Article

Spatio-Temporal Characteristics and Obstacle Factors of the Urban-Rural Integration of China’s Shrinking Cities in the Context of Sustainable Development

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Abstract: Based on the fundamental concept of sustainable development, this study empirically analyzes the spatio-temporal characteristics, formation mechanisms and obstacle factors of the urban-rural integration of shrinking cities in China, from 2008 to 2018. The conclusions are as follows: the overall level of the urban-rural integration of shrinking cities in China is low; the internal differences of urban-rural integration are also small, and the changes are slow. Next, the space difference is high in the east and low in the west, high in the south and low in the north. Moreover, differences exist among different levels of urban agglomerations. Urban economic efficiency, urban resources and environment, urban social equity and rural economic efficiency are the main factors affecting the urban-rural integration of shrinking cities in China. Urban and rural economic efficiency are the two most prominent shortcomings that restrict the urban-rural integration of shrinking cities. The spatial resistance mode of each city is more than the two-system resistance; the main resistance of shrinking cities with a higher level of urban-rural integration also comes from the non-economic field. This study expands the research scope that up till now has ignored the discussion of urban-rural issues in the research of shrinking cities at home and abroad, and provides practical guidance for the sustainable development of shrinking cities in China.

Keywords: sustainable development; shrinking city; urban-rural relationship; spatio-temporal pattern; China

1. Introduction

Since the 1960s, urban shrinkage, which is characterized by population loss, industrial decline, empty urban space and public facilities being left idle, has been spreading continuously, evolving on a global scale into an objective existence and geographical fact that is independent of human will [1,2]. Urban shrinkage has given rise to a series of urban and regional development problems, which are mainly reflected in the unsustainable development of the central city and the urban-rural relationship within the urban functional region. For example, the decline in urban economic growth makes it difficult to activate the multiplier effect that drives the development of urban and rural industries. This, in turn, restricts the overall upgrading of urban-rural industries. The service functions of the shrinking cities are declining, and the ability to attract more people and the corresponding economic activity is gradually being weakened. The result is that the waste of land in terms of the central city’s land resources is serious, and the progress of regional urbanization is slow. Rural non-agricultural industries are developing slowly, and farmers’ income growth is limited. Education, medical care, sanitation and other facilities are increasingly insufficient. Therefore, the transfer of the rural population out of the shrinking region is accelerating [3].

At the end of the 19th century, some urban geography and urban planning scholars turned their focus on the combination of urban and rural spaces when seeking solutions to...
urban problems [4]. After years of exploration, the academic community generally believed that the relationship between urban and rural areas is the foundation of positioning and guiding the development of cities and regions. Also, clarifying the relationship between urban and rural areas is an important way to guarantee the realization of regional sustainable development [5]. To solve the problem of shrinking cities, the issue of improving rural and urban areas must be dealt with as a unified concept. As for the perspective of the research progress of shrinking cities, early studies on urban shrinkage focused on the discussion of that concept [6,7]. In the 1990s, researchers began to pay attention to the spatial patterns, characteristics, and influence mechanisms of urban shrinkage [8–12]. Since 2010, the focus has turned to measuring the degree [13–16] and researching the countermeasures of urban shrinkage [17–24]. On the whole, existing studies mainly focus on the central city, but no research has been conducted involving the urban-rural relationship of shrinking cities [25]. However, such research would undoubtedly be of great significance to the sustainable transformation of the urban function of shrinking cities.

China has a total of 663 cities, including four municipalities that are directly under the central government, 293 prefecture-level cities and 366 county-level cities. Since the end of the 1990s, urban shrinkage has gradually become obvious in China. The country’s urban development is faced with the coexistence of growth and contraction [26–28]. Based on the fact that the urban-rural relationship of shrinking cities has not yet attracted the attention of academic circles, this paper takes the shrinking prefecture-level cities in China as an example. On the basis of a theoretical analysis of the inner relationship between urban-rural integration and urban-rural sustainable development, a coupling coordination degree model, geographic detector model, and obstacle degree model are used to conduct an empirical analysis of spatio-temporal characteristics, as well as the formation mechanism and the obstacle factors of urban-rural integration of shrinking cities in China. This study can expand the research scope that, up till now, has ignored the discussion of urban-rural issues in the research of shrinking cities. In addition, based on an in-depth and comprehensive analysis of the urban-rural relationship in shrinking cities, this study can provide practical guidance for the sustainable development of shrinking cities in China.

2. Theoretical Basis

2.1. Definition of the Shrinking Prefecture-Level Cities in China

The shrinkage and growth of cities is a gradual process, and the observation of that shrinkage should be based on a certain time interval. Referring to the research conclusions of Guo Yuanyuan et al. [29], in terms of time span, this paper selects 2008 and 2018 as the observation time nodes of urban contraction to investigate the population growth changes in municipal districts. The results show that a total of 53 prefecture-level cities in China have experienced population decline, showing obvious shrinkage characteristics. These cities are mainly found in resource-based cities, old industrial cities and remote agricultural cities, and are mainly distributed in northeast and northwest China, with a small number in central China and on the coastal areas of China (Figure 1).

