

## Article

# Rural Migration and Urbanization in China: Historical Evolution and Coupling Pattern

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**Abstract:** Using a population dataset of China, this study analyzes the spatial pattern of rural migration and urbanization and their coupling coordination relationship and investigates the causes of their spatial heterogeneity. Results show that rural migration and urbanization from 1978 to 2017 can be divided into three stages, i.e., the recovery and development stage, the stable and rapid development stage, and the stage of promoting the citizenization of the rural migrant population. From 2000 to 2010, counties with average annual growth rates of the ratio of rural migration (GRM) ranging from 0 to 5.00% showed a spatial pattern of ubiquitous distribution, while there were significant spatial inequalities in the average annual growth rates of the urbanization rate of the residential population (GUR) and hukou-registered population (GUH). Since urbanization and rural migration are two synergistic processes, coupling coordination degrees (CCDs) between GRM and GRU as well as GRM and GUH were generally between 0.60 and 0.80. Due to the gaps in socioeconomic development, spatial distance, and the policy system, they also showed regional heterogeneity, and there were notable differences in CCD between rural migration and urbanization of residential and hukou-registered populations. Finally, we propose that China should implement targeted and people-oriented measures to guide rural migration, promote new-type urbanization, and achieve integrated urban–rural development.

**Keywords:** rural migration; urbanization; coupling coordination degree; urban–rural relationship; hukou system; China

## 1. Introduction

It is widely acknowledged that rural migration is an inevitable phenomenon in the process of social and economic development [1] and plays an important role in the evolution of urbanization [2]. As the most populous country in the world, China has experienced a rapid increase in its rural migrant population since the early 1980s, when the reform of the household registration (hukou) system was on the agenda [3–5]. In 2017, the number reached 291 million. Generally, the flow direction of migrants is mainly from rural to urban areas. Due to the large number of rural laborers leaving the countryside to work in urban areas, China has undergone the largest and fastest urbanization in the world [6–8]. According to the National Bureau of Statistics of China (NBS), the level of urbanization in China increased from 17.92% in 1978 to 58.52% in 2017 [9]. The rapid urbanization promoted China's transformation from an agricultural to an industrial society and provided a tremendous impetus for its economic development [10].

To scientifically understand rural migration and its interaction with urbanization, many theories have been proposed to construct a theoretical framework for these analyses—notably, the dual economy model, developed by Lewis [11], and its extensions, made by Jorgenson [12], Ranis and Fei [13], and Kelley et al. [14]. Moreover, the most influential model was suggested by Todaro [15] and was further extended by Harris and Todaro [16] and Corden and Findlay [17]. The models assume that rural migration proceeds in response to the employment opportunities available in urban areas and the expected urban–rural income gaps. These studies provide useful references for understanding rural migration and urbanization, effectively promoting urban–rural sustainable development.

In general, urbanization is a comprehensive concept which mainly includes the transformation of individual identity, land use, and industrial structure [18–20]. From the point of view of demography, urbanization is a dynamic process of transforming rural populations into urban populations, such that rural-to-urban migrants represent an important component of urban populations [21–23]. Regarding land use, a village is a geographical space dominated by agricultural land, while a city is dominated by construction land. To meet the needs of the growing rural-to-urban migrant population, urban space is constantly expanding, and farmland near urban areas is being converted into construction land, thus promoting the development of urbanization [7,24–26]. From 2000 to 2010, the contribution rates of rural-to-urban migration and construction land expansion to the development of urbanization in China were approximately 30% and 65%, respectively [27]. In addition, economists hold the view that urbanization refers to the process of transforming traditional agricultural cultivation into large-scale socialized production; thus, the industrial and employment structure changes from agriculture to non-agricultural industry [28]. During this process, rural–urban migrants provide a large amount of labor force for industrial development [29] and broaden the market space [30,31]. The analyses above indicate that rural migration promotes urbanization in multiple ways. On the one hand, the advantages originating from factors agglomeration and location conditions make urban areas attractive to the rural population [32]; on the other hand, the driving effect of urban areas on rural population become increasingly apparent with the spillover of polarization effect [33].

Cities and villages are interdependent—only when both achieve sustainable development can they support each other [34]. However, influenced by the GDP-oriented performance appraisal system, urbanization in China has been instrumentalized for a long time, and local governments pay more attention to the speed of urbanization than to the quality [35,36]. In addition, rural migrants, who are important parts of the urban residential population, have no access to civil rights because of the segmentation of the hukou system, causing the universal semi-urbanization and urban–rural wandering [37–39]. Thus, urbanization in China presents an unhealthy state of low level and poor quality, and rural decline has become a common issue, both of which make it difficult to support the sustainable development of urbanization [34,40,41]. To solve these problems and promote urban–rural integrated development, new-type urbanization, which is people-oriented, has become a practical choice for the Chinese government [35,42]. Since the urban–rural dual structure still exists, large-scale rural migration remains the outstanding limitation of new-type urbanization and restricts the realization of rural revitalization. Essentially, rural migration and urbanization are two synergistic processes; the decrease in rural population in a certain area means the development of urbanization. However, there are differences in the regional relationship between rural migration and urbanization in China due to the hukou system and location conditions. Therefore, it is necessary to investigate the coupling spatial patterns of the two processes and explore mechanism behind them. The findings of this study will provide a scientific basis to guide the decision-making to promote China’s new-type urbanization and rural revitalization in the new era.

The rest of this article is structured as follows. Section 2 introduces the data and methodology. Then, based on the analysis of evolution of rural migration and urbanization in China from 1978 to 2017, this study reveals the spatial pattern and coupling coordination degrees in Section 3. Section 4 discusses main causes of the spatial differentiation and investigates some key issues for promoting

urban and rural sustainable development against the background of large-scale rural migration and rapid urbanization, and we present concluding remarks and policy implications in Section 5.

## 2. Materials and Methods

### 2.1. Materials

This study makes full use of the data on rural migration and urbanization in China at national and county level. Data on demographic structure and population growth at the national level since the reform and opening-up are collected from the China Population Statistics Yearbook [43] and the China Population and Employment Statistics Yearbook [44]. Demographic data at the county level in 2000 and 2010 are derived from tabulation of the 2000 and 2010 Population Census of the People's Republic of China by County, respectively [45]. The data on the administrative division in 2010 are available at the Resource and Environment Data Cloud Platform [46] and are adjusted to be in accordance with those of 2000. In this study, the migrant population refers to those who do not live in their hukou-registered places for at least half a year, and those who have migrated to urban or rural areas and have obtained the local hukou are not included in the migrant population. Meanwhile, Arc GIS is used to perform the calculations and represent them graphically.

Considering the research design, units without rural/urban populations, as well as Hong Kong, Macao, and Taiwan, are excluded from this study; thus, 2435, 2787, and 2758 units are obtained to analyze rural migration, as well as the urbanization of hukou-registered and residential population, respectively. Due to the spatial heterogeneity of economic development, China can be divided into four parts, namely the eastern, central, western, and northeastern regions (Figure 1). Specifically, the eastern region includes Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan; the central region includes Shanxi, Henan, Anhui, Hubei, Hunan, and Jiangxi; the western region includes Guangxi, Guizhou, Chongqing, Sichuan, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Inner Mongolia; and the northeastern region includes Heilongjiang, Jilin, and Liaoning [47].



