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Changing Rural Development Inequality in Jilin Province, Northeast China

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Abstract: Rural development inequality is an important practical issue during the course of full establishment of a ′moderately well-off society′ in modern China, and the objective understanding and evaluation of the status and regional inequality of rural development can provide scientific basis for ′building a new countryside′ and coordination development of rural-urban regions. Based on the county-level data of 2000, 2005 and 2009, this paper examines the rural development inequality of Jilin Province in Northeast China by establishing a rural development index. The spatio-temporal dynamic patterns and domain factors are discussed by using the method of exploratory spatial data analysis and multi-regression model. The results are shown as follows. Firstly, most of the counties were in lower development level, which accounted for 58.3%, 62.5% and 66.7% of the total counties in 2000, 2005 and 2009, respectively. The characteristics of spatial inequality were very obvious at county level. For example, rural development level of Changchun Proper and the proper of seven prefecture-level cities were much higher than that of the surrounding regions. The counties in the eastern and northern Jilin Province were the lowest regions of rural development level, while the middle counties were the rapid growth areas in rural economy. Secondly, Moran′s I of rural development index (RDI) was 0.01, –0.16 and –0.06 in 2000, 2005 and 2009, respectively, which indicated that spatial agglomeration of RDI was not obvious in Jilin Province, and took on the characteristic of random distribution. The counties of both the units and its adjacent units have higher development level (HH) were transferred from the western areas to the eastern areas, while the countries of both the units and its adjacent units have lower development level (LL) were diffused from the eastern to middle and western Jilin Province. Finally, the result of multi-regression analysis showed that the improvement of agricultural production condition, development of agricultural economics and the adjustment of industrial structure were the domain factors affecting rural development inequality of Jilin Province in the later ten years.

Keywords: rural development index; exploratory spatial data analysis; multi-regression model; Jilin Province

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1 Introduction

Since ′reform and opening up′ in 1978, China has been experiencing a gradual transition from a command economy to a market economy, and has achieved tremendous economic growth in the last three decades (Li and Wei, 2010). Moreover, the uneven process of interregional and intraregional development has also been intensified with the propulsion of a series of others national development strategies. China′s regional inequality has not only influenced the growth rate and quality of the whole national economy, but also brought a series of political and social issues, which has become a serious issue attracting considerable attention from both the policy makers and scholars.

In recent years, serious concerns about China′s regional inequality have been raised both inside and outside China and a large body of academic literatures

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attempting to describe and explain its patterns, processes and mechanisms. Almost all of the theoretical and practical studies aimed to answer three problems, namely, the question whether regional inequality increase or decrease over time, the causes of regional inequality, and the development strategies for reducing regional inequality (Lipshitz, 1992). New analysis frameworks and spatial econometric methods were also put forward to reveal the patterns and mechanisms of China′s regional inequality. Scholars argued that China′s economic reforms can be better understood as a triple process of decentralization, marketization and globalization, regional inequality in China is sensitive to geographical scale, and is influenced by multiple mechanisms (Wei, 1999; Wei, 2002, Li and Wei, 2010; Liao and Wei, 2012). Such factors as fiscal decentralization, foreign investment, policy bias, labor mobility and globalization of science and technology have important influence on China′s regional inequality (Wei, 1996; Lu and Wang, 2002; Ying, 2003; Kanbur and Zhang, 2005; Sun and Wang, 2005; Fu, 2007; Lu and Wei, 2007; Ho and Li, 2008; Segal, 2008; Tsui and Wang, 2008). Indicating the importance of this issue, the People′s Congress listed regional inequality as one of the most pressing problems to be targeted since the Ninth Five-Year Plan (1996–2000), and series strategies and policies have been implemented to solve economic polarization and alleviate regional inequality. For example, in 1997, the ′Western Development Strategy′ was launched to boost economic development of 12 provincial-level regions (i.e., Sichuan, Shannxi, Chongqing, Gansu, Qinghai, Yunnan, Guizhou, Guanxi, Tibet, Ningxia, Inner Mongolia and Xinjiang) in the poorer western China. In 2003, the ′Northeast Area Revitalization Plan′ was proposed as a national strategy to improve the comprehensive revitalization of the old industrial bases in Northeast China (Liaoning, Jilin and Heilongjiang) and elsewhere. In 2006, the strategy of ′Rising of Central China′ was implemented in order to accelerate the rapid and coordinated development of the provinces (i.e., Hunan, Hubei, Anhui, Jiangxi, Henan, Shanxi) in the central China. The pattern of regional inequality in China has been changed with the implementation of these policies at different periods, and the Chinese government′s programs and efforts to reduce regional inequality have had some initial success, interregional and intraregional inequalities became stable and then declined (Fan and Sun, 2008).