2.2. Unsustainability of the Urban-Rural Relationship of Shrinking Cities in China

2.2.1. Weak Economic Linkages between Urban and Rural Areas

Shrinking cities in China are mainly resource-based cities, old industrial cities and remote agricultural cities whose economic structure is in crisis. The old industrial system, dominated by heavy chemical industry and formed in resource-based cities and old industrial cities before the reform and opening up, is mainly characterized by a short industrial chain, weak forward and backward connection and regional connection [30]. This structure makes it difficult to exert a radiation and driving effect on the development of peripheral areas. Moreover, the economic scale of central cities in remote agricultural areas is small. The characteristics of economic development are not prominent, and the driving effect of industrial advantages is not obvious. The peripheries of most shrinking cities are made up of traditional agricultural areas. The development of non-agricultural
industries is still in the initial state, and the connection with urban industries is insufficient. The spatial distribution of towns at county level is scattered, and the carrying capacity of large industrial transfers from central cities is poor. As a result, the concentration and optimal allocation of urban and rural resource elements in shrinking cities lag behind; the connection between urban and rural industries is also weak. This makes it difficult to activate the multiplier effect that drives the development of urban and rural industries, and thus, the transformation and development of shrinking cities and regions is restricted.

Figure 1. Spatial layout of shrinking prefecture-level cities in China.

2.2.2. Disconnect of Social Development in Urban and Rural Areas

There is an obvious disconnect between urban and rural social development in shrinking cities, including in terms of employment, income and basic public services. On the one hand, the sluggish economic development of the shrinking cities makes it difficult to create a large number of jobs. In addition, there are still a large number of laid-off workers to be resettled [31]. Therefore, the power to attract the peripheral population and corresponding economic activity is insufficient in the shrinking cities. At the same time, the functions of most shrinking cities are relatively simple; the development of basic public service functions is relatively backward, and the ability to radiate and drive rural development is also weak. On the other hand, on the peripheries of shrinking cities, the rural population and the surplus labor force is large, but the development of rural secondary and tertiary industries lags behind. This is leading to a low proportion of local population transfer and the slow growth of rural residents’ incomes. Therefore, the proportion of population moving out of the district is high, and the internal support for rural transformation and development is insufficient.

2.2.3. Inadequate Coordination of Urban-Rural Resources and Environmental Protection

For a long time, the urban-rural resources and the environmental protection of shrinking cities in China have not been coordinated enough. As a result, urban and rural areas are still facing serious resource and environmental problems. For example, China’s shrinking
cities are mainly resource-based and old industrial cities, which have always faced serious environmental pollution problems because of the traditional heavy-polluting industries. In recent years, the rapid development of the agricultural processing industry, which has occurred in the process of the transformation of shrinking cities, has brought new environmental pollution problems. In addition, due to the impact of an economic investment shortage, most shrinking cities are being confronted with the problems of large amounts of idle land and lagging landscape construction [32]. The rural settlements on the peripheries of shrinking cities have a large amount of land (in terms of scale) and serious land waste issues. The vast majority of rural settlements do not have any water supply and drainage facilities; nor do they have environmental sanitation facilities. Therefore, the problem of rural environmental pollution needs urgent attention [33].

2.3. Urban-Rural Integration and Urban-Rural Sustainable Development of Shrinking Cities in China

As early as the 19th century, Marx and Engels had revealed the inevitable trend of the urban-rural relationship from the perspective of historical materialism, which in turn will evolve from the separation and opposition to the fusion and integration of urban and rural areas [34]. It has been pointed out that, in essence, the integrated development of urban and rural areas should be regarded as a process of realizing the mutual support, coordination, coexistence and long-term sustainable development of urban and rural areas as an organism [35]. In the late 20th century, the science of sustainable development emerged. This field focuses on achieving long-term coordination between economic and social development goals and environmental limits. The ultimate goal is to improve human well-being, namely to meet the material and spiritual needs of present and future generations [36,37]. Therefore, to promote integrated urban-rural development, the evolution of urban-rural relationships should be understood within the overall framework of sustainability science.

In essence, urban-rural integration is the sustainable development within the scope of urban and rural areas. In effect, urban-rural integration is the concrete embodiment and reflection of the general sustainable development of regional space.

The problem with urban-rural development in shrinking cities in China is actually the problem of regional sustainable development. In view of the ultimate goal of urban-rural integration, and considering the basic concept that sustainable development emphasizes the consideration of economic efficiency, resources and environment, and society equality, the mechanism model of urban-rural integration in shrinking cities under the framework of sustainable development is summarized. That is, this study summarizes the urban-rural interactive evolution model of industrial economic linkage, resource and environment support, and social development balance (Figure 2). Among them, the industrial economic connection between urban and rural areas is the forerunner and foundation of the model; resources and the environment are the fundamental support, and balanced social development is the ultimate goal. In this model, urban and rural areas are regarded as being an interdependent, mutually-reinforcing organic system. Emphasis is placed on promoting the balanced and coordinated development of subsystems and their elements in different dimensions of the urban-rural system. The aim of the model is to achieve the overall integration of urban and rural areas from the aspects of economic efficiency, resources and environmental protection, as well as social equity. The goal is to realize the development of shrinking cities, transforming from an uncoordinated region with weak sustainable development ability between urban and rural areas (Point O in Figure 2), to becoming a coordinated region with strong sustainable development ability between urban and rural areas (point A in Figure 2).
3. Research Data and Methods