**Figure 1.** Administrative divisions of China and the four economic regions.

## 2.2. Methods

### 2.2.1. Measurement of Rural Migration and Urbanization

Rural migration and urbanization are two dynamic processes. The former refers to the spatial movement of the rural population [48], and the latter refers to the increase in urban population in the total population [20]. In line with the research objectives, this study employs the average annual growth rate of the ratio of migrant population (GRM) to reflect the situation of rural migration, and the calculation formula is as follows:

$$GRM_i = \sqrt[m-n]{RRM_i^m / RRM_i^n} - 1 = \sqrt[m-n]{(RHP_i^m / RRP_i^m) / (RHP_i^n / RRP_i^n)} - 1 \quad (1)$$

where  $RRM$  denotes the ratio of rural migrants,  $RHP$  and  $RRP$  are the rural hukou-registered and residential populations, respectively;  $m$  and  $n$  are time nodes, and  $i$  is the research unit. Accordingly, the urbanization of unit  $i$  in a specific period can be measured by the average annual growth rate of urbanization rate ( $GRU$ ), and its formula is

$$GRU_i = \sqrt[m-n]{UR_i^m / UR_i^n} - 1 = \sqrt[m-n]{(UP_i^m / TP_i^m) / (UP_i^n / TP_i^n)} - 1 \quad (2)$$

where  $UR$  refers to urbanization rate;  $UP$  and  $TP$  denote the urban population and total population, respectively. Due to the hukou system, there are two demographic standards in China, i.e., hukou-registered and residential populations. Therefore,  $GRU$  can be further divided into annual average growth rate of the urbanization rate of hukou-registered population ( $GUH$ ) and residential population ( $GUR$ ) [49].

### 2.2.2. Coupling Coordination Degree Model

Coupling is a physical concept which refers to the interaction between two or more things [50]. Recently, it has been widely used in studies of social sciences to investigate issues such as the relationship between urbanization and environment [51,52] and the connection between population growth and economic development [53]. In this study, the relationship between rural migration and urbanization through the interaction of elements is defined as the coupling system of rural migration and urbanization, and the coefficient of the coupling system can be calculated as follows:

$$C = 2 \times \left[ (GRM_i \times GRU_i) / (GRM_i + GRU_i)^2 \right]^{1/2} \quad (3)$$

where  $C$  is the coupling coefficient and belongs to the interval of [0.00, 1.00]. Furthermore, the coupling coordination degree ( $CCD$ ) is employed to measure the consistency between the two subsystems of rural migration and urbanization, and it can be specified as follows:

$$D = \sqrt{C \times T} = \alpha GRM_i + \beta GRU_i \quad (4)$$

where  $D$  and  $T$  denote the  $CCD$  and the comprehensive level of the two subsystems;  $\alpha$  and  $\beta$  are the contribution rates of the two subsystems when measuring  $T$ . Since rural migration is as important as urbanization, the values of  $\alpha$  and  $\beta$  are both 0.5. According to the value of  $D$  and related research [51,54],  $CCD$  between rural migration and urbanization can be divided into three types and six subtypes (Table 1).

**Table 1.** Classification of coupling coordination degree between rural migration and urbanization.

Type	Unbalanced Development		Transitional Development		Balanced Development	
Subtype	Seriously Unbalanced Development	Moderately Unbalanced Development	Slightly Unbalanced Development	Barely Balanced Development	Superiorly Balanced Development	Favorably Balanced Development
<i>D</i>	$0 < D \leq 0.2$	$0.2 < D \leq 0.4$	$0.4 < D \leq 0.5$	$0.5 < D \leq 0.6$	$0.6 < D \leq 0.8$	$0.8 < D \leq 1.0$

### 2.2.3. Spatial Autocorrelation Analysis

Spatial autocorrelation refers to the spatial interaction of different objects in different regions, and objects in proximity are more closely related than distant ones [55]. Here, Moran's indexes, including global Moran's *I* and local Moran's *I*, are employed to explore the regional differentiation of CCD between rural migration and urbanization. Specifically, global Moran's *I* is the earliest method adopted for the global clustering test, which detects the patterns and levels of spatial clustering among neighboring objects and is given as follows [56]:

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})^2} = \frac{\sum_{i=1}^n \sum_{j \neq i}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{S^2 \sum_{i=1}^n \sum_{j=1}^n w_{ij}} \quad (5)$$

where *n* is the number of research units;  $x_i$  and  $x_j$  are the attribute values of units *i* and *j*,  $\bar{x}$ , and  $S^2$  are the average and variance of *x*, respectively;  $w_{ij}$  is the spatial weight matrix, where  $w_{ij} = 1$  if units *i* and *j* share at least one border and zero otherwise.

Local Moran's *I*, also known as the local indicator of spatial association (*LISA*), is used to check whether there are similar or different observed values gathering within a certain area [57]. The *LISA* of spatial unit *i*, which reflects the degree of spatial correlation between unit *i* and its neighboring units, is defined as follows:

$$I_i = \sum_{j \neq i} w_{ij} (x_j - \bar{x}) \times (x_i - \bar{x}) / S^2 \quad (6)$$

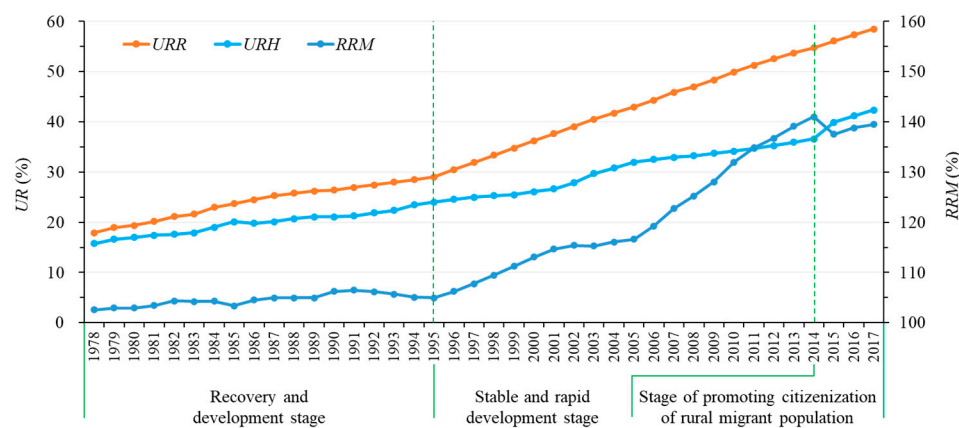
If  $I_i$  is positive, then it means that the unit with high value is surrounded by units with high values or the unit with low value is surrounded by units with low values; otherwise, it means that the unit with high value is surrounded by units with low values or the unit with low value is surrounded by units with high values.

