator value as opposed to the development level of urbanization—that is, the smaller its value is, the higher the urbanization development level is.

1. Urbanization of population. Population is the core element of urbanization, its essence is the transfer of a population's economic activities from primary industry to secondary and tertiary industry. On the one hand, population is regarded as the labor force and the builder of urbanization [46]. On the other hand, population is regarded as the main body of resource consumption for the study of regional population carrying capacity [1]. The proportion of the non-agricultural population is usually used to reflect the urbanization level of the population [47]. Specifically, the number of employees in the secondary and tertiary industries in rural areas could indicate the urbanization level. As the basic population management system in Chinese society, the household registration system was linked with the resource allocation [48]. The household registration system, which was implemented for a long time, limited the two-way flow of rural labor force [49]. Therefore, we use the size and density of the household registration population to reflect the size of the county population, and the proportion of employees in secondary and tertiary industries to reflect the distribution structure of the population in production.
2. Urbanization of land. Land is the most important space carrier of urbanization [50]. A large number of studies have explored the law of the coordinated development of population and land. The measurements of existing studies mainly used the urban built-up area [20,51] reflecting land urbanization. However, unlike the urban area, there is large-scale agricultural land that is not allowed to be developed by policy in rural areas. Hence, the index of built-up areas being replaced by non-agricultural areas in county urbanization is examined in this study. We chose administrative areas to measure the basic scale of land urbanization, and used the area of facility agriculture and non-agriculture [52] to describe the spatial structure of county land urbanization.
3. Urbanization of industry. Per capita GDP is an important indicator widely used in the existing literature to reflect regional economic and industrial development [53–55]. The number of industrial enterprises is the most intuitive manifestation of a county's economy [56]. Considering that the urbanization of a county's industry takes the development of township industry as the main mode, we used the number of industrial enterprises to reflect the scale of the county's industry. Furthermore, the

urbanization of a county redistributes the proportions of primary, secondary, and tertiary industries [57]. We used the proportion of primary, secondary, and tertiary industries' GDP to measure the county industrial structure.

Table 1. Evaluation index system of population, land, and industry at the county level.

Target Layer (A)	Factor Layer (B)	Indicator Layer (C)	Unit	Direction
Development Level of County Urbanization (A)	Population (B ₁)	Scale	Population Size (C ₁)	+
			Population Density (C ₂)	+
		Structure	Proportion of Non-Agricultural Employees (C ₃)	+
	Land (B ₂)	Scale	Administrative Area (C ₄)	+
		Structure	Non-Agricultural Land Area (C ₅)	+
			Facility Agriculture Covered Area (C ₆)	-
	Industry (B ₃)	Scale	Per Capita GDP (C ₇)	+
			Number of Industrial Enterprises (C ₈)	+
		Structure	Proportion of Primary Industry in GDP (C ₉)	-
			Proportion of Secondary Industry in GDP (C ₁₀)	+
			Proportion of Tertiary Industry in GDP (C ₁₁)	+

Note: + represents positive indicator; - represents negative indicator.

2.4. Data Preprocessing and Data Standardization

Due to the different dimensions of data, it was necessary to standardize data first. All the data were used to form the initial matrix, $X = \{x_{ij}\}_{nm}$, $j = 1, 2, \dots, m$; $i = 1, 2, \dots, n$, where n represents the number of districts and counties, and m is the number of indicators. x_{ij} represents the index value of the i district and j county. There are differences in the dimensionless treatment of positive indicators and negative indicators.

$$y_{ij} = \frac{x_{ij} - x_{j\min}}{x_{j\max} - x_{j\min}} \text{ (Positive indicator)} \quad (1)$$

$$y_{ij} = \frac{x_{j\max} - x_{ij}}{x_{j\max} - x_{j\min}} \text{ (Negative indicator)} \quad (2)$$

where $x_{j\min}$ and $x_{j\max}$ denote the minimum value and maximum value of the j item index, respectively. Since the logarithm is needed to calculate the weight, in order to meet the requirements of logarithmic value, $y_{ij}' = y_{ij} + 0.5$, the indicator is translated to get the standardized matrix $Y = \{y_{ij}'\}_{nm}$.

- Determine indicator weight

The weight of the index was determined by the entropy weight method. The entropy weight method is a relatively objective weight calculation method, which has been widely used in the field of social economy [58,59]. The entropy weight method was used to calculate the weight of three population urbanization indicators, three land urbanization indicators, and five industrial urbanization indicators. The calculation formula of index entropy weight is as follows:

$$W_j = \frac{1 - E_j}{m - \sum_{j=1}^m E_j} \quad (3)$$

where E_j is the information entropy corresponding to the first j index of the subsystem:

$$E_j = -k \sum_{i=1}^n (p_{ij} \times \ln p_{ij}) \quad (4)$$

Among them, $k = 1/lmm$, the proportion of the i district and j county in the index is

$$p_{ij} = \frac{y'_{ij}}{\sum_{i=1}^n y'_{ij}} \quad (5)$$

- Robustness Analysis

The concept of robustness comes from engineering, but it also comes from a special term in statistics [60]. Robustness is a property of maintaining the stability of the system, which plays a role in maintaining the safety and stability of the system in the face of danger and abnormal conditions. In practical problems, because of the inaccuracy of the measurement or the subjectivity of the selected index, it is difficult to make the measurement. The difference between the actual value and the standard value of the parameters is large, so it is necessary to use robustness to control the stability of the system [61]. As for the data standardization and uncertainty in the selection and construction of comprehensive indicators in this study, the robustness analysis was used to test the comprehensive development level of urbanization. For the original index, the maximum method, the minimum method, and the average method were applied to the 2019 data from counties in Shaanxi Province, calculating the index by the value method and rank method [61]. Each index was ranked to increase the credibility of the results.

The maximum method:

$$y_{ijt} = \frac{x_{ijt}}{\max_t x_{ijt}} \quad (6)$$

The minimum method:

$$y_{ijt} = \frac{x_{ijt}}{\min_t x_{ijt}} \quad (7)$$

The average method:

$$y_{ijt} = \frac{x_{ijt}}{\bar{x}_{ijt}} \quad (8)$$

The rank method:

$$y = \frac{1}{x} (x > 0) \quad (9)$$

The rank was assigned by the composite indicator to a given county. Rank F is an output of the uncertainty/sensitivity analysis. The average shift in county rankings is also explored. This latter statistic captures the relative shift in the position of the entire system of counties in a single number. It can be calculated as the average of the absolute differences in counties' rank with respect to the original ranking [45].

$$\overline{R_s} = \frac{1}{M} \sum_{i=1}^M |Rank_{reg}(F) - Rank(F_i)| \quad (10)$$

2.5. Modeling

- Evaluation Function of Subsystem Development Level

The development function of the subsystem measures the comprehensive development level of the i subsystem:

$$f_i(U_t) = \sum_{j=1}^m W_{jt} y'_{ijt} \quad (11)$$

where $f_i(U_{1t})$ represents the comprehensive development of the population subsystem of the county, $f_i(U_{2t})$ represents the comprehensive development of the land subsystem, and $f_i(U_{3t})$ represents the comprehensive development of the industry subsystem. The overall development level of urbanization is obtained by a weighted average of the comprehensive development level of the population, land, and industry subsystems.

- Coupling Degree Function

The coupling degree function is a concept derived from physics, which represents the strength of the close cooperation and interaction between two or more systems. The coupling degree function C_t can reveal the interaction and internal coordination mechanism between population, land, and industry in regional development.

$$C_t = \left\{ \frac{f(U_{1t}) \times f(U_{2t}) \times f(U_{3t})}{\prod(f(U_{it}) + f(U_{jt}))} \right\}^{\frac{1}{3}} \quad (12)$$

where $i, j = 1, 2, 3, i \neq j$. When the value of C_t is between 0 and 1, the closer to 1 the value is, the closer the relationship between subsystems is, and the more orderly the coordination state is; the closer to 0 the value is, the looser the relationship between the subsystems is.