3.1. Research Data Acquisition

Given the basic requirements of urban-rural integration and sustainable development, the quantitative measurement of urban-rural integration in China’s shrinking cities requires the establishment of an indicator system for the sustainable development of urban and rural areas, respectively. These indicators include three subsystems in urban and rural areas, namely economic efficiency, resources and environment, and social equity. The selection of urban and rural sustainable development indicators mainly follows the principle of comprehensiveness, scientificity, dominance and accessibility. This paper also refers to existing quantitative research literature on urban-rural relationships, at and above the prefecture-level scale in China, since 2003. The literature pertaining to the urban-rural relationship evaluation research is based on the traditional theory of urbanization and the research results of Rondineli, Enwin, etc. [38,39]. Therefore, the correlation between urban and rural areas is mainly interpreted as the economy, population and social elements. This is determined through the use of high-frequency research indexes, including those related to the urban and rural economy, urban and rural industrial structure, urban and rural population, the urban and rural population density, the income of urban and rural residents, urban and rural public service levels, etc. However, in the context of sustainable development, it is necessary to pay full attention to the coordination of the ecological environment in the urban-rural system. There is also a need to supplement the urban and rural development indicators for the ecological environment in the indicator system of this paper. The details are shown in Table 1.

There are 53 shrinking prefecture-level cities in China. China’s urban shrinkage began to become increasingly obvious at the start of the 2008 financial crisis, so the data from 2008 to 2018 were selected for analysis. The original data are all from the China City Statistical Yearbook (2009–2019) [40]; the missing data were obtained by interpolating the adjacent years.
Table 1. Evaluation indicator system of urban and rural sustainable development.

| Urban System | Rural System | Indicators                                                                 |
|--------------|--------------|-----------------------------------------------------------------------------|
| Economic  efficiency subsystem | Economic efficiency subsystem | Urban per capita GDP (X1)/yuan (RMB)                                      |
| Resources and environment subsystem | Resources and environment subsystem | Urban second industry output value per capita (X2)/yuan (RMB)               |
| Social equality subsystem | Social equality subsystem | Urban tertiary industry output value per capita (X3)/yuan (RMB)             |
|                        |                        | Urban fixed asset investment (X4)/yuan (RMB)                              |
|                        |                        | Urban built-up area (X5)/km²                                               |
|                        |                        | Urban green belt area per capita (X6)/m²                                  |
|                        |                        | Urban wastewater emissions per unit of output (X7)/ton                   |
|                        |                        | SO₂ emissions of urban unit output value (X8)/ton                         |
|                        |                        | Number of employees in urban unit (X9)/person                            |
|                        |                        | City on-the-job worker average wage (X10)/yuan (RMB)                      |
|                        |                        | Number of doctors per 10,000 people in cities (X11)/person               |
|                        |                        | Number of primary and secondary school teachers per 10,000 urban residents (X12)/person |
|                        |                        | Output value of agriculture per capita (X13)/yuan (RMB)                  |
|                        |                        | Output value of the secondary industry in rural areas per capita (X14)/yuan (RMB) |
|                        |                        | Output value of rural tertiary industry per capita (X15)/yuan (RMB)       |
|                        |                        | Rural fixed assets investment (X16)/yuan (RMB)                           |
|                        |                        | Rural administrative area (X17)/km²                                       |
|                        |                        | Sown area of crops per capita in rural area (X18)/hm²                   |
|                        |                        | Rural agricultural chemical fertilizer application intensity (X19)/kg/hm² |
|                        |                        | Rural population density (X20)/person/km²                                |
|                        |                        | Number of rural employees (X21)/person                                    |
|                        |                        | Savings balance of rural residents at year-end (X22)/yuan (RMB)          |
|                        |                        | Number of doctors per 10,000 people in rural areas (X23)/person          |
|                        |                        | Number of primary and secondary school teachers per 10,000 people in rural areas (X24)/person |

3.2. Research Method

3.2.1. Coupling Coordination Degree Model

The measurement model of urban-rural integration should reflect the dual connotation of multi-dimensional interaction and sustainable coordinated development between urban and rural areas. Therefore, a coupling coordination degree model used in physics is employed to measure the degree to which two or more systems or motion forms influence each other, based on the interaction. This paper draws on this model to quantitatively characterize the level of urban-rural integration by calculating the urban-rural coupling coordination degree [41]. The formula for calculating the urban-rural coupling coordination degree is as follows:

\[
C = \frac{U_1 U_2}{(U_1 + U_2)^2} \quad (1)
\]

\[
D = (C \cdot T)^{1/2} \quad (2)
\]

\[
T = \alpha(U_1) + \beta(U_2) \quad (3)
\]

In the formula, \(C\) is the coupling degree, which is used to measure the degree of urban-rural interaction, regardless of advantages or disadvantages; \(D\) is the coupling coordination degree, representing the integration of urban and rural systems in the process of interaction. The value range of \(C\) and \(D\) is \([0,1]\), and the closer the value gets to 1, the better the effect will be. In addition, \(T\) is the comprehensive evaluation index of the two systems, reflecting the overall benefit or level of the two systems. Finally, \(U_1\) and \(U_2\) are the scores of the sustainable development of the urban and rural system; and \(\alpha\) and \(\beta\) are undetermined parameters, which need to meet \(\alpha + \beta = 1\). Since urban and rural areas play dominant and basic roles in promoting urban-rural integration, their contribution rates will also be different. Taking the regional characteristics of shrinking cities into account, this paper sets \(\alpha = 0.65\) and \(\beta = 0.35\) [42]. The solution for \(U_1\) and \(U_2\) is as follows:

\[
U_1 = U_2 = \sum \lambda_{ij} u_{ij}, \sum \lambda_{ij} = 1 \quad (4)
\]
In the formula: $u_{ij}$ is the standardized indicator value of indicator $j$ in urban system (rural system) $i$, and $\lambda_{ij}$ represents the weight of indicator $j$ in urban system (rural system) $i$, which are necessary to satisfy $\sum \lambda_{ij} = 1$; $U_1$ and $U_2$ are the evaluation scores of the sustainable development of urban and rural areas, respectively, which can be substituted into Formulas (1) and (3) to calculate the urban-rural coupling coordination degree $D$ of each shrinking city. Also, the urban-rural coupling coordination degree can be divided into nine grades (Table 2).

| Value of Coupling Coordination Degree | (0–0.2) | (0.2–0.3) | (0.3–0.4) | (0.4–0.5) | (0.5–0.6) | (0.6–0.7) | (0.7–0.8) | (0.8–1) |
|-------------------------------------|---------|------------|------------|------------|------------|------------|------------|--------|
| Coupling coordination level         | Severe disorder | Moderate disorder | Mild disorder | Near disorder | Reluctant coordination | Primary coordination | Intermediate coordination | Good coordination |

3.2.2. Geographic Detector Model

A geographic detector model is a statistical method proposed by Wang J S and Xu C D to discuss disease risk [43]. In recent years, the model has been widely used to detect the causes and mechanisms of the spatial differentiation patterns of certain geographical factors, such as poverty, tourism, water carrying capacity, etc. [44–46]. The model’s working principle is to calculate the ratio of the total variance of an index in different regions to the total variance of the index in the whole study area, as follows:

$$P_{D,H} = 1 - \frac{1}{n\delta^2_H} \sum_{i=1}^{m} n_{D,i} \delta^2_{D,i}$$

In the formula, $D$ is the influencing factor of urban-rural integration, in this paper, all the indicators in Table 1 are selected as the influencing factors; $H$ is the difference index of urban-rural integration, and $P_{D,H}$ is the explanatory power of $D$ to $H$; $n$ and $\delta^2$ are the variances of the number of shrinking cities and the urban-rural integration difference index in China; $m$ is the classification number of impact factors; and $n_{D,i}$ is the sample number of $D$ index in class $i$. The value range of $P_{D,H}$ is 0–1. The greater the value is, the greater the influence of this factor on urban-rural integration will be.

3.2.3. Obstacle Degree Model

An obstacle degree model is introduced to study the obstacles to urban-rural integration. By ranking the obstacle degree, the degree of obstacles of each indicator and each subsystem in the urban and rural system to the urban-rural integration of shrinking cities in China is determined. The calculation formula is as follows:

$$O_{ij} = (1 - x'_{ij}\theta) \times w_{ij} \times 100\% / \sum_{j=1}^{n} (1 - x'_{ij}) \times w_{ij}$$

In the formula, $O_{ij}$ is the obstacle degree of a single indicator to urban-rural integration; $x'_{ij}$ is the standardized value of the $j$th single indicator of the $i$th subsystem; $w_{ij}$ is the corresponding weight, and $n$ is the number of indicators [47].

4. Research Results

4.1. Spatio-Temporal Characteristics of Urban-Rural Integration

4.1.1. Characteristics of Temporal Series

From 2008 to 2018, the urban-rural coupling coordination degree of shrinking cities in China always maintained a pattern of low levels and small regional gaps. As can be seen from Table 3, the mean value of the urban-rural coupling coordination degree of 53 shrinking cities in China increased from 0.38 to 0.43. Those values were continuously in the low level of the coupling coordination range (0.30, 0.50). The range of the urban-rural
coupling coordination degree increased from 0.10 to 0.12; the standard deviation increased from 0.02 to 0.03, and the coefficient of variation remained at the level of 0.06. These findings indicate that the regional differences of the urban-rural integration levels of shrinking cities in China were not obvious, and the change was slow. Therefore, the evolution of the type structure of urban-rural coupling coordination also shows the characteristics of gentle progress. From 2008 to 2018, the newly-added areas in each type transformed from adjacent types; there was no leapfrog growth or backward development phenomenon. For example, in China’s 53 shrinking cities, the urban-rural coupling coordination degree of Zhenjiang, Zibo and Xiangyang developed from one of mild disorder, through near disorder, to reluctant coordination. The urban-rural coupling coordination degree of Neijiang, Guangan and Ziyang was always mild disorder, and the other 47 cities all transformed from mild disorder to near disorder.