## 3. Results and Analysis

### 3.1. Rural Migration and Urbanization in China

The gradual deepening of reform and opening-up has promoted population movement in China. Figure 2 exhibits the evolution of rural migration and urbanization in China from 1978 to 2017. It is obvious that both *RRM* and *UR*, including the urbanization rate of residential (*URR*) and hukou-registered populations (*URH*), show upward trends, and there are different features in different periods. Specifically, the growth rate of *URR* after 1995 was significantly faster than that before 1995; the growth rate of *URH* remained relatively stable before 2014, but it has accelerated since then; *RRM* remained at a low level before 1995 and then developed rapidly, but it has shown a negative trend since 2014. According to the evolutionary characteristics of *RRM* and *UR* from 1978 to 2017, rural migration and urbanization in China can be divided into three stages, i.e., the recovery and development stage, the stable and rapid development stage, and the stage of promoting the citizenization of rural migrant population.





**Figure 2.** Evolution of rural migration and urbanization in China from 1978 to 2017. The green lines are the dividing lines of three stages.

### 3.1.1. Recovery and Development Stage (1978~1995)

China's domestic reform realized the gradual transformation from a planned economy to a market economy, which led to the rapid development of the urban–rural economy [58]. In this context, labor shortage in urban areas made rural-to-urban migration increase rapidly, and the hukou system restricting population migration was gradually loosened by virtue of policies such as *nongzhuanfei* (converting the nature of hukou from agricultural to non-agricultural), thus promoting the development of urbanization [59]. However, affected by the rooted urban–rural dual structure, rural migration was seriously limited by scale, and the loosening of the hukou system was confined to small towns. In this period, *RRM* only increased from 102.55% to 104.98%, with an average annual growth rate of 0.14%; *URR* and *URH* developed from 17.92% and 15.80% to 29.04% and 24.00%, respectively, and the gap between the two remained relatively stable and small.

### 3.1.2. Stable and Rapid Development Stage (1995~2014)

The establishment and improvement of the market economy calls for further development of system reform, especially the hukou system, to meet the needs of industrialization and urbanization [60]. Therefore, the central government abolished the dual division of agricultural and non-agricultural hukou and established three household registration systems, i.e., residential hukou, temporary hukou, and lodging hukou. Entering the 21st century, the government continually explored the construction of a unified hukou system in urban and rural areas. In addition, hukou system reform in small towns was carried out from pilot trials to full-scale implementation and has been applied to small and medium-sized cities since 2008. These reforms shifted the primary functions of the hukou system from migration control to social management and demographic statistics, promoting population migration from rural to urban areas and from backward to developed areas [59]. As a result, China's *RRM*, *URR*, and *URH* increased to 141.04%, 54.77%, and 36.63% in 2014, with average annual growth rates of 1.57%, 3.40%, and 2.25%, respectively, and the gap between *URR* and *URH* increased from 5.04% in 1995 to 18.14% in 2014.

### 3.1.3. Stage of Promoting Citizenization of Rural Migrant Population (2014~2017)

Since social welfare, the core of citizenship, was not included in the hukou system reform, China's urban–rural and *URR*–*URH* gaps continued to widen, which seriously hindered social and economic sustainable development [61]. To solve this critical problem and improve the quality of urbanization, the National New-Type Urbanization Plan (2014–2020) was put forward in March 2014 [62]. This plan gave priority to people, promoted the citizenization of rural migrants with the ability to obtain stable employment and sustainable livelihood in urban areas, and finally achieved the goal of extending basic public services to fully cover the urban residential population and letting people share the fruits

of reform and development. These practices helped to improve the quality of industrialization and urbanization and provided solutions for the principal contradiction of unbalanced and insufficient development, especially the unbalanced urban–rural development and insufficient rural development. In this stage, *RRM* showed a negative development trend due to the accelerated citizenization of rural migrants; *URR* increased steadily, while the growth rate of *URH* accelerated remarkably and was significantly greater than that of *URR*; thus, the gap between them dropped from 18.14% in 2014 to 16.17% in 2017.

### 3.2. Spatial Patterns of Rural Migration and Urbanization

Based on the data of rural migration and urbanization at county level from 2000 to 2010, spatial patterns of *GRM*, *GUR* and *GUH* are analyzed (Figure 3). In terms of the regional differentiation of *GRM*, the values of *GRM* in 82.25% of the counties in China ranged from 0% to 5.00%, and there were 316 counties with a *GRM* less than 0, which were mainly distributed in Xinjiang, Tibet, Northeastern China, and areas of Guangdong other than the Pearl River Delta. According to calculations, *GRM* in Xiqing of Tianjin was the smallest, followed by Eergu'Na and Genhe in Inner Mongolia, and the top three values of *GRM* were in Holingol (Inner Mongolia), Beidaihe (Hebei), and Shunde (Guangdong). The regional differences in *GUR* and *GUH* from 2000 to 2010 were more significant than the differences regarding rural migration. Specifically, there were 568 counties with a *GUR* less than 0 and 296 counties with a *GUR* greater than 10.00%; both showed the characteristics of a relatively scattered distribution. Moreover, there were four counties with an average annual growth rate above 30.00%, which were Gaoyi and Nanhe (Hebei), Yuanyang (Henan), and Linxia (Gansu); on the other end of the spectrum, there were six counties with a *GUR* less than −10.00%, and they were Hetian and Urho (Xinjiang), Yanshan (Guangxi), Sanshan (Anhui), Langkazi, and Longzi (Tibet). Regarding *GUH*, the values of 26.80% of the counties were below 0, which showed a characteristic of dispersion as a whole and agglomeration in the local area; Sanshan and Yindong in Anhui Province and Qinghe in Hebei Province were the only three counties with *GUH* less than −10.00%; the counties with *GUH* greater than 10.00% were mainly distributed in Sichuan Basin, Xinjiang, and Tibet.