- Coupling Coordination Degree Function

The coupling degree function can only show the closeness of the subsystem relationship. However, it cannot determine the level of coordinated development. Therefore, it is necessary to introduce the coupling coordination degree function to reflect the coordination degree between subsystems. The coupling coordination function is expressed as follows:

$$R_t = (C_t \times T_t)^{\frac{1}{3}} \quad (13)$$

Among these terms, R_t refers to the coupling coordination; the higher the value is, the subsystems coordinate with each other at a higher level. On the contrary, they cooperate with each other at a lower level. C_t is the coupling degree. T_t is the comprehensive evaluation indicators, $T_t = \alpha f(U_{1t}) + \beta f(U_{2t}) + \gamma f(U_{3t})$. We set up $\alpha = \beta = \gamma = 1/3$, which means that the three subsystems of population, land, and industry are equally important to urbanization development in counties.

According to the value of the coupling coordination degree, combined with the characteristics of the county social and economic development level, the coordinated development degree of the system can be divided into three stages: when $R_t < 0.70$, it was in the stage of low-level coupling and coordinated development; when $0.70 \leq R_t < 0.75$, it was in the stage of intermediate coupling and coordinated development; and when $R_t \geq 0.75$, it was in the stage of high-level coupling and coordinated development.

3. Results

3.1. Evaluation of Urbanization Development

3.1.1. Comprehensive Development Evaluation of Urbanization

The comprehensive urbanization level of counties in Shaanxi Province has been gradually improved since 2014 (Figure 2). According to the time trend, there are two stages of urbanization in Western counties, namely “increment” and “quality improvement”: Firstly, 2014–2016 was the period of rapid growth, namely the “increment” stage. The county population–land–industry comprehensive development index rose from 0.73 to 0.745 in 2 years. Secondly, after 2016 was the “quality improvement” stage. It rose steadily, and the county population–land–industry comprehensive development index showed a steady, moderate, and slow growth trend. “Increment” and “Quality Improvement” are terms describing the stage of China’s economic and social development. “Increment” refers to the rapid development stage which generally refers to the urbanization stage of China’s rapid economic expansion in the past. “Quality Improvement” refers to achieving high-quality development through improving efficiency. In this stage, economic expansion is not only emphasized, but more attention is also paid to coordinated, efficient, and green sustainable development. It can be seen that the comprehensive urbanization development level is basically consistent with the change in economic development stage during the 12th and the 13th Five-Year period in China. The 12th Five-Year period is the incremental stage of economic development, and the urbanization level of population, land and industry in

county is rapidly rising at the same time. In the 13th Five-Year Plan period, the development speed tends to be flat and enters the stage of “transition”. The key point is to achieve the improvement in total factor productivity through the coordinated allocation of elements.

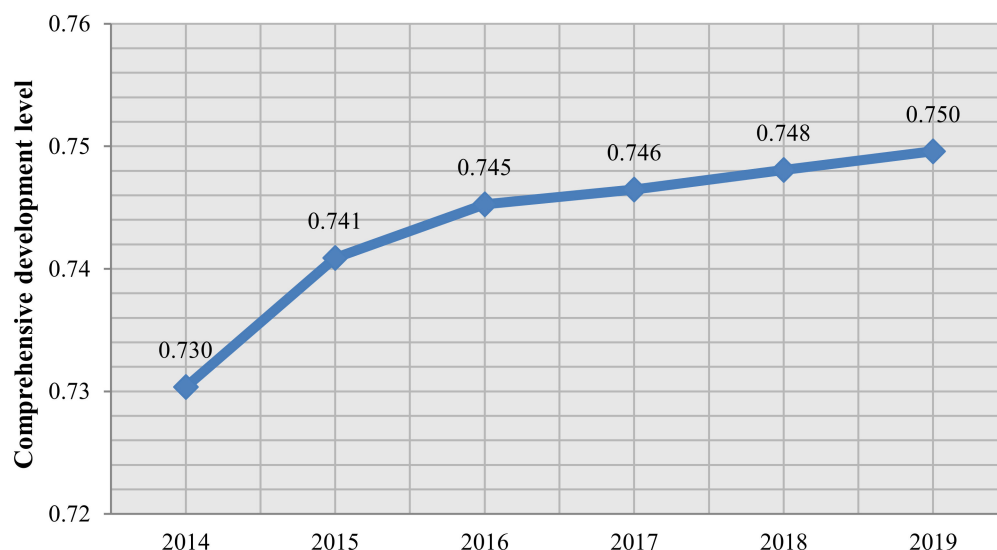


Figure 2. Time series tendency of comprehensive urbanization development in Shaanxi Province.

In terms of spatial characteristics, comprehensive development level shows imbalance (Figures 3a and 4). The lowest comprehensive development level is in Foping County (0.629) and the highest level is in Shenmu (1.089). There are significant differences in urbanization level among the three regions from north to south: Northern Shaanxi, the Guanzhong area, and Southern Shaanxi. The level of urbanization development in Guanzhong (0.759) is much higher than that in Northern Shaanxi (0.745) and Southern Shaanxi (0.738), as shown in Figure 3b.

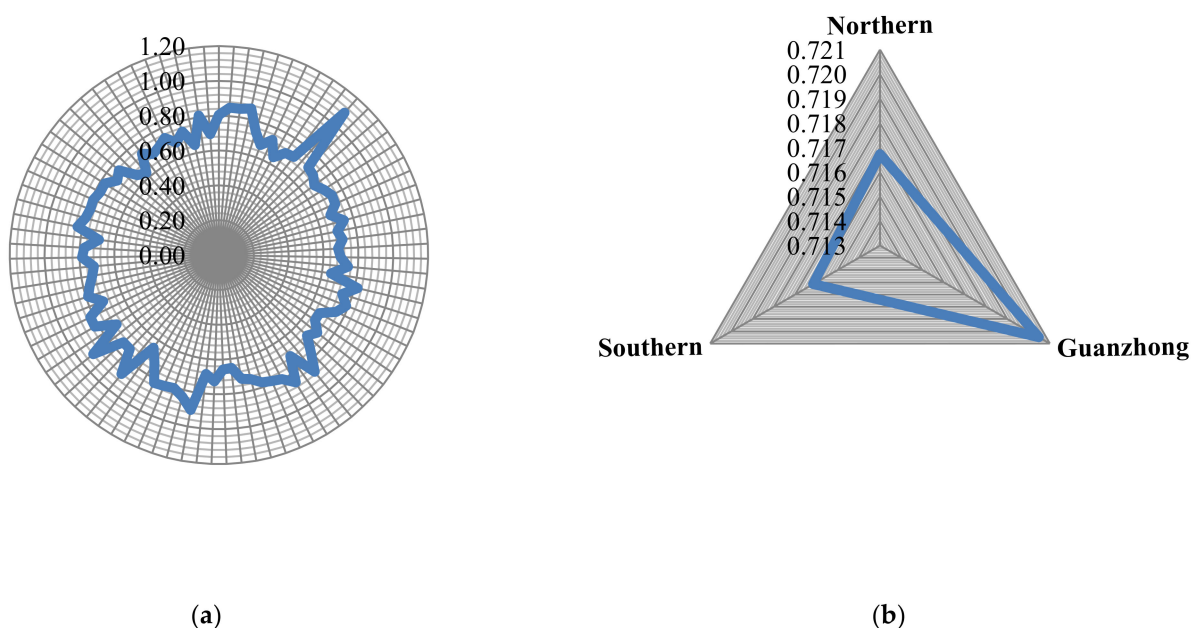


Figure 3. Spatial characteristics of urbanization comprehensive development in Shaanxi Province: (a) county-level characteristics; (b) regional characteristics. The results are calculated based on the data from The China County Statistical Yearbook (2019).