Table 3. Change of the mean value and difference indexes of urban-rural coupling coordination degrees in shrinking cities of China.

|          | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|----------|------|------|------|------|------|------|------|------|------|------|------|
| Mean value | 0.38 | 0.39 | 0.39 | 0.40 | 0.40 | 0.41 | 0.41 | 0.42 | 0.42 | 0.43 | 0.43 |
| Range    | 0.10 | 0.10 | 0.11 | 0.11 | 0.14 | 0.12 | 0.12 | 0.11 | 0.12 | 0.12 | 0.12 |
| Standard deviation | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Coefficient of variation | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |

4.1.2. Evolution of Spatial Pattern

The years of 2008, 2011, 2014 and 2018 were selected as observation points from which to draw the spatial distribution of the urban-rural coupling coordination degree of shrinking cities in China. As shown in Figure 3, the spatial pattern features of the urban-rural coupling coordination of shrinking cities in China can be mainly summarized as having east-west and north-south differences, as well as urban agglomeration level differences. (1) From the perspective of the three major economic zones in eastern, central and western China, the results show the characteristics of being high in the east and low in the west. In 2008, the mean value of the urban-rural coupling coordination degree of shrinking cities in the three economic zones in China was central (0.39) > eastern (0.38) > western (0.37). By 2018, the mean values were eastern (0.44) > central (0.43) > western (0.41). The average increase of the urban-rural coupling coordination degree of shrinking cities in the three regions was as follows: eastern (0.06) > central (0.04) = western (0.04). This finding indicates that the spatial pattern of high in the east and low in the west will remain unchanged for a certain period of time. (2) The number of shrinking cities in northern China is 35, while the number in southern China is 18. The urban-rural coupling coordination shows a change from high in the north and low in the south, to high in the south and low in the north. From 2008 to 2018, the average value of the urban-rural coupling coordination degree of shrinking cities in China gradually changed from northern (0.39) > southern (0.36), to southern (0.43) > northern (0.42). (3) The spatial distribution of China’s shrinking cities involves three national urban agglomerations (the Yangtze River delta, the middle reaches of the Yangtze River, and Chengdu-Chongqing), six regional urban agglomerations (Ha-Chang, the central and southern parts of Liaoning, Shandong Peninsula, Jianghuai, the west coast of the Taiwan Straits, and Guanzhong) and four territorial urban agglomerations (Jinzhourong, along the Yellow River in Ningxia, Hu-Bao-E-Yu, and Lanzhou-Xining). The level of the coupling coordination degree of shrinking cities showed the characteristics of national urban agglomeration > regional urban agglomeration > territorial urban agglomeration. In 2018, three reluctant coordination regions were distributed in the urban agglomerations of the Yangtze River delta, the middle reaches of the Yangtze River and the Shandong Peninsula. The urban-rural coupling coordination level of Jilin, Huzhou, Zoushan and Changde, in the near disorder type, is closer to the degree of reluctant coordination, because these areas are located in the Ha-Chang urban
agglomeration, the Yangtze River Delta urban agglomeration and the middle reaches of the Yangtze River urban agglomeration.

**Figure 3.** Evolution of the spatial patterns of urban-rural integration in the shrinking cities of China.

4.2. Mechanisms of the Spatio-Temporal Evolution of Urban-Rural Integration

Internal influence factors have a direct effect on the changes of the spatio-temporal pattern of urban-rural integration. Meanwhile, external factors affect urban-rural integration by influencing the internal elements and structure of the urban-rural system. Therefore, the determination of internal influence factors is the premise and basis for the in-depth analysis and understanding of the dynamic mechanism of urban-rural integration. A geographical detector model is used to detect the factor determinants of various indicators within the urban and rural system; only the top 10 main influencing indicators are listed. As can be seen from Figure 4, in 2008, 2011, 2014, and 2018, the indicators with a frequency of greater than 3 mainly included X1, X2, X3, X5, X6, X9, X11, X14, and X15. The results show that the driving force of urban-rural integration in shrinking cities is firstly manifested by the centripetal transfer of peripheral regional elements brought about by urban economic, ecological and social advantages. Central cities also play an important leading role in urban-rural integration development. Second, the driving force is manifested by the industries and service linkage between urban and rural areas, which are promoted by the development of rural non-agricultural industries. However, the effect of these factors is generally weak, which is the main reason for the slow development of urban-rural integration in China’s shrinking cities [48].
Driving factors of urban economic efficiency. The spatial and temporal pattern of urban-rural integration in shrinking cities is highly correlated with the spatial differentiation of urban economic efficiency indicators. The influence of each indicator in the subsystem of urban economic efficiency is large and appears repeatedly. In fact, X3 appears four times, and X1 and X2 both appear three times. This finding shows that the urban-rural economic integration of shrinking cities is more reflected by the radiation of the commercial service functions of central cities to the periphery. However, the sluggish industrial development and the limited urban economic growth cause X1 and X2 to have a relatively weak drive to the periphery villages.

Driving factors from urban resources and environment. In the factors with strong effects on urban-rural integration, X5 and X6 both appeared four times. These results show that the agglomeration and diffusion capacities of cities with different spatial scales are the main reasons for the formation and evolution of the spatial differences of urban-rural integration. For example, Jilin, Zhenjiang, Huzhou, Zhoushan, Taian, Xiangyang, Changde and Zibo, with a high level of urban-rural integration, all have a population of more than 1 million. From 2008 to 2018, the number of national development zones in the eight cities increased from three to 11. Large-scale urban spatial growth drives the increase of population in central cities and further affects the urban-rural integration of shrinking cities. At the same time, the differences in the ecological environment in shrinking cities, as well as other factors, also affect the migration of rural population to cities, thereby easily playing a role in the spatial differentiation of urban-rural integration.