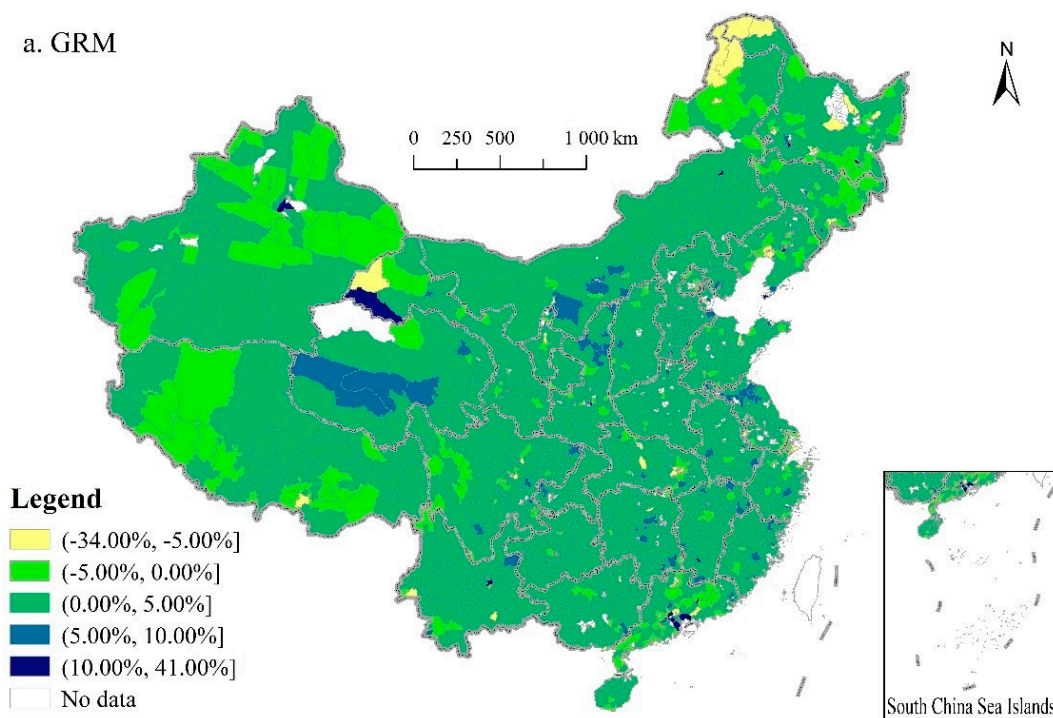
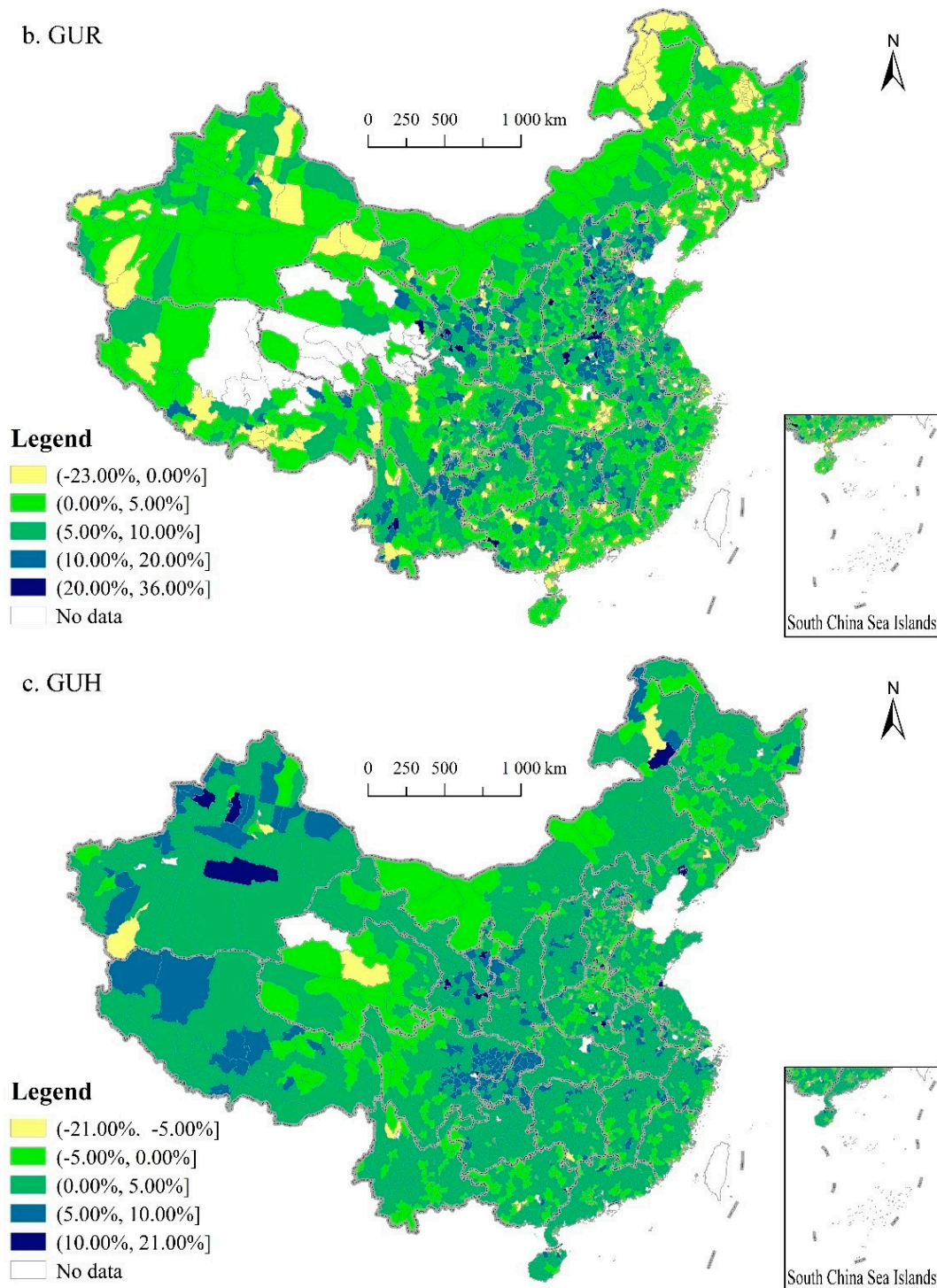


Figure 3. Cont.



**Figure 3.** Spatial patterns of China's rural migration and urbanization at county level from 2000 to 2010.

Furthermore, this study analyzed the spatial inequality of rural migration and urbanization in China from the perspective of economic regionalization (Table 2). Although the migration of the rural population from 2000 to 2010 was gradually liberalized, the existence of the urban–rural dual hukou system made the *GRM* of most counties in the four economic regions range from 0% to 5.00%, and there were a large proportion of counties located in the interval of  $(-5.00\%, 0]$  especially in Northeastern China. Meanwhile, due to the restrictions of the hukou system and other factors, *GUH* was slow, and the regional difference was not significant. However, *GUR* was significantly faster than *GUH*,



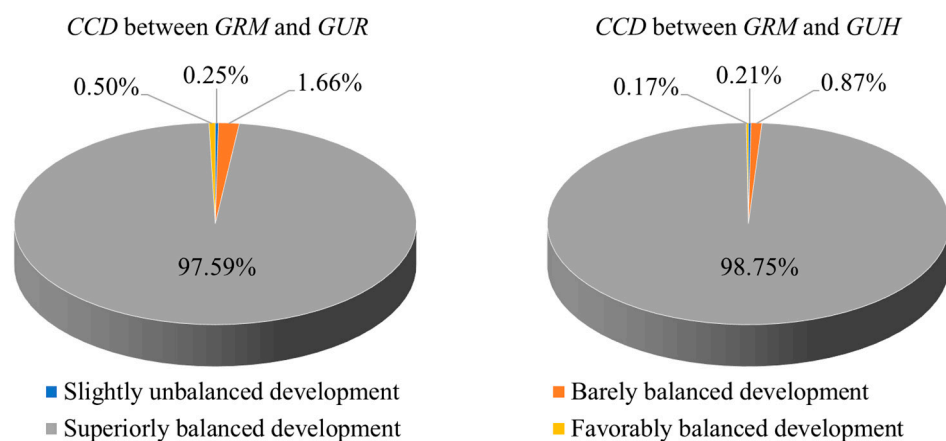
and *GUR* in Northeastern China was significantly slower than that in other regions due to its sustained economic weakness. Specifically, *GUH* at county level in the four regions mainly ranged from 0% to 5.00%; additionally, there were some counties with a *GUH* ranging from −5.00% to 0% in Eastern, Central, Western, and Northeastern China, representing 32.18%, 24.49%, 19.42%, and 37.49% of the counties in these regions, respectively. Regarding the *GUR*, 65.42%, 69.12%, 74.16%, and 58.51% of the counties in Eastern, Central, Western, and Northeastern China were distributed in the interval of (0, 10.00%], respectively. Moreover, the proportion of counties with *GUR* less than zero was 41.49% in Northeastern China, followed by 23.10% in Eastern China, 18.12% in Central China, and 14.75% in Western China.