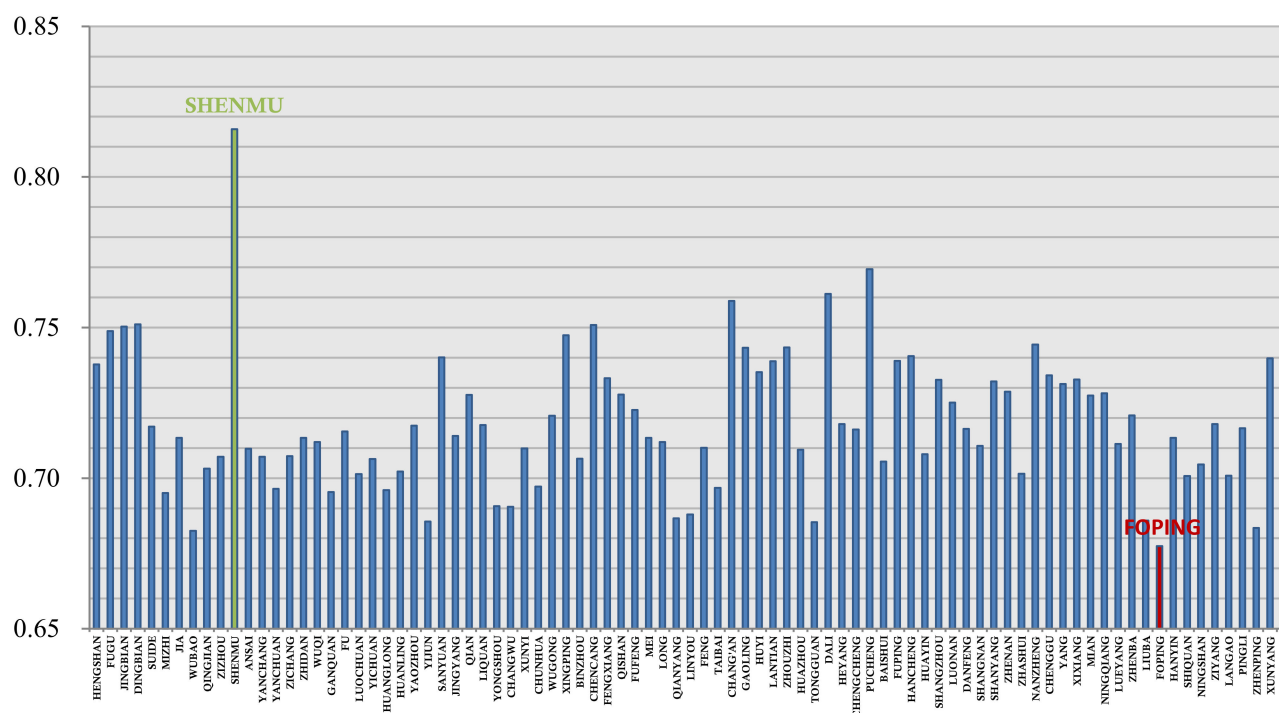


Figure 4. County distribution characteristics of urbanization comprehensive development in Shaanxi Province. The lowest comprehensive development level is in Foping County (RED) and the highest level is in Shenmu (GREEN). The results are calculated based on the data from The China County Statistical Yearbook (2019).

Further analysis of various administrative cities in Shaanxi shows more clearly that the urbanization of counties in Shaanxi Province presents a circle structure of core-edge. It could mainly be divided into four regions with different development degrees (Figure 5). The core area of urbanization development is in Xi'an, which had the highest county urbanization level (0.837 in average). As the provincial capital city, Xi'an has a very good radiating and driving effect on its surrounding counties. As shown in Figure 5, the radiation effect of Xi'an is mainly reflected in the population spillover and industrial expansion to the surrounding areas. With the development of the "one hour commuting circle" function in Xi'an, urban spillover population moved to the surrounding suburbs, showing the diffusion effect of counter-urbanization. Large-scale manufacturing industry relocates to the surrounding areas to seek the cheapest rent. Therefore, Xi'an and its surrounding small cities gradually form a metropolitan area with strong internal connectivity. The second edge circle includes Weinan City and Yulin City: Weinan City is located close to Xi'an and the Yellow River. Rich economic and water resources were necessary conditions for its economic development; Yulin City is a mineral resource-intensive area, and the second industry plays an obvious role in driving its economic development. The third layer combines Xianyang, Baoji, Shangluo, and Hanzhong, and the most marginal area in the core-edge structure is distributed in Yan'an, Tongchuan, and Ankang.

Table 2 shows the robustness test results of the proposed method. The comprehensive development level of county urbanization and the ranking of each city are calculated by five methods, respectively. It can be seen from the table that the ranking with different methods is basically stable. We obtained a final ranking by averaging the five rankings. The final ranking is consistent with the ranking obtained by this research method, and the county urbanization level can also be divided into four echelons. The development level of county urbanization in Xi'an is the highest, followed by the resource-based cities Yulin and Weinan. There is only one controversy in whether Yan'an or Hanzhong belong to the last echelon, but that does not affect the general law. The method, as shown through the robustness test, and the conclusion are stable and effective. Simultaneously, the last

column of Table 2 shows the uncertainty of this study's ranking, and the uncertainty of the top and bottom cities are controlled in a small range.

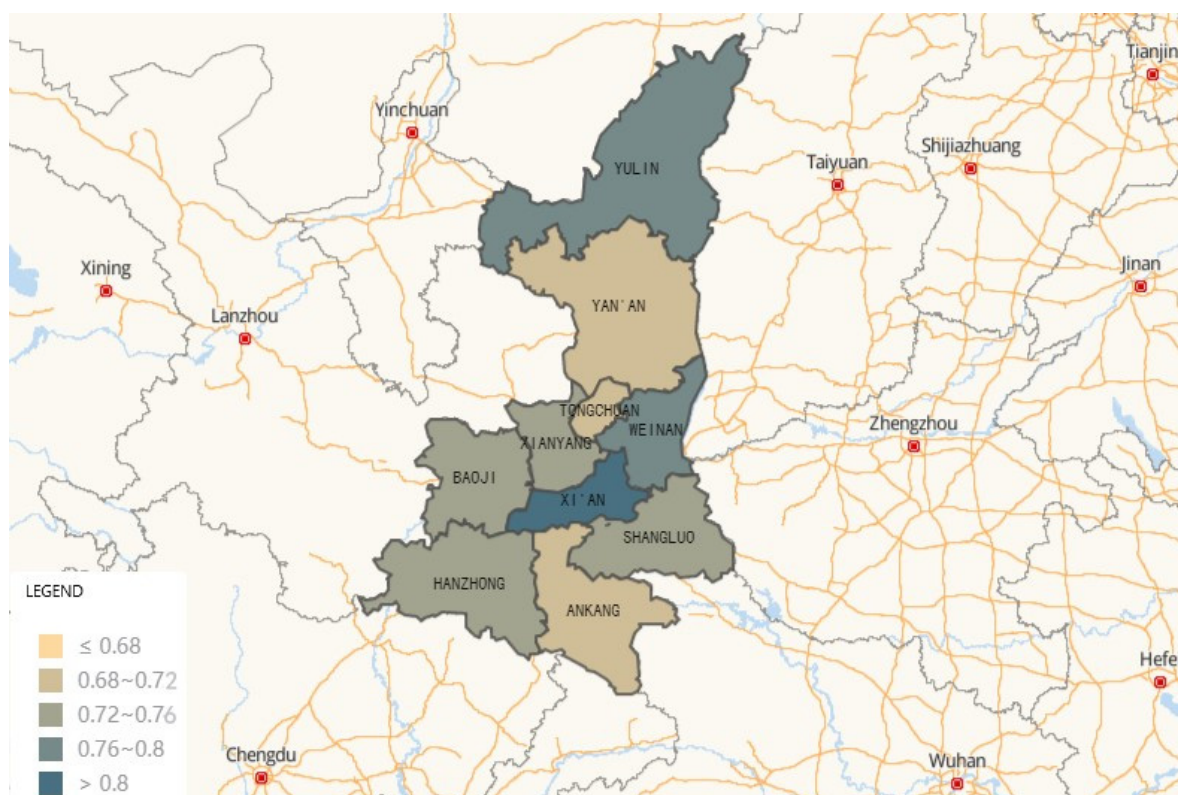


Figure 5. Regional differences of comprehensive urbanization development in Shaanxi Province. The results are calculated based on the data from the China County Statistical Yearbook (2019).

Table 2. Comprehensive urbanization development level and its ranking using different methods.