China′s regional inequality can be decomposed into inland-coastal, inter and intra provincial, rural-urban, inter-rural and inter-urban inequality. Surveying from the previous literatures, it can be found that the inland-coastal and inter-provincial inequalities have been paid more attention (Liu, 2005b; Liu, 2006a; Li and Wei, 2010; Chen and Zhu, 2012). Much attempts has been devoted also to urban-rural dimension of China′s regional inequality. Xue (1997) found that rural-urban gap was the major component of county-level regional inequality in China. Chang (2002) argued that, for China′s widening income inequality, the most critical factor is the rural-urban gap, while others found that the contribution of rural-urban gap to China′s overall regional inequality has not changed very much over time (Tsui, 1993; Hussain *et al*., 1994; Kanbur and Zhang, 1999).

China is a developing country with a huge total population of 1.33×10^9 in 2009, and the rural population was 7.13×10^8, which accounted for 53.61% of the total mainland of China (NBSC, 2010). As a large agricultural nation, the production and development of the rural sector in China are not only crucial from economic perspective but also important from political perspective and social stability in particular (Wu, 1997). Therefore, China built its national economy on the agriculture foundation since early time, and the national industrialization was pushed forward somehow under the sacrifice of agriculture and the farmers (Wu, 1997). However, with the rapid propulsion of urbanization and industrialization, China has experienced an uneven transition from the primarily agricultural economy to an industrial urban economy. The different regions of rural China achieved very different levels of development and showed different spato-temporal characters of regional inequality, despite more than 40 years of egalitarian regional development policy (Knight and Song, 1993). The patterns and trends of China′s rural inequality at provincial level are different from regional inequality in general and higher than those of regional urban inequality (Hussain *et al*., 1994; Tsui, 1996; Jones *et al*., 2003). Before 1978, regional development philosophy in China was to wipe out regional disparities through an even distribution of productive materials and activities. There was no obvious difference in the degree of development in the regional rural economy in China (Long *et al*., 2010b). However, the early 1980s saw high growth in

primary sector output in the wake of de-collectivization and the privatization of land-use rights under the ′household responsibility system′, which was introduced and adopted throughout China in the mid-1980s, and to a great extent stimulate rural economic growth at the early periods of China′s transition (Lin, 1992; Chow, 2002). At the same time, the reform-induced industrialization and urbanization have rapidly altered the physical and human landscapes in China′s rural areas, as evidenced by the substantial rate of rural housing development, rural to urban migration, agricultural to non-agricultural land conversion, widening rural-urban income gap, and regional rural inequalities (Long *et al*., 2010b).

China′s rural inequality has attracted increasing attention from the scholars both inside and outside China in the last three decades. Many attempts have been made to examine the patterns and reasons by analyzing residents′ income distribution and regional inequality in rural China (Griffin and Saith, 1982; Hsiung and Putterman, 1989; Lyons 1991; Bramall and Jones, 1993; Knight and Song, 1993; Hussain *et al*., 1994; Tsui, 1998a; Ravallion and Chen, 1999; Morduch and Sicular, 2002; Wan, 2004). The results on both the directions of and the reasons for post-reform inequality trends seem accordant. Most of the previous researches have demonstrated increasing income inequality (Hsiung and Putterman, 1989; Rozelle, 1994; 1996; Yao, 1997; Tsui, 1998b, Wan, 2001; Wan *et al.*, 2008; Qu and Du, 2010), only few shown falling income inequality (Seldon, 1985; Qin and Yang, 2012). Almost all of the researches argued that the income of non-agricultural industries provided the greatest contribution to residents′ income in rural China (Zhang, 1992; Chen, 1999; Li, 2000). Regional inequality of rural economy was also an important research hotspot in this period (Liu, 2006b; Chen *et al*., 2009; Zhang and Liu, 2008; Liu *et al*., 2010; Chen *et al*., 2010). Scholars argued that rural economic inequality became increasing outstanding in the last three decades (Liu, 2008). Rapid industrialization and urbanization improved the uneven growth of regional economy in rural China and brought about important impact on rural industrial structure, employment and landuse (Liu, 2007). Some scholars argued that rural industrialization was the main cause to enlarge the rural inequality (Hare and West, 1993; Rozelle, 1994; 1996; Tsui, 1998b; Zhang, 1998; Wan, 2001; Liu, 2006b). Some considered that the agricultural income that comes from crops still plays an important role, even the most domain course, to enlarge the rural inequality (Tsui, 1998b; Ravallion and Chen 1999). Still others attributed China′s rural inequality to such factors as efficiency of agricultural labor, economic base and adjustment of industrial structure, as well as endowment of resources, natural conditions, territorial culture and rural policies (Liu, 2002; Wang *et al*., 2006; Chen *et al*., 2009; Zhang *et al*., 2010). Moreover, China′s rural inequality is also an important practical issue that has been paid serious attention by policy makers. Series strategies, such as ′building a new countryside′, ′integrated plan for rural-urban development′ and full establishment of a ′moderately well-off society′, were proposed and implemented to improve the harmonious development of the rural areas and alleviate regional inequality in rural China. These strategies, treated as important and long-term tasks, have been listed to the national economic and social development planning of different period in China.