**Table 2.** Statistics of China's rural migration and urbanization in the four economic regions.

	Grade	Eastern China	Central China	Western China	Northeastern China	Total
<i>GRM</i> (Average annual growth rate of the ratio of migrant population)	(−34.00%, −5.00%)	2.40%	1.67%	1.40%	6.16%	2.14%
	(−5.00%, 0.00%)	11.52%	5.33%	11.52%	21.33%	10.85%
	(0.00%, 5.00%)	80.00%	88.33%	83.17%	67.30%	82.25%
	(5.00%, 10.00%)	4.80%	4.33%	3.41%	1.90%	3.86%
	(10.00%, 41.00%)	1.28%	0.33%	0.50%	3.32%	0.90%
<i>GUR</i> (Average annual growth rate of the urbanization rate of residential populations)	(−23.00%, 0.00%)	23.10%	18.12%	14.75%	41.49%	20.59%
	(0.00%, 5.00%)	42.86%	33.19%	42.62%	52.48%	41.33%
	(5.00%, 10.00%]	22.56%	34.93%	31.53%	6.03%	27.34%
	(10.00%, 20.00%)	10.28%	12.32%	10.32%	0.00%	9.75%
	(20.00%, 36.00%)	1.20%	1.45%	0.77%	0.00%	0.98%
<i>GUH</i> (Average annual growth rate of the urbanization rate of hukou-registered populations)	(−21.00%, −5.00%)	1.07%	0.72%	0.75%	0.71%	0.83%
	(−5.00%, 0.00%)	32.18%	24.49%	19.42%	37.94%	25.98%
	(0.00%, 5.00%)	63.15%	68.26%	67.17%	59.57%	65.59%
	(5.00%, 10.00%)	3.20%	5.65%	11.44%	0.71%	6.71%
	(10.00%, 21.00%)	0.40%	0.87%	1.22%	1.06%	0.90%

### 3.3. Coupling Pattern of Rural Migration and Urbanization

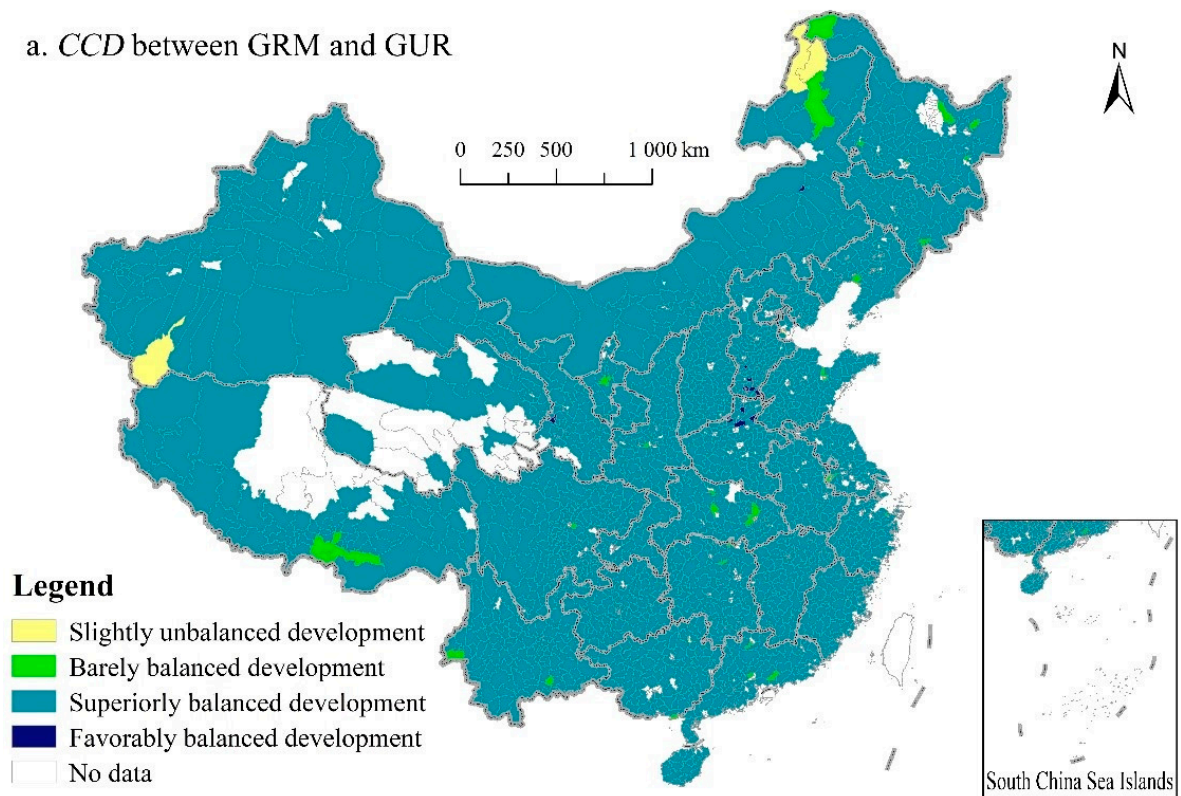
In consideration of the differences between the urbanization of hukou-registered and residential populations, both *CCD* between *GRM* and *GUR* and *CCD* between *GRM* and *GUH* from 2000 to 2010 are calculated. To meet the needs of the study, county-level administrative units without rural or urban populations are excluded, and a total of 2404 research units are obtained. Figure 4 shows that *CCD* between *GRM* and *GUR* in 97.59% of the counties ranged from 0.60 to 0.80, which meant that they belonged to the type of superiorly balanced development, and the proportion of counties with *CCD* between *GRM* and *GUH* belonging to this type was 98.75%. To a large extent, rural migration and urbanization are coordinated development and mutual promotion. Concerning the means, the average of *CCD* between *GRM* and *GUR* was 0.69, which was higher than that between *GRM* and *GUH*. From the perspective of spatial distribution, the superiorly balanced development of both presented the characteristics of universal distribution throughout the country, while other types were small in quantity and scattered in distribution (Figure 5a,b).