Driving factors of urban social equity. In this study, X9 and X11 have significant effects on urban-rural integration; the frequency of occurrence is three. The employment opportunities and living conditions of shrinking cities are positively correlated with their economic development and industrial structure. The shrinking cities in the eastern, southern and large urban agglomerations have a high level of urban-rural integration. In addition, the important influencing factors are the strong attraction of urban employment and better social service facilities. On the other hand, the central cities in the marginal areas of the northeast, northwest and in the resource-based areas are small in scale, and their historical problems are serious. Moreover, the government cannot afford the required urban construction costs, and as a result, the lack of urban functions leads to the cities’ weak agglomeration ability and the serious backwardness of urban-rural integration.

Driving factors from rural economic efficiency. In this study, X14 and X15 both appear three times, thereby representing bottom-up urban-rural economic correlation. However, rural urbanization on the peripheries of shrinking cities in the eastern and central regions started early. Additionally, the counties on the peripheries of cities such as Huzhou and
Huangshan have national high-tech industrial development zones. A good non-agricultural industrial foundation is the premise for a close connection between urban and rural areas.

4.3. Diagnosis of Obstacle Factors of Urban-Rural Integration

Exploring the obstacles to urban-rural integration in China’s shrinking cities is of great significance in terms of improving the sustainability of their urban-rural relationship. An obstacle degree model is used to measure the obstacle degree of each sub-indicator and subsystem of the shrinking urban and rural system. An obstacle factor diagnosis is also carried out according to the frequency and magnitude of the obstacle degree.

4.3.1. Obstacle Factors of the Indicator Layer

The top 10 indicators of obstacle degree over the years were taken as the main obstacle factors, and the occurrence frequency of the main obstacle factors was statistically analyzed. As can be seen from Table 4, X4, X5, X6, X9, X14, X15, X16, X17 and X22 were the main obstacle factors from 2008 to 2018. In addition, X13 only played an obvious obstacle role from 2008 to 2011, while X18 had an increasing obstacle degree after 2012. This shows that: (1) the obstacle factors of urban-rural integration in shrinking cities are relatively stable. These factors mainly include insufficient urban fixed asset investment, the slow advancement of space development, the need for an improved living environment, the scarcity of jobs in central cities, rural economic strength and the limited number of non-agricultural industries. All of these factors lead to the low development level of rural residents’ income growth and large numbers of the surplus rural labor force shifting to areas outside the shrinking cities. (2) In terms of time change, the influences of urban investment, employment and environmental conditions are gradually strengthening. This finding indicates that the development weakness of the shrinking cities has not been significantly improved. Meanwhile, the non-agricultural industries on the rural periphery of the shrinking cities have developed to a certain extent; their obstacles have also weakened.

Table 4. Obstacle indicators and their obstacle degree of urban-rural integration of shrinking cities in China.

| Year | X4  | X5  | X6  | X9  | X13 | X14 | X15 | X16 | X17 | X18 | X22 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 2008 | 0.122 | 0.126 | 0.129 | 0.129 | 0.092 | 0.113 | 0.103 | 0.117 | 0.112 | 0.108 |
| 2009 | 0.122 | 0.125 | 0.130 | 0.131 | 0.093 | 0.113 | 0.103 | 0.115 | 0.114 | 0.108 |
| 2010 | 0.121 | 0.125 | 0.130 | 0.132 | 0.092 | 0.110 | 0.102 | 0.113 | 0.115 | 0.109 |
| 2011 | 0.121 | 0.124 | 0.130 | 0.130 | 0.091 | 0.106 | 0.101 | 0.113 | 0.117 | 0.106 |
| 2012 | 0.120 | 0.125 | 0.132 | 0.131 | 0.104 | 0.104 | 0.110 | 0.118 | 0.089 | 0.105 |
| 2013 | 0.119 | 0.125 | 0.132 | 0.128 | 0.102 | 0.099 | 0.107 | 0.120 | 0.090 | 0.103 |
| 2014 | 0.118 | 0.123 | 0.132 | 0.128 | 0.103 | 0.098 | 0.103 | 0.119 | 0.091 | 0.101 |
| 2015 | 0.118 | 0.123 | 0.132 | 0.131 | 0.104 | 0.096 | 0.103 | 0.121 | 0.091 | 0.095 |
| 2016 | 0.121 | 0.125 | 0.131 | 0.136 | 0.106 | 0.094 | 0.102 | 0.122 | 0.091 | 0.094 |
| 2017 | 0.119 | 0.126 | 0.135 | 0.139 | 0.107 | 0.094 | 0.103 | 0.125 | 0.093 | 0.093 |

4.3.2. Obstacle Factors of Subsystem Layer

The subsystem layer is more generalized than the indicator layer. The time series analysis of the obstacle factors of the subsystem layer in each year was conducted, and the results are shown in Table 5. The results show that, from 2008 to 2018, the obstacle degree of the rural economic efficiency subsystem was the largest, followed by the urban economic efficiency subsystem. However, the former decreased continuously while the latter gradually strengthened. The subsystem of social equity in both urban and rural areas also has strong influence, and both of them show an increasing trend. The obstacles in the field of resources and environment were the least impactful. During most of the study period, those in the field of urban resources and environment decreased, while those in the field of rural resources and environment increased; they were equal in 2018. Therefore, in order to guarantee the rural-urban integration of shrinking cities, attention should first
be paid to economic transformation and development. Then, steps should be taken to strengthen the ability to resist social risk and to revitalize social development. At the same time, strengthen the regulation and guarantee of ecological carrying capacity should be strengthened.