City	Entropy Weight Method (Ranking)	Maximum Method (Ranking)	Minimum Method (Ranking)	Average Method (Ranking)	Rank Method (Ranking)	Average Value of Ranking	Final Ranking	$\bar{R}_s$
XI'AN	0.837 (1)	0.860 (1)	71.676 (2)	1.878 (1)	1.706 (4)	1.8	1	1
XIANYANG	0.742 (6)	0.769 (6)	61.126 (3)	1.516 (4)	1.463 (7)	5.2	5	1.25
BAOJI	0.738 (7)	0.765 (7)	32.828 (6)	1.432 (5)	1.613 (6)	6.2	6	1
WEINAN	0.772 (3)	0.797 (3)	196.580 (1)	1.806 (2)	1.338 (10)	3.8	3	2.25
TONGCHUAN	0.697 (10)	0.724 (10)	14.699 (10)	1.229 (10)	1.369 (9)	9.8	10	0.25
YAN'AN	0.707 (9)	0.734 (8)	49.783 (4)	1.319 (9)	1.740 (3)	6.6	7	3
HANZHONG	0.749 (5)	0.774 (5)	20.559 (9)	1.414 (7)	1.452 (8)	6.8	8	2.25
YULIN	0.784 (2)	0.810 (2)	40.425 (5)	1.602 (3)	1.887 (2)	2.8	2	1
ANKANG	0.717 (8)	0.744 (9)	31.031 (7)	1.329 (8)	1.625 (5)	7.4	9	1.25
SHANGLUO	0.751 (4)	0.776 (4)	24.558 (8)	1.429 (6)	2.048 (1)	4.6	4	1.75

The uncertainty analysis for the 10 cites is given in Figure 6 for the ranks, ordered by their original position, ranging from Xi'an, rank = 1, to Tongchuan, rank = 10. Note the choice of ranks, instead of composite indicator values. The rectangle in the box graph represents the distance between the estimated ranking and the original ranking. The width of the fifth percentile bounds and the ordering of the average ranking (grey square) are often at odds with the ordering of the original ranking (blue diamond). Although one could still see the difference between the group of leaders and that of laggards, there are considerable differences between the new and the original ranking. Based on this, we obtained the new rankings presented in Table 2.

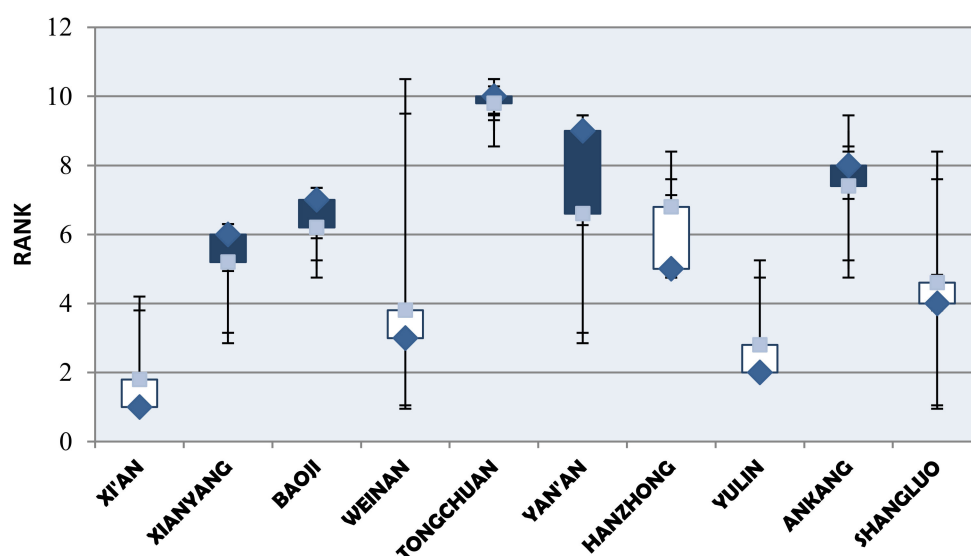


Figure 6. Uncertainty analysis of rankings in comprehensive urbanization development. The grey square represents the average ranking calculated by various methods. The blue diamond represents the original ranking.

3.1.2. Separate Evaluation on Urbanization of Population, Land and Industry

Further study on subsystems separately shows that the urbanization level of industry in Shaanxi counties is significantly higher than that of population and land (Figure 7), indicating that the main driving force of county urbanization in Western China is industrial agglomeration. Most of the county land belongs to agricultural land, which makes it difficult to drive urbanization by expanding land urbanization. The urbanization led by land expansion also deviates from the intensive and efficient requirements of high-quality urbanization. Therefore, the feasible path of county urbanization development is to attract the return of population by industrial agglomeration, so as to promote the comprehensive level of urbanization.

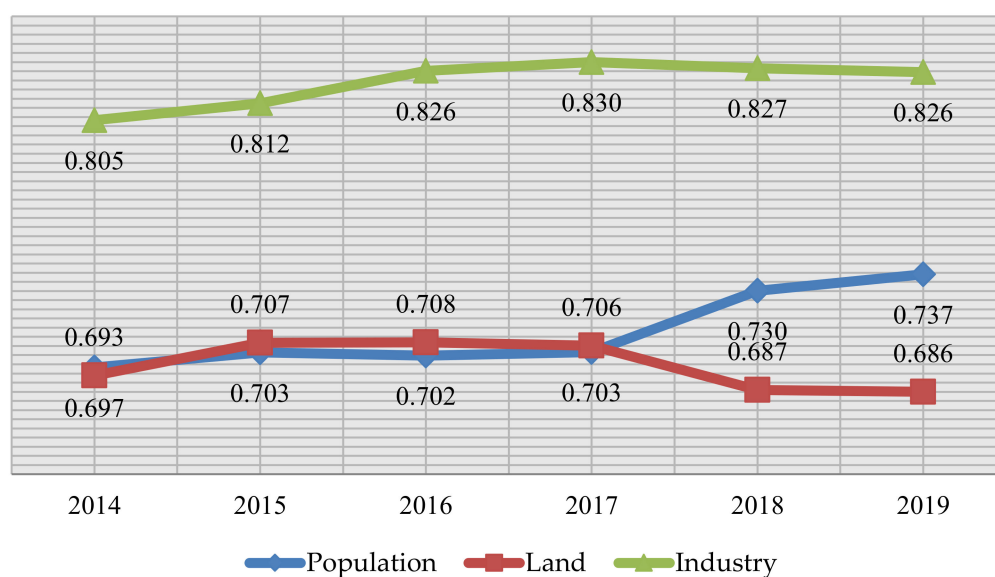


Figure 7. Time tendency of population, land, and industry subsystem development level. The results are calculated based on the data from the China County Statistical Yearbook (2019).

In terms of time tendency, it can be found that the development levels of population, land, and industrial subsystems all experienced a period of rapid rise before 2016. Then,

the development process of the industry subsystem experienced a steady rise stage, and reached the peak in 2017, and had a slight downward trend in the following two years. The population and land subsystems went through the opposite trend of development. After 2017, the population reform policy was stimulated by the nationwide registered residence policy reform. The population return trend was obvious, showing that the development level of the county's population subsystem increased rapidly, from 0.703 to 0.737 in a short span of two years. At the same time, China continued to promote rural land in 2017. The urbanization level of county land decreased continuously because of the increase in the scale of agricultural land. From the perspective of development law, in the 13th Five-Year Plan period, especially after 2017, the county social and economic development had a "return to rise" trend from industrial urbanization to the new-type agriculture stage.

As the spatial characteristics of the subsystem show, the urbanization development level of the population and industry subsystem presents the characteristics of the core-edge structure, with Xi'an as the core. The typical characteristics of Xi'an are population urbanization. As an important national central city, Xi'an had always been a highly populated area. Especially after the implementation of its talent policy in 2017, it achieved a new wave of population agglomeration growth in a short time, forming a "core-edge" circle structure with Xi'an as the highly populated economic agglomeration center and spreading outward, as shown in Figure 8. The scarcity of land in economically developed areas is reflected in the fact that the development level of land urbanization in Xi'an was much lower than in others. The restrictive characteristics of land subsystems were not only reflected in Xi'an City, but it can also be seen from Figure 9 that the land subsystem in the Guanzhong area, composed of Tongchuan, Xianyang, Baoji, Xi'an and Weinan, was a constraint to its social and economic development. Northern Shaanxi conforms to the characteristics of resource-intensive cities. Its industrial development was relatively high due to the drive of the resource mining industry, but the outflow of population was relatively serious. Therefore, the development of the population subsystem was insufficient in Northern Shaanxi. In Southern Shaanxi, the development level of each subsystem was relatively consistent.