**Figure 4.** Statistics of the types of coupling coordination degree between rural migration and urbanization.

Furthermore, Moran's I statistic of CCD at county level was employed to reveal the geographic pattern of CCD between rural migration and urbanization in China. Results showed that the global Moran's I of CCD between GRM and GUR as well as CCD between GRM and GUH from 2000 to 2010 were 0.2644 and 0.2136, respectively, and both passed the significance tests at the 1% level, which indicates that there were positive spatial autocorrelation and significant spatial agglomeration of CCD. In addition, local Moran's I or LISA of CCD at county level was examined to determine whether there was spatial autocorrelation in local space [57]. The LISA cluster map shows that there were distinct spatial agglomeration features in CCD between rural migration and urbanization (Figure 5c,d). Specifically, there were 763 counties with a high-high cluster (HH) pattern of CCD between GRM and GUR, which were mainly located in Huang-Huai-Hai Plain, Loess Plateau, Western Yunnan-Guizhou Plateau, Eastern Sichuan Basin, as well as Western Hubei and most of Hunan; the number of counties with a low-low cluster (LL) pattern was 397, mainly distributed in Northeastern and Southern China, Southern and Eastern Xinjiang, Western Sichuan Plateau, and Southern Tibet. Additionally, there were 89 and 336 counties presenting a spatial pattern of high-low (HL) and low-high outlier (LH), respectively. The former was scattered in the periphery of the counties with an LL pattern, and the latter was characterized by a staggered distribution with HH pattern counties. Regarding the spatial pattern of CCD between GRM and GUH, the number of counties with HH and LL patterns was 491 and 495, respectively, where the former was concentrated in Northern Xinjiang, Loess Plateau, Sichuan Basin, Eastern Yunnan-Guizhou Plateau, and the middle and lower reaches of the Yangtze River Plain, and the latter was mainly distributed in Northeastern and Southern China, Huang-Huai-Hai Plain, and the mountainous borderland of Western Yunnan. Meanwhile, there were 199 and 190 counties with HL and LH patterns, which were staggered with low-value counties and high-value counties, respectively.

a. CCD between GRM and GUR



b. CCD between GRM and GUH

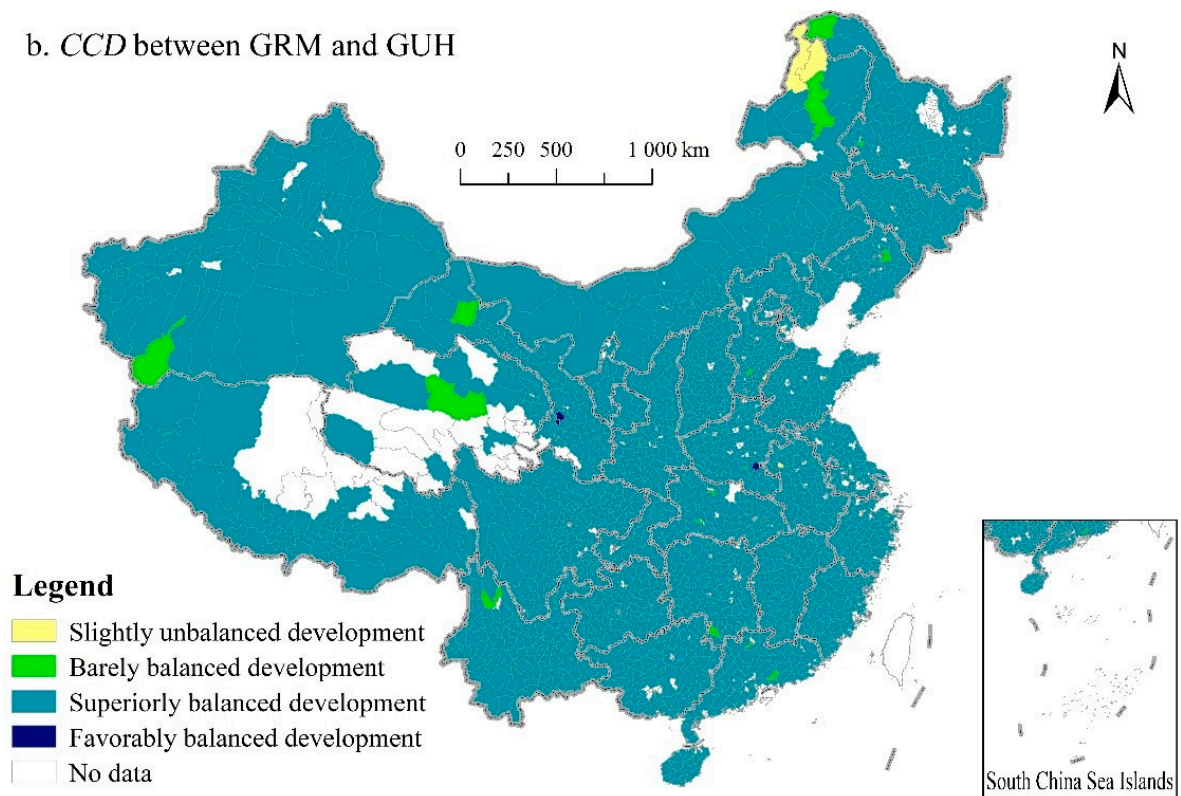
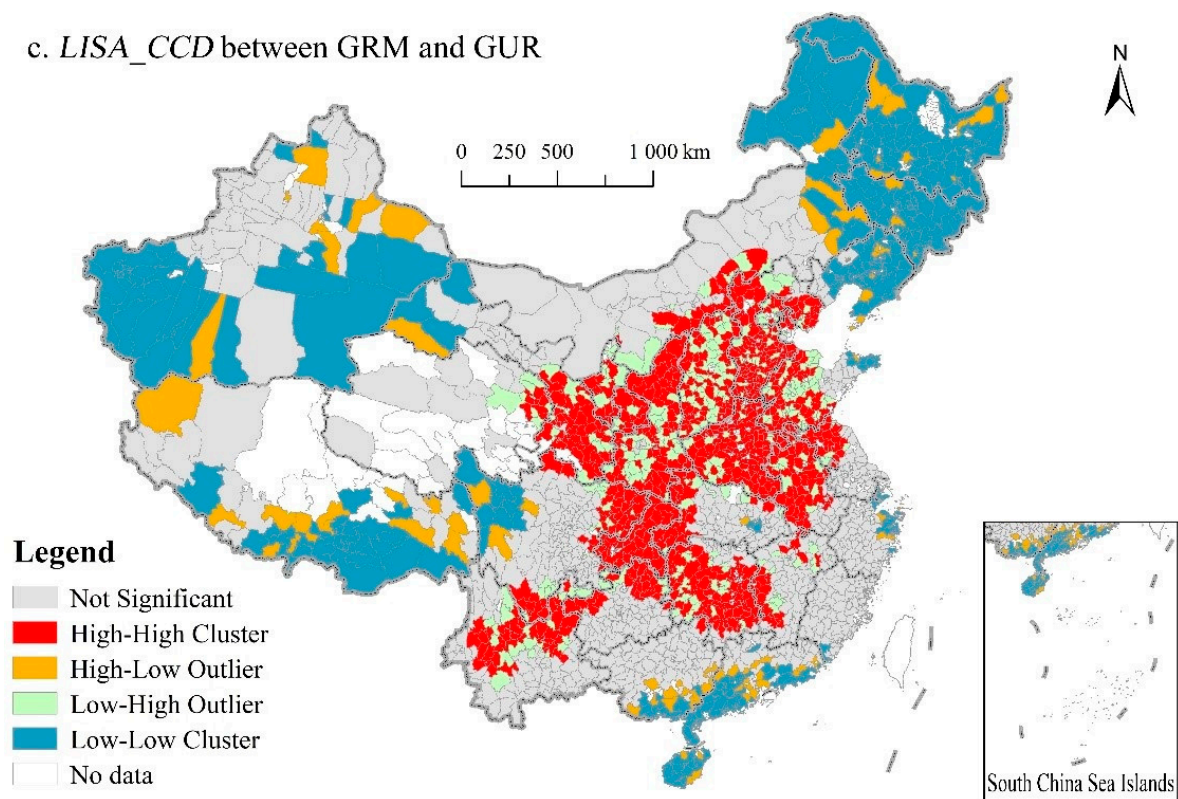
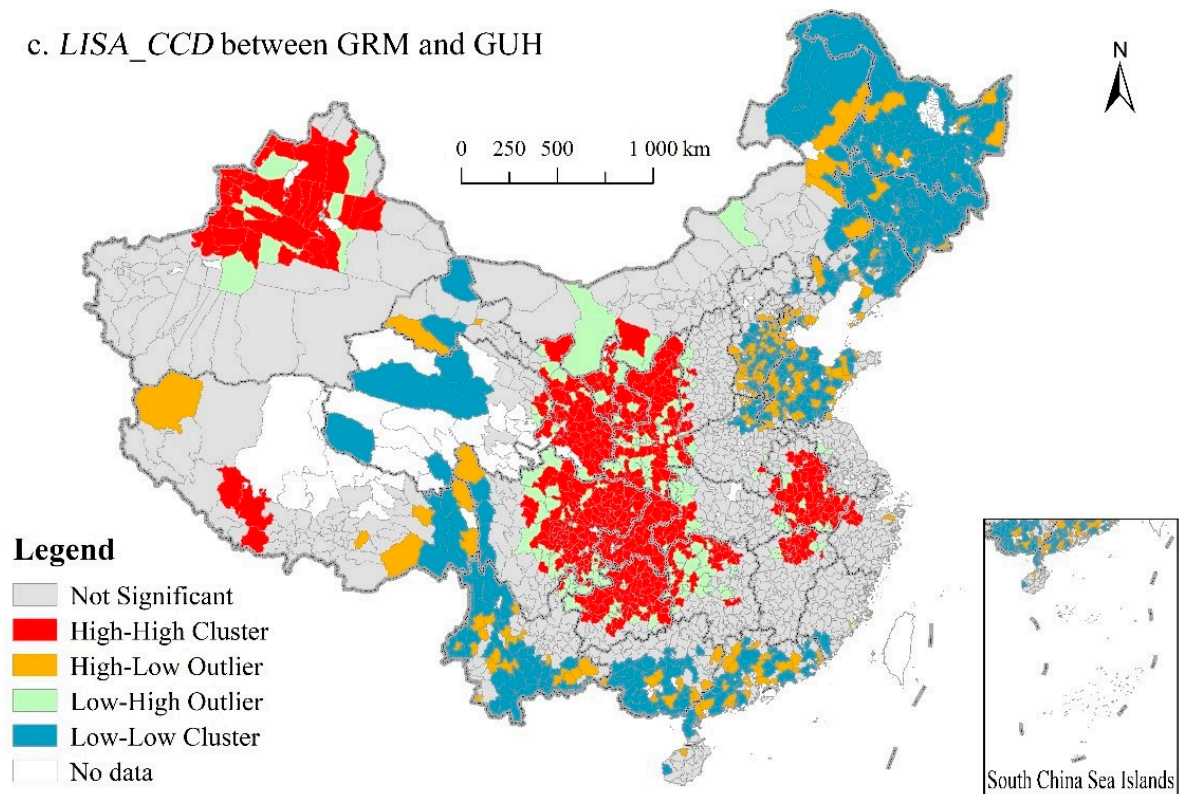