Table 5. Obstacle degree of subsystems for the urban-rural integration of shrinking cities in China.

| Year | Urban Economic Efficiency | Urban Resources and Environment | Urban Social Equity | Rural Economic Efficiency | Rural Resources and Environment | Rural Social Equity |
|------|--------------------------|---------------------------------|--------------------|--------------------------|---------------------------------|-------------------|
| 2008 | 0.376                    | 0.319                           | 0.301              | 0.424                    | 0.262                           | 0.313             |
| 2009 | 0.377                    | 0.318                           | 0.302              | 0.423                    | 0.267                           | 0.31              |
| 2010 | 0.375                    | 0.317                           | 0.305              | 0.416                    | 0.27                            | 0.315             |
| 2011 | 0.366                    | 0.323                           | 0.304              | 0.41                      | 0.27                            | 0.315             |
| 2012 | 0.367                    | 0.325                           | 0.308              | 0.401                    | 0.278                           | 0.321             |
| 2013 | 0.372                    | 0.32                            | 0.309              | 0.398                    | 0.282                           | 0.32              |
| 2014 | 0.373                    | 0.319                           | 0.309              | 0.393                    | 0.283                           | 0.323             |
| 2015 | 0.38                     | 0.316                           | 0.311              | 0.392                    | 0.286                           | 0.321             |
| 2016 | 0.387                    | 0.297                           | 0.322              | 0.392                    | 0.288                           | 0.321             |
| 2017 | 0.389                    | 0.294                           | 0.327              | 0.386                    | 0.293                           | 0.321             |
| 2018 | 0.387                    | 0.293                           | 0.33               | 0.387                    | 0.293                           | 0.319             |
| Average value | 0.377 | 0.313                           | 0.312              | 0.402                    | 0.279                           | 0.318             |

4.3.3. Division of the Spatial Resistance Pattern

Taking the average obstacle degree of the subsystem layer > 33.33% as the principle to identify the resistance of each shrinking city, the spatial resistance patterns are divided according to different cities (Table 6). The results show that each shrinking city has more than two subsystems of resistance. This finding indicates that a single subsystem does not constitute an obstacle to urban-rural integration. It is therefore necessary to comprehensively consider the degree of obstacles of each subsystem, in order to analyze the resistance mode. The resistance models of urban-rural integration in China’s shrinking cities include three categories of two-system, three-system and four-system resistance models, which can be further divided into 10 subcategories.

In the two-system resistance modes, 16 cities belong to the type whereby both urban and rural economic obstacles are prominent. These cities are mainly concentrated in the northeast and northwest of China. Zibo has a high level of urban-rural integration and less resistance in economic development and is the only city whose urban-rural integration is hindered by the resources and environment of both urban and rural areas. Therefore, Zibo needs to pay attention to the sustainable development of both urban and rural resources, as well as the environment. Taian has the greatest number of obstacles in the field of urban economy and rural resources and environment. The city’s urban-rural integration will require strengthening the urban economy, while at the same time taking the rational development and utilization of rural resources and environment into account.

In the three-system resistance models, the level of urban-rural integration in Zhenjiang is the highest. There, the economic foundation of urban-rural integration is good. The obstacles to future development in Zhenjiang come from the issues of urban and rural resources and environment protection, as well as the urban social subsystem. The urban-rural integration of Zhoushan requires enhancing the level of urban economic and social development, and taking the rural ecological environment into account. Liaoyuan and Huangshan are less restricted by resources and environment conditions, but the urban and rural economic resistance and urban social obstacles in these two cities are obvious. The largest numbers of shrinking cities are those that need to consider urban economy, rural economy and rural social equity barriers, or those that need to consider urban economy, rural economy and urban-rural resources and environment at the same time. This group is mainly comprised of the old industrial cities and resource-based cities in inland areas. Their
urban economic development is weak, and their left-over historical social and ecological problems are serious.

Table 6. Spatial pattern of resistance paradigm of urban-rural integration in shrinking cities of China.

| Resistance Pattern | Resistance Type | Number of Cities | City Name |
|--------------------|-----------------|------------------|-----------|
| 2 resistance       | Rural economy, urban economy | 16 | Dandong, Jinzhou, Fuxin, Tieling, Xuchang, Guangyuan, Tongchuan, Wuwei, Dingxi, Longnan, Haidong, Guyuan, Zhongwei |
|                    | Rural ecology, urban economy | 1 | Tai’an |
|                    | Rural ecology, urban ecology | 1 | Zibo |
|                    | Rural economy, urban economy, rural society | 11 | Bayan Nur, Fushun, Benxi, Qiqihar, Jixi, Hegang, Shuangyashan, Yichun, Jiamusi, Qitaibei, Zhangye, Linfen, Anshan, Tonghua, Quzhou, Xiangyang, Jingmen, Jingzhou, Huanggang, Changde, Neijiang, Leshan, Guang’an, Ziyang, Baiyin, Xining |
| 3 resistance       | Rural economy, urban economy, urban (rural) ecology | 15 | |
|                    | Rural economy, urban economy, urban society | 2 | Liaooyuan, Huangshan |
|                    | Urban economy, rural ecology, urban society | 1 | Zhenjiang |
|                    | Rural economy, urban economy, urban society | 1 | Zhoushan |
|                    | Rural economy, urban economy, rural ecology, urban ecology | 3 | Tongliao, Jilin, Nanping |
|                    | Rural economy, urban economy, rural ecology, urban ecology | 2 | Huzhou, Suining |

Among the four resistance modes, Huzhou and Suining are the two cities that need to consider the resistance of urban and rural economy, urban and rural resources and environment; the obstacles of urban and rural social development are relatively small. The urban-rural integrated development of Tongliao, Jilin and Nanping not only faces the obstacles of urban and rural economic efficiency, but these cities must also consider the obstacles of rural social equity and urban resources and environment.