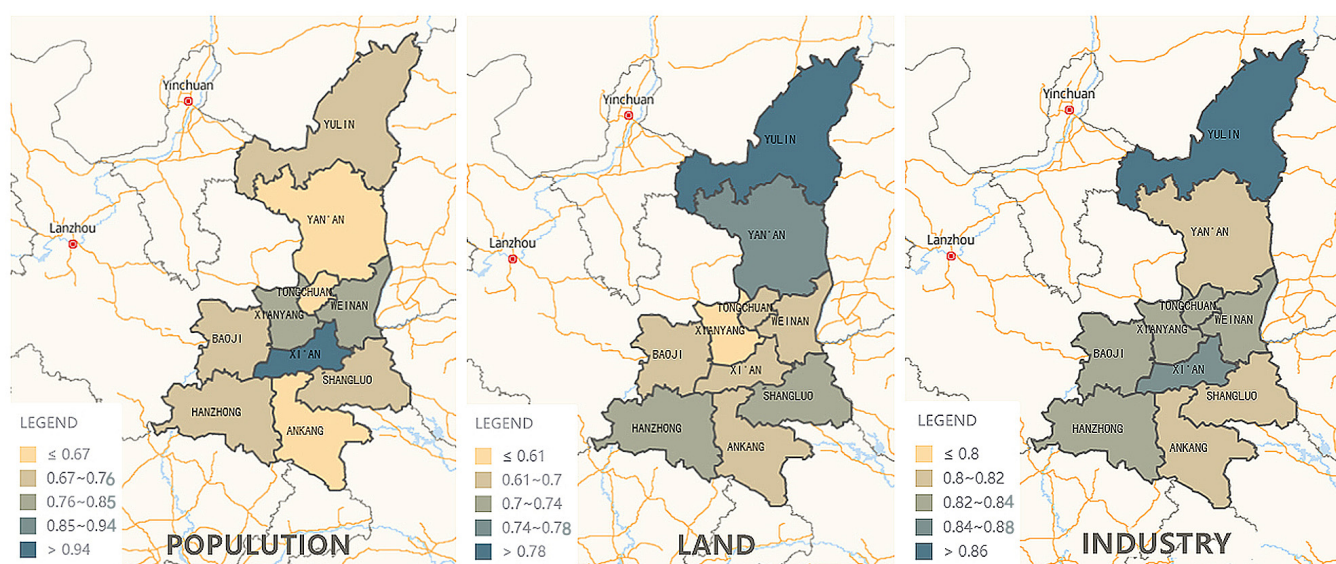


Figure 8. Distribution of population, land and industry urbanization level in Shaanxi Province. The results are calculated based on the data from the China County Statistical Yearbook (2019).

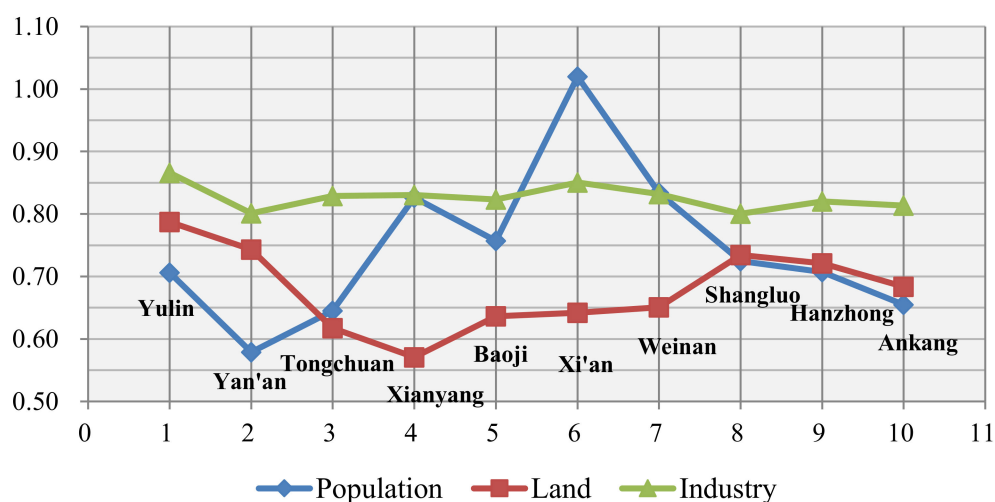


Figure 9. Urbanization development level of population, land, and industry at the city level. The results are calculated based on the data from the China County Statistical Yearbook (2019).

3.2. Evaluation of Population–Land–Industry Coupling Coordination Degree

3.2.1. Temporal-Spatial Characteristics of Population–Land–Industry Coupling Coordination

Temporal Characteristics

The coupling coordination degree of population, land, and industry shows a continue rising trend (Figure 10). This trend is similar to that in the comprehensive urbanization development level. Taking 2016 as the boundary, it is divided into the rapid increased “Increment” stage and the slow increased “Quality Improvement” stage. In the 12th Five-Year period before 2016, the coupling coordination degree increased sharply with the comprehensive development level of subsystems, and in the 13th Five-Year period, although the growth rate decreased slightly, it was still rising slowly. The consistency trend of urbanization development and coupling coordination shows that the “Increment” and “Quality Improvement” in the process of social and economic development cannot be strictly separated. It is often accompanied by the continuous adjustment of their coordinated scheduling process. The coupling coordination degree is not adjusted separately, but is based on factor agglomeration. It gradually adjusted to be more coordinated with the continuous agglomerate of population and industry in western counties.

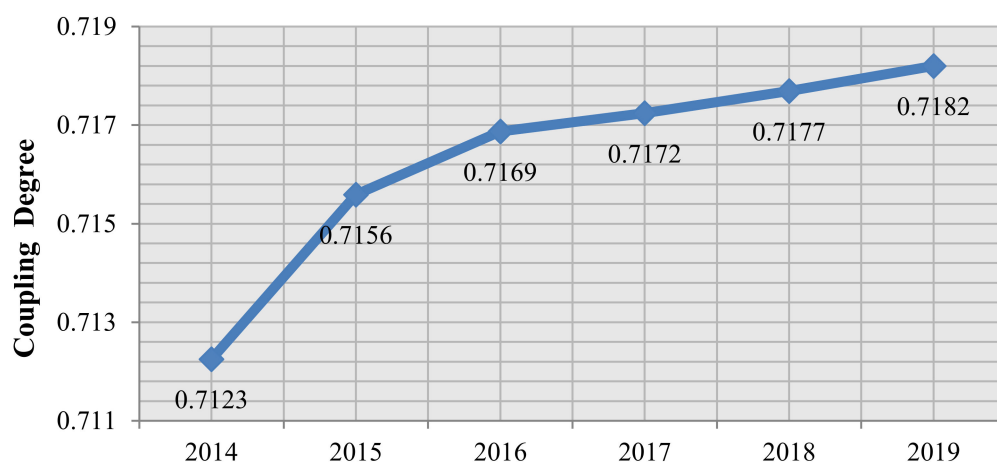


Figure 10. Time tendency of population–land–industry coupling coordination degree in Shaanxi Province. The results are calculated based on the data from The China County Statistical Yearbook (2014–2019).

Spatial Characteristics

Although the coupling and coordination degree was rising, there were still differences in the development speed from the perspective of regional distribution. The coupling coordination degree of the central city, Xi'an, was the highest (Figure 11a). Driven by Xi'an, the Guanzhong area was much coordinated than Northern and Southern Shaanxi (Figure 11b). In addition, the coupling coordination degree of Yulin City, which is located in Northern Shaanxi, was relatively high. However, Ankang, Yan'an, and Tongchuan had the lowest coupling coordination level, which is similar to the comprehensive urbanization development level of the three cities. The urbanization of population, land, and industry in Ankang, Yan'an, and Tongchuan was developed slowly from 2014 to 2019. Therefore, the coupling coordination degree was difficult to be dynamically adjusted in the development process. Combined with the in-depth analysis of the subsystem development level, Yan'an and Ankang showed a lack of industrial development, which promoted the continuous outflow of population in turn. Although these cities have the advantage based on land area, the shrinking of population and industry was still observed. Although Tongchuan had the relative advantages of industry, it focused on coal and cement, which are facing transformation owing to high levels of pollution. In addition, population outflow and land restriction caused the lower coordination degree.