Figure 5. Cont.



c. *LISA\_CCD* between GRM and GURc. *LISA\_CCD* between GRM and GUH**Figure 5.** Spatial pattern of the coupling coordination degree between rural migration and urbanization.



## 4. Discussion

### 4.1. Results Discussion

In general, there are inherent laws in population migration, such as distance decay and bidirectional flow [63]. Most rural migrants usually move to urban areas nearby, and only when the benefits are high enough will they make the decision to migrate to a farther place. Meanwhile, population migration from rural to urban areas promotes the development of urbanization through labor supply and market demand [15,64], and urbanization is essentially a process of factor agglomeration [31], which not only creates more jobs but also provides diversified services. These increase the attractiveness of cities and towns to rural migrants [65–67], forming a development cycle of rural migration and urbanization. Due to the relationship of mutual promotion between rural migration and urbanization, there are positive correlations between *GRM* and *GUR* as well as *GRM* and *GUH*, and their states of coupling coordination degree within most counties belong to the type of balanced development, which means that the faster the rural population emigrates, the faster the regional urbanization develops. However, due to the division of the hukou system, the urbanization of the hukou-registered population seriously lags behind that of the residential population; thus, the *CCD* between *GRM* and *GUH* is generally smaller than that between *GRM* and *GUR*.

As a result of the regional differences in geographic conditions and socioeconomic development, there are significant spatial imbalances in the *CCDs* between *GRM* and *GRU* as well as *GRM* and *GUH* from 2000 to 2010. The background of physical geography is the basic condition of population migration [68] and plays its role through affecting the willingness and difficulty of migration. From the perspective of economic development, the purpose of people's migration is to achieve higher incomes to meet their various needs [69,70], especially education and healthcare. The higher the level of economic development in a region, the more migrant workers flow into this region, the quicker the urbanization develops, and the fewer local farmers flow out. From this point of view, *CCDs* in the developed eastern region, which is the primary destination of rural migrants, are generally lower than those in central and western regions. The presence of roads which connect different areas is another important reason for the spatial heterogeneity of *CCDs*. Meanwhile, institutional variables, including regional development policies and hukou system reform, promote population migration [71]. The former strengthens the unbalanced pattern of China's economic development, and the latter releases the controls over population migration. In addition, *CCDs* are also influenced by the level of urbanization at the starting point [72].