5. Discussion

(1) The analysis results of the mechanism of urban-rural integration in shrinking cities show that a sustainable urban-rural integration relationship is based on economic linkage. Also, the obstacle of urban-rural dual segmentation in shrinking cities not being effectively solved is due to the lack of industrial support of urban-rural linkage. The rural non-agricultural industry foundation is weak, and the urban absorption of the rural surplus labor force has become the main path of the connection between urban and rural areas of shrinking cities. However, the shrinking urban economy and population scale make it difficult for urban development to sustain itself; the absorption capacity of the rural population is even more limited. Therefore, in order to realize the coordinated development of urban and rural shrinking cities in China, we should take the lead to fully demonstrate the relationship between urban and rural industries under the guidance of the concept of smart contraction.

(2) The research of this paper has obvious policy guiding value. According to the spatio-temporal pattern of the urban-rural relationship in the shrinking cities in China, regional differences should be fully considered in terms of both regulation and guidance. Shrinking cities in the old industrial base and mature urban agglomerations should pay attention to the construction of new industries, as well as social and cultural innovation.
and ecological environment improvement. Meanwhile, the peripheral rural areas should protect or adjust the existing urban development pattern, based on future development goals. An industrial access threshold mechanism should be established, and a supporting space for industrial association should be built in the central city. The central city of the resource-based shrinking cities should focus on solving the problems of ecological environment deterioration, urban congestion, and the current low carrying capacity of urban infrastructure. In the future, towns in the peripheral regions should take the development path of smart shrinkage. They should shrink the size of urban development in an orderly way and accelerate the development of modern service industries, in order to strengthen the connection between urban and rural areas. The central city of shrinking cities in remote agricultural areas should focus on strengthening the construction of urban facilities and on protecting the environment. They should also strengthen the industrial connection between urban and rural areas, with agricultural products processing and tourism as the key points.

(3) This paper studies shrinking cities from the perspective of urban and rural space, and expands the research scope of shrinking cities. However, the paper still has some shortcomings. First of all, there are both prefecture-level and county-level shrinking cities in China. However, this paper only analyzes the prefecture-level shrinking cities in China and does not study the county-level shrinking cities, due to the limitation of the ability to acquire data. Secondly, in the construction of the urban-rural coupling coordination index system based on the framework of sustainable development, there are few indicators of urban and rural resources and environment. This is also due to the problem of data availability. This information is expected to be supplemented by continuous observation and research in the future.

6. Conclusions

According to the internal relationship between urban-rural integration and sustainable development, urban-rural integration is essentially a sustainable development within the urban scope, which is effectively the specific embodiment of general sustainable development in the region. China’s shrinking cities have serious sustainable development problems, including weak economic connection between urban and rural areas, unbalanced social and cultural development between urban and rural areas, and disconnection between urban and rural resources and urban and rural environmental protection. Based on the comprehensive selection of analysis indicators from the factors of economic efficiency, resources and environment, and social equality, this study conducts a quantitative analysis of the spatio-temporal evolution of urban-rural integration in shrinking cities, from 2008 to 2018. The results show that:

(1) The urban-rural integration of shrinking cities in China is generally low and develops slowly. The average level of urban-rural integration has been in the low range of (0.3, 0.50). The range of the urban-rural coupling coordination degree increased from 0.1 to 0.12 during the study period, during which time the standard deviation increased from 0.02 to 0.03, and the coefficient of variation remained at 0.06. These findings indicate that the internal development difference of the urban-rural integration level in China’s shrinking cities was not obvious during the study period, and the change was small. At the same time, the urban-rural integration of shrinking cities in China presents a spatial pattern of high in the east and low in the west, and high in the south and low in the north. Moreover, differences exist among different levels of urban agglomerations.

(2) From the perspective of the driving mechanism, the driving factors affecting the urban-rural integration of shrinking cities in China are weak. This is the main reason for the slow evolution of the spatio-temporal pattern of urban-rural integration. Moreover, most of the major influencing factors are from the urban system. This finding indicates that the urban-rural integration of shrinking cities is still in the initial stage of the agglomeration of elements from the periphery to the center. In terms of
specific subsystems, the urban economic subsystem, urban resource and environment subsystem, urban social equity subsystem and rural economic subsystem show an obvious drive, especially urban economic efficiency, which drives most significantly.

(3) The diagnosis of the obstacle factors of urban-rural integration at the indicator layer and subsystem layer in China’s shrinking cities shows that the economic efficiency obstacle to urban-rural integration is the most prominent. Of these factors, the rural economic barrier is stronger than the urban economic barrier, but the former is declining and the latter is increasing. This study also finds that, in cities with a high level of urban-rural integration, the obstacles to urban-rural integration mainly come from the fields of resources, environment or social equity. This finding proves that urban-rural economic interaction is the forerunner and premise of urban-rural integration.

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