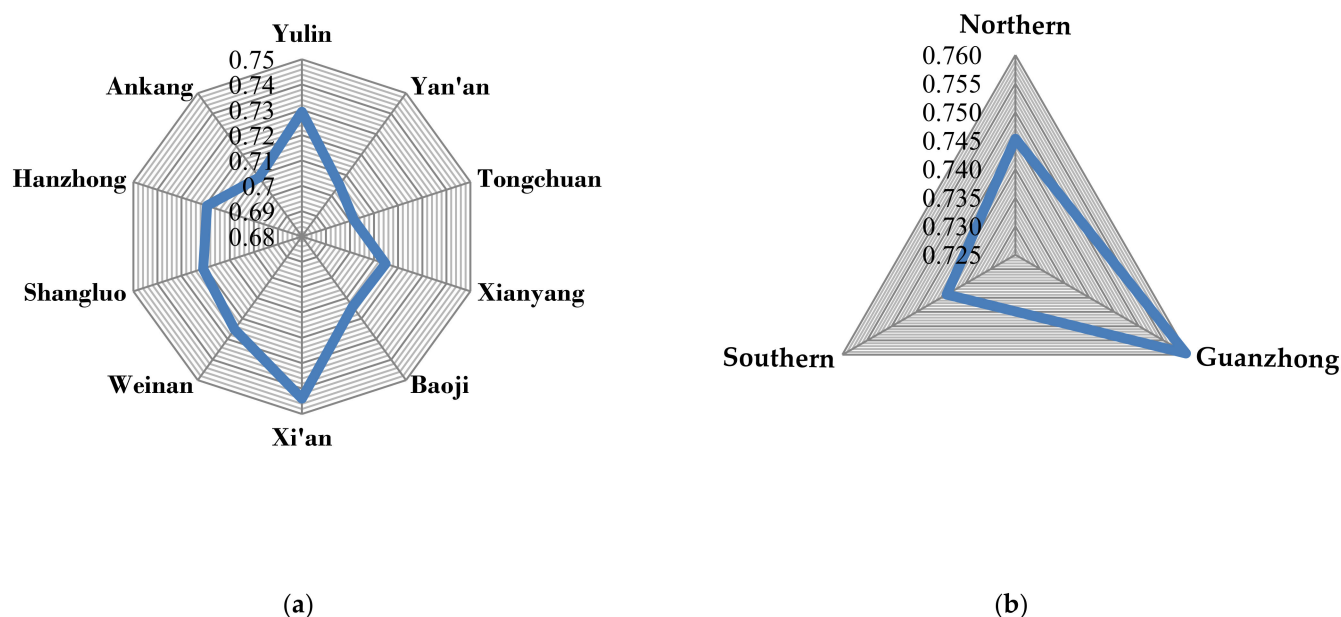


Figure 11. Regional distribution characteristics of population–land–industry coupling coordination degree in Shaanxi Province: (a) city-level characteristics; (b) regional characteristics. The results are calculated based on the data from The China County Statistical Yearbook (2019).

3.2.2. Analysis of Dual Coupling Relationship between Population, Land, and Industry

The coordinated development of county urbanization refers to the coordination of the urbanization level of population, land, and industry. If the coupling coordination degree of the three factors is at a low level, it is necessary to identify the better and less developed subsystems, so as to promote urbanization through strengthening advantages and complementing weaknesses. The urbanization development types under the coordinated development idea could be divided into “population lagging type”, “land lagging type”, and “industry lagging type”. By analyzing the coupling relationship between population, land, and industry, it would help to screen out which type it is. It shows the general characteristic in Figure 12. On the whole, the coupling coordination degree of the three combinations (population–land, land–industry, population–industry) was gradually in-

creasing. Among them, the coupling coordination level between population and industry was the highest, while the land–industry coupling coordination degree increased the most.

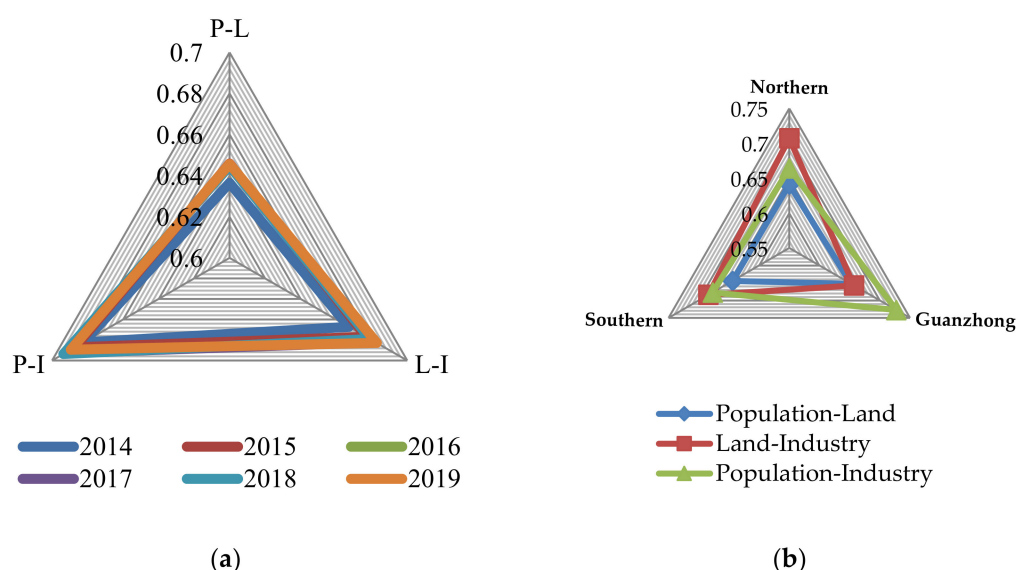


Figure 12. Spatiotemporal characteristics of dual coupling coordination of population, land, and industry in Shaanxi Province: (a) temporal characteristics; (b) regional characteristics. The results are calculated based on the data from The China County Statistical Yearbook (2014–2019).

Analysis of Population–Land Coupling Coordination

The coordination of population and land urbanization in county usually refers to the coordination between non-agricultural employment population growth and non-agricultural area growth, which represented the mutual adaptation of agricultural transfer population and non-agricultural living and production space. On the whole, the coupling coordination degree of population and land in counties improved from 2014 to 2019, but the overall level was still low (Figure 12a). It can be seen that the county population did not adapt to the development of land urbanization in the whole province. The key reason lies in the hollow population of the county—that is, the population density in the surrounding areas of the central city was too high, while the population in other areas outflowed seriously, which made it difficult to use land resources intensively and efficiently.

Analysis of Land–Industry Coupling Coordination

The land–industry coupling degree of Shaanxi Province increased significantly from 2014 to 2019. It was higher in Northern and Southern Shaanxi (Figure 12b). Yulin, Yan’an, Hanzhong, and Shangluo were the regions with large administrative area in the whole province, so the land–industry coupling coordination degree was better. The Guanzhong area lagged behind (Figure 13). From the analysis results of comprehensive urbanization development level, it could be concluded that the development of industry urbanization level in the Guanzhong area was better, and the reason why land–industry coordination degree lagged behind may be due to the limitation of land area. However, it was not feasible to take the road of land expansion to drive urbanization in the future. Therefore, to optimize the development path of the Guanzhong region, we need to optimize the existing spatial layout planning of the county, leading to the high-quality development of urbanization through the intensive and efficient use of land.