In Eastern China, the Lingnan region is strongly influenced by the Pearl River Delta, and many rural populations migrate to the developed bay area, which results in relatively low coupling coordination between the urbanization and rural migration within a county; due to the limitations of the hukou system, many rural migrants do not gain urban hukou; thus, *CCD* between *GRM* and *GUR* in the Huang-Huai-Hai area shows a characteristic of high-value cluster, while *CCD* between *GRM* and *GUH* shows characteristics of a low-value cluster. Promoted by transport improvement and demand for improved living conditions, the rapid migration of the rural population to urban areas in Shanxi, Henan, and Hunan makes the *CCD* between *GRM* and *GUR* generally high; the urbanization of the hukou-registered population in Anhui in 2000 was low, but it developed rapidly with the rapid development of the Wanjiajiang economic belt and the promotion of hukou system reform, and in response, the *CCD* between *GRM* and *GUH* is high. The level of urbanization in Northeastern China is relatively high, and the rural population is relatively stable, but its urbanization develops slowly because of the economic recession, such that *CCDs* there are significantly lower than in other areas. In Western China, there are comparative advantages in the locations of Shaanxi, Ningxia, Chongqing, East Gansu, East Sichuan, and other areas; thus, urbanization in these areas develops rapidly, and many rural populations outflow under the influence of county urbanization and regional growth pole, resulting in high values of *CCD* between rural migration and urbanization. Meanwhile, restricted by the natural and geographical conditions, urbanization in Xinjiang and Qinghai-Tibet Plateau develops

slowly, and the scale of rural migration is small, thus forming the low-low cluster of *CCDs* between *GRM* and *GUR*. However, on the northern slopes of the Tianshan Mountains, the good conditions make many rural populations turn into urban populations; thus, *CCDs* between *GRM* and *GUH* are higher here than in surrounding areas.

#### 4.2. Rural Migration and Urbanization

Rural migration and urbanization are inevitable trends in population evolution [20,73] and show characteristics of coordinated development [66]. Most countries in the world are experiencing these two processes regardless of their development stage and will continue to do so for a long time [2,21,74–76]. Previous related studies have been mainly conducted at the macro-provincial or national level and investigate the influence of rural migration on urbanization [2,66,77] or the role of urbanization in rural migration [2,78], with a lack of attention devoted to the coupling coordination pattern between the two processes [72]. China is still the largest developing country; its urbanization will continue to develop rapidly and, due to the urban–rural and regional disparities, the scale of rural-to-urban and west-to-east migration will remain large. Moreover, the existence of the hukou system makes rural migration and urbanization in China present some unique characteristics, especially the difference between hukou-registered and residential populations. Therefore, it is helpful to discuss rural migration and urbanization from the perspective of coupling coordination patterns to grasp the critical shortcomings in urban and rural population evolution and promote regional sustainable development.

Rural migration is a double-edged sword. Moderate mobility of rural populations is conducive to the coordinated and sustainable development of urban and rural areas by optimizing resource allocation, thus boosting urban–rural integration, while serious problems will arise since excessive rural-to-urban population migration leads to imbalances in the human–environment relationship in urban and rural areas. Specifically, when the population concentration exceeds the carrying capacity of the city, it will cause urban diseases, such as environmental pollution and traffic congestion, and, influenced by the shortage of livelihood capital, a large number of rural migrants will gather in low-standard and high-density geographic spaces, especially urban villages and shanty towns [7,79]. Moreover, since rural migrants do not have urban hukou, they experience social exclusion and cannot fully enjoy urban social welfare [80]. These factors reduce the quality of urbanization in China, especially in the Pearl River Delta, Yangtze River Delta, and Beijing-Tianjin. To promote urbanization, new-type urbanization, which is people-oriented, has become the choice of the Chinese government. On the other hand, large rural-to-urban migration results in the hollowing of the countryside [41,81]. As a result, population aging and abandonment of arable land are becoming increasingly prominent in rural areas, which not only restricts rural sustainable development but also weakens the foundation of urbanization [49]. In this context, a rural revitalization strategy was put forward in the 19th session of the National Congress of Communist Party of China (CPC) to achieve the goal of integrated urban–rural development and became the guideline for the issues concerning agriculture, countryside, and farmers in the new era.

### 5. Conclusions and Policy Implications

Cities and villages are two distinct but closely related spatial units [34]. Here, we investigated the evolution of rural migration and urbanization in China from 1978 to 2017 and divided it into three stages, i.e., the recovery and development stage (1978–1995), the stable and rapid development stage (1995–2014), and the stage of promoting the citizenization of the rural migrant population (2014–2017). Counties with *GRM* ranging from 0% to 5.00% in 2000–2010 showed a spatial pattern of ubiquitous distribution, while there were obvious regional differences in *GUR* and *GUH*. The average of *GUR* at county-level from 2000 to 2010 was higher than that of *GUH*, and *GUR* in Northeastern China was significantly slower than that of other regions. Due to the mutually reinforcing relationship between *GRM* and *GRU*, *CCDs* between *GRM* and *GRU* as well as *GRM* and *GUH* were generally in the interval of (0.6, 0.8], which means that they were in the state of superiorly balanced development. Regional

inequality, geographical distance, and the hukou system were the main factors influencing the spatial differentiation of rural migration and urbanization and their CCDs. This study only considers the changes in the overall level of mobility when measuring rural migration and does not consider the structure of immigration and emigration. In future studies, the destination structure of rural migration, especially considering those who migrate to urban areas, should be investigated to fully understand the contribution of rural migration to urbanization in a region. Moreover, due to the availability of research data, the materials used in this study are not up to date; thus, it needs to be supplemented with data from the new round of the population census in 2020.

Due to the urban–rural dual hukou system, urbanization of the hukou-registered population in China has seriously lagged behind that of the residential population for a long time [49]. In addition, rural migration is facing many problems in the process of rapid urbanization, which are mainly manifested in the large scale of rural-to-urban migration and the low degree and high cost of the citizenization of rural migration [82]. It is estimated that the total number of rural migrants who need to be transformed into urban citizens will be nearly 390 million in 2030 [83]. To address these problems and promote integrated development of urban and rural areas, targeted measures should be implemented. Firstly, it is urgent to deepen hukou system reform and establish a unified household registration system in urban and rural areas, thus releasing restrictions on obtaining urban hukou and improving the urbanization rate of the hukou-registered population. Secondly, governments should strengthen their vocational skills training to ensure that rural migrants can settle down stably in urban areas and gradually transform into urban citizens. In addition, these measures will help to solve the problem of urban–rural wandering. Thirdly, it is necessary to establish a residence permit system to promote the full coverage of basic public services and social security in urban areas across the residential population and realize the peaceful living and working of rural migrants. In addition, since a city is developed from a village, rural population outflow needs to be guided to alleviate human–environment conflicts, laying a solid foundation for realizing the goal of agricultural and rural modernization and improving the quality of urbanization. Overall, the eastern coastal areas, especially the Yangtze River Delta, the Pearl River Delta, and Beijing–Tianjin region, should pay more attention to promoting the citizenization of the transfer population and urban–rural integration, while the central and western regions need to strive for rural revitalization and promote the simultaneous improvement of the quantity and quality of urbanization.

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