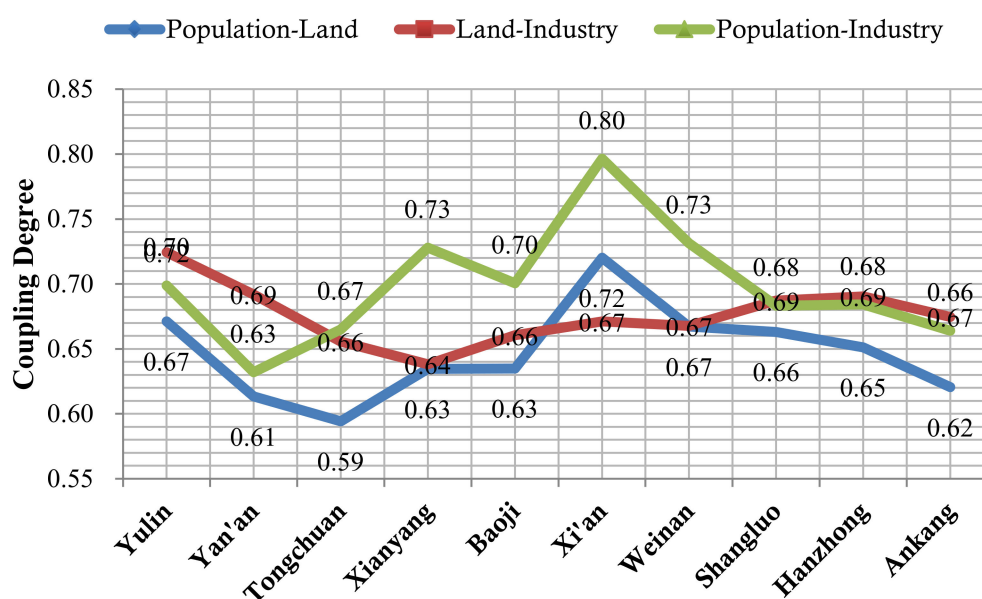


Figure 13. Differences in dual coupling coordination of population, land, and industry at the city level. The results are calculated based on the data from The China County Statistical Yearbook (2019).

Analysis of Population–Industry Coupling Coordination

The population–industry coordination degree increased slightly from 2014 to 2019, and then fell (Figure 12a). The Guanzhong area was significantly higher than Northern and Southern Shaanxi (Figure 12b). Xi'an had the highest population–industry coordination degree (Figure 13). Under its radiation, the population–industry coordination degree of Xianyang and Weinan was relatively high. Xi'an had the highest coordination degree for population–land and population–industry. In particular, the coordination degree of population–industry showed a “core-edge” structure. Counties which are close to Xi'an City had a better coordination degree of population–industry. This proves that the central city of Xi'an played a significant role in guiding the surrounding counties.

3.3. Evaluation of Urbanization Development in Shaanxi Counties

According to the classification of population, land, and industry coupling coordination, counties with high coordination degree include Chang'a, Chencang, Dali, Pucheng, Jingbian, Dingbian, and Shenmu. Counties with a low coordination degree include Yongshou, Changwu, Chunhua, Qianyang, Linyou, Taibai, Tongguan, Yijun, Yanchuan, Ganquan, Huanglong, Liuba, Foping, Mizhi, Wubao, and Zhenping. Through further screening of the sub-systems, it is found that the coordination lag type of population–land, land–industry and population–industry is shown in Table 3. Attention should be paid to Qianyang, Yijun, Foping, Wubao, and Zhenping, because these counties lag behind both in comprehensive coordination and dual coordination.

From the distribution of the urbanization coordinated development, counties with high coordination have an obvious agglomeration effect, and were distributed in Guanzhong Plain urban agglomeration and resource-based cities in Northern Shaanxi. Firstly, the coordination degree of urbanization in Western counties was significantly affected by their location. Xi'an, the central city of Shaanxi Province, is located at the core of Guanzhong Plain urban agglomeration. Previous studies showed that the radiation effect of central cities is limited by distance. Due to the spatial advantages of counties near the central cities, under the effect of the industrial spillover effect of the central cities, the economic and social development was also rapid, and the coordination level of urbanization was constantly improving. However, most of the low coordination districts and counties were at the edge of administrative provinces, and they were at a relative disadvantage in terms of location. So, their urbanization development and coordination were much lower. Sec-

only, the driving effect of industrial agglomeration was most obvious in the process of Western counties' urbanization. A previous study demonstrated that due to the role of land policy, county urbanization could not rely on land expansion. Therefore, the level of land urbanization in Shaanxi Province was basically consistent, and its fluctuation range was small. At the same time, population hollowing had always been an important problem of county urbanization. The previous results also prove that population urbanization only improved significantly around the central city. However, it did not play a positive role in the broader county level. Yulin County is rich in mineral resources. Even with the background of population outflow, the developed industry in this region has grown into the second gathering area with high level and highly coordinated development of county urbanization. It could be seen that in the development of Western county urbanization, land urbanization may not play an important role, and population urbanization has not yet played its role. Therefore, at this stage, the development depends on the driving role of industrial agglomeration.

Table 3. Evaluation of coordinated development of county in Shaanxi Province.

Development Mode	Low Coordination	Moderate Coordination	High Coordination
Population -Land -Industry coupling coordination	Yongshou, Changwu, Chunhua, Qianyang, Linyou, Taibai, Tongguan, Yijun, Yanchuan, Ganquan, Huanglong, Liuba, Foping, Mizhi, Wubao, Zhenping	Gaoling, Guyi, Lantian, Zhouzhi, Sanyuan, Jingyang, Qianxian, Liquan, Wugong, Xingping, Binzhou, Fengxiang, Qishan, Fufeng, Mei, Longxian, Fengxian, Huazhou, Heyang, Chengcheng, Baishui, Fuping, Hancheng, Huayin, Yaozhou, Ansai, Yanxian, Zichang, Zhidan, Wuqi, Fuxian, Luochuan, Yichuan, Huangling, Nanzheng, Chenggu, Yang, Xixiang, Mianxian, Ningqiang, Lueyang, Zhenba, Hengshan, Fugu, Suide, Jia, Qingjian, Zizhou, Hanyin, Shiquan, Ningshan, Ziyang, Langao, Pingli, Xunyang, Baihe, Shangzhou, Luonan, Danfeng, Shangnan, Shanyang, Zhen'an, Zhashui	Chang'an, Chencang, Dali, Pucheng, Jingbian, Dingbian, Shenmu
Population–Land Coordination lag type	Yongshou, Changwu, Chunhua, Qianyang, Linyou, Taibai, Tongguan, Baishui, Yijun, Yanchuan, Ganquan, Huanglong, Huangling, Liuba, Foping, Mizhi, Wubao, Qingjian, Shiquan, Ping		
Land–Industry Coordination lag type	Chang'an, Jingyang, Qianxian, Liquan, Yongshou, Changwu Chunhua, Wugong, Xingping, Binzhou, Qishan, Fufeng, Mei, Qianyang, Huazhou, Tongguan, Chengcheng, Baishui, Fuping, Huayin, Yijun, Foping, Mizhi, Wubao, Zhenping, Baihe		
Population–Industry Coordination lag type	Qianyang, Linyou, Fengxian, Taibai, Yijun, Ansai, Yanchuan, Zhidan, Wuqi, Ganquan, Fuxian, Luochuan, Yichuan, Huanglong, Huangling, Liuba, Foping, Wubao, Ningshan, Langao, Zhenping Zhashui		

However, the driving effect of industrial agglomeration without the population's driving force was unsustainable. Therefore, to stimulate the urbanization development of Western counties, it is necessary to guide the return of outflowed agricultural transfer population. This depends on providing more jobs through the county's economic development, strengthening the county's comprehensive service capacity through infrastructure construction, and attracting the agricultural transfer population to gather in the county. The essence of urbanization development is to respect the main function of the region. The distribution of low cooperation counties shows that some of them are in ecological migration areas. Therefore, the high-quality development of county urbanization does not involve pursuing the homogeneity of each district and county to develop the industrial economy and gather the population, but instead involves choosing the potential cities and towns to grow into the growth pole that can drive the development of surrounding counties through institutional cultivation. At present, there are only two central cities (Xi'an City and Shenmu City) which have a radiation effect on their surrounding counties. Compared with the vast distribution space, the radiation capacity of the two cities was very limited.

Therefore, it is necessary to cultivate leading central towns with certain distribution rules to effectively drive the development of Western county urbanization.

4. Discussion

High-quality urbanization is the core of high-quality development [60,61]. In order to implement the new development concept of innovation, coordination, green, openness, and sharing in urbanization of Western counties, sustainable development must be taken as guiding principle. As an important part of county urbanization, the coordinated development of population, land, and industry is the core issue of sustainable development of county urbanization. This study of county urbanization in Western China has important reference significance. Based on the coupling coordination analysis of population, land, and industry at the county scale in Shaanxi Province, the following findings are obtained:

1. Taking 2016 as the boundary, county urbanization in Shaanxi Province could also be divided into the stages of “Increment” and “Quality Improvement”, which is consistent with the overall development characteristics of China’s “stable rising period”. Before 2016, both the comprehensive development level of urbanization and the coordination degree of population, land, and industry showed a rapid rising feature. In this stage, the rapid economic expansion was achieved through factor agglomeration. From 2016 to now, the development of county urbanization in Shaanxi entered a stable rising period, characterized by pursuing the coordinated development of various elements. This feature in the urbanization of counties was consistent with the development characteristics of China from the incremental stage of the 12th Five-Year Plan period to the quality improvement stage of the 13th Five-Year Plan period. After entering the 13th Five-Year Plan period, the county economic growth slowed down, and more attention was paid to structural adjustment and quality improvement, which are so-called “new development concepts”. These are new development ideas in China proposed by Xi Jinping, which are characterized by innovation, coordination, green, openness, and sharing with pursuing high-quality development. The new development concept is strategic, and programmatic in a longer period. Therefore, after the year of 2016, the urbanization of China entered the stage of “Quality Improvement”. In the quality improvement stage, coordination is based on increments. The coupling coordination degree of population, land, and industry and the trend of comprehensive urbanization level are synchronized, which shows that increment and quality improvement cannot be strictly distinguished in the process of economic development. The coupling coordination degree was not adjusted separately, but based on the factor agglomeration, and each subsystem gradually adjusted to be more coordinated in the process of factor agglomeration. Therefore, factor agglomeration could not be neglected in the stage of economic upgrading. County high-quality urbanization still needs to take measures to achieve the agglomeration effect of population, capital, and industry as the precondition, give full play to the growth potential, maintain a reasonable growth rate, and coordinately realize the improvement in quality and expansion of quantity.
2. In general, the urbanization development in counties of Shaanxi Province presents the characteristics of a “core-edge” circle structure, and the radiation effect of central cities was significant. Both the urbanization development level and coupling coordination degree of population and industry subsystems showed the differential sequence circle distribution of Xi’an as the core city. Xianyang, Weinan, Baoji comprised the second echelon, and Yan’an, Ankang constituted the last. Among them, the circle structure of population urbanization was more obvious than that of industry urbanization, which indicated that central cities played an obvious radiation effect in industry urbanization, but the development of population urbanization was still in the siphon stage. Due to the effect of the circle structure, county urbanization in Shaanxi Province shows obvious differences between the Guanzhong area, Northern, and Southern Shaanxi region. First of all, the Guanzhong area presented the

characteristics of “strong development and strong coordination”. The overall level of county urbanization development in the Guanzhong area was obviously high, and the coupling coordination of population, land, and industry was also higher. Population agglomeration and economic development promoted and coordinated each other, showing good development and coordination characteristics. However, land resources were the constraints of the development of Guanzhong area. To strengthen development, we need to strengthen the regional planning and enhance the intensive use of land resources. Secondly, the spatial differentiation of Northern Shaanxi was obvious. Shenmu City had the best population–land–industry coordination level. Due to its pulling effect, the comprehensive urbanization development level of Northern Shaanxi was relatively high. However, at the same time, the county urbanization of Yan’an city was at a disadvantage, and the regional gap was huge within Northern Shaanxi. Finally, Southern Shaanxi presents the feature of “weak level coordination”—that is, the level of urbanization development was general, forming a relatively low level of coordinated development.

3. The main driving force of urbanization in Western counties was industry agglomeration, and population hollowing was the restricting factor of county development. The development level of industry urbanization in counties was much higher than that of population and land urbanization. It could be seen that industry agglomeration of initial scale has formed in China’s Western counties. In recent years, the government planned to move the large-scale manufacturing industry to small towns in the central and western regions, and guided industries to form cluster in the counties through financial inclination. For example, Shaanxi provincial government introduced the policy of accelerating the development of county industrial concentration areas and industrial parks in 2018. One of the important tasks of the Development and Reform Commission in 2020 was the construction of the county industrial park to guide the industrial agglomeration of counties. Urbanization could be driven by population, technology, industry, and land. As a large part of county land is agricultural land, unlike urbanization in cities, county could not undergoes urbanization through expanding urban construction. At the same time, simply leading the urbanization level through land exploitation also deviated from the requirement of high-quality urbanization being intensive and efficient and the original purpose of being people-oriented [62,63]. In the case of relatively insufficient population agglomeration, township industry was the main driving force of urbanization in the Western counties of China. Generally, industry development can promote population agglomeration [20,64]. However, at present, the urbanization level of industry is much higher than that of population. This indicates that although county industry agglomeration achieved an initial effect, the county production and living space construction did not reach the level to attract population agglomeration. County infrastructure, public services, and other comprehensive services’ capacity was inadequate, which reduced the attractiveness for the population. Therefore, in order to promote further development of county urbanization, the government should direct its financial expenditure to public facilities, such as county infrastructure, human settlement environment, public service construction, etc. Attracting population occurs through improving county life quality, thus promoting the improvement in the urbanization level.

5. Conclusions

The high-quality development of urbanization in Western counties plays an important role in the construction of high-quality urbanization in China [65]. Shaanxi Province, located at the East–West junction of the Yellow River and HU Line, has the comprehensive strategic position of the national main functional area development strategy, the ecological protection and high-quality development strategy of the Yellow River Basin, and the development strategy of “One Belt and One Road”. This study on county urbanization

construction in Shaanxi Province has certain reference significance for the development of county urbanization in Western China.

Overall, although the coordinated development of population, land, and industry urbanization at the county scale in Shaanxi Province is in its rising stage, there were also significant imbalances. The population outflow problem was prevalent in county areas, restricting the development and construction of urbanization. As an important driving force of urbanization, population agglomeration is relatively backward in the county urbanization of Shaanxi Province. At the same time, there was a lack of regional central cities in the whole province. Xi'an, as a national central city, had an obvious radiation effect. However, due to the limited radiation range of central cities, only one central city made it difficult to promote the development of county urbanization in the whole province. Therefore, the urbanization development of Western counties should focus on system-led county comprehensive service capacity construction to improve the attraction of returned migrant workers. With the interactive agglomeration of population and industry, a pattern of multiple central cities leading the development of county urbanization should be formed. Firstly, we should continuously strengthen the construction of public facilities, such as industrial park and industrial service facilities. A county is a collection of vast rural areas. Due to the unequal distribution of public facilities, there is a position discrimination effect in county economic development. Through the construction of public facilities and innovation application [66], the negative impact of spatial distance on county economic development can be eliminated to a great extent. Through fiscal policy tilting, it could promote the county's industrial economy and form characteristic industrial agglomeration based on counties' advantages, stabilized employment growth, and economic development environment. Secondly, we should increase the financial expenditure to the county public infrastructure, public service capacity, and human settlement environment construction, so as to form an ecological and livable high-quality living environment, increasing the attractiveness of population agglomeration in Western counties. Thirdly, through the evaluation of county urbanization development, we should select a batch of small county towns which have development and leading potential and cultivate a batch of central counties which can grow into new regional highlands. Finally, through the establishment of PPP (Public Private Partnership, namely the cooperation between government and social capital, is a project operation mode in public infrastructure.) mechanism to solve the problem of government funding, we should attract capital into the county to provide public services and infrastructure construction. Finally, from the perspective of long-term sustainable development, we should strengthen the development of rural education, culture, and innovation industries. It should also be ensured that rural urbanization builders are promoted from generation to generation [38].

Although there are some important findings in this study, there are still limitations. On the one hand, the measurement dimension of county data changes after 2014, which shortens the research cycle of this study, and causes the research to fail to fully show the development and change in county urbanization in a longer historical period. On the other hand, the data measurement sample is rich, but the content is limited, which makes the availability limited in the index design. This study measured the level of urbanization development both from the scale and structure of each subsystem, and measured the concept as much as possible. Future research should start from the following aspects. First of all, future research should expand on a variety of data sources, further improve the index system, and analyze the coordination of county population, land and industrial urbanization more accurately. At the same time, based on the analysis of the county population agglomeration situation and its influence factors, we will put forward policy suggestions to promote urbanization construction at the county scale.

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