According to the above-mentioned review, it can be found that important achievements have been made on regional and rural inequality in China. Most of the previous researches focused on the regional and rural inequality among the provinces and the three zones of eastern, central and western China (macro-middle scale), and counties (micro-scale). The statistical methods and spatial econometric models (i.e. variation coefficient, weighted variation coefficient, Theil′s index, Gini coefficient, spatial regression and geographically weighted regression) were applied to examine and illustrate the dynamics pattern and mechanism of China′s regional and rural inequality (Liu, 2006b; Guo *et al*., 2009; Li *et al*., 2008; Chen *et al*., 2009). However, there are still three fields that deserve more research efforts. Firstly, the previous researches emphasized the rural inequality of the whole country or the eastern coastal regions, but ignored the rural inequality in typical agricultural areas (i.e. the Northeast Plain, the North China Plain and the Middle and Lower Changjiang (Yangtze) River Plain), which are characterized as the most important commodity grain and farm produce bases in China, and maybe have different characteristics and driving mechanisms comparing with the eastern coast regions or urban regions. Therefore, rural inequality of typical agricultural areas should be paid more attention in further studies. Secondly, Scholars usually use the index of GDP, per capita GDP or income to explain the regional rural ine-

quality in China, while single index might ignore some important information and can not reflect the actual situation of rural inequality objectively. Therefore, comprehensive index system should be developed to depict rural inequality and illustrate its spatial pattern. Finally, traditional mathematical statistical method can reveal the temporal characteristics of rural inequality, but can not reflect its spatial correlation. This paper attempts to examine the spatio-temporal patterns of rural development inequality in Jilin Province and identify its domain factors by using the method of the exploratory spatial data analysis and multi-regression model. The purpose of this paper is to provide scientific basis for making regional policy and decision for the harmonious development of the rural areas in Jilin Province.

2 Materials and Methods

2.1 Study area

Jilin Province (40°52′–46°18′N, 121°38′–131°19′E) is located in the middle part of Northeast China, with a population of 2.74×10^7 in 2009. It covers a total area of 1.874×10^5 km^2 and is comprised of one sub-provincial city (Changchun), seven prefecture-level cities (i.e. Songyuan, Liaoyuan, Jilin, Siping, Baicheng, Baishang and Tonghua) and one autonomous prefecture (Yanbian), along with forty counties/county-level cities/autonomous counties (Fig. 1). As we all know, Jilin Province is one of the most important commodity grain and agricultural products bases in China. The total cropland area is 6.20×10^6 ha, and its per capita cropland area is 0.23 ha in 2009 (NBSC, 2010), which is much higher than that of the average level (0.1 ha) in China. In general, Jilin Province can contribute 4.6% of grain yields and 10% of commodity grain to China in average annual.

Since China lunched the policies of ′reform and opening up′ in 1978 and ′household responsibility system′ in the early 1980s, the rural areas in Jilin Province have achieved tremendous economic growth. For example, the gross output value of agriculture, farmer′s net income and total grain yields promoted 1.5 times, 6.3 times and 0.2 times from 1990 to 2009, respectively. Additionally, great achievements have also been made on strategic adjustment of agricultural structure. Single agricultural structure, taking grain production as the uppermost industry, has been changed in the last three decades. For example, the proportion of crop farming in agriculture reduced from 71.5% to 44.8%, and the proportion of animal husbandry increased from 21.9% to 47.6% from 1999 to 2009. The animal husbandry has become one of the most potential industries for improving rural economic growth in Jilin Province. However, due to the differentiations of spatial location, agricultural conditions and endowment of resources, rural development level in different areas are inequality. Especially, when stepping into the 21st century, conditions of rural areas in Jilin Province have changed with the implementation of ′Northeast Area Revitalization Plan′ in 2003 and ′building a new countryside′ in 2006, which may have important impact on rural inequality of the province. This paper attempts to examine the spatio-temporal patterns and illustrate domain factors of rural inequality in Jilin Province before and after the implementation of these policies.

2.2 Data sources

Forty eight units are selected in this study to examine rural inequality in Jilin Province, including the propers of Changchun, Jilin, Songyuan, Tonghua, Liaoyuan, Bacheng, Baishan, Siping and 40 counties/county-level cities/autonomous counties (Fig. 1).

The original data of the indicators utilized in this study are derived mostly from the *Jilin Statistical Yearbook* (2001; 2006; 2010) (JSB, 2001; 2006; 2010). Per capita housing areas of the propers of Changchun and the seven prefecture-level cities are replaced by the average values of each city for the lack of statistical data, and other indicators are calculated according to the relative statistical data.

2.3 Methods

2.3.1 Rural development index (RDI)

Based on the principle of availability of statistical data, representative and comparability of the indicators, a comprehensive index system is established to evaluate rural inequality in Jilin Province, which includes 12 specific indicators that are quite relative to rural development and can be measured at county level. These indicators were grouped into three topics, namely, economic strength, agricultural production and living conditions (Table 1).

The principal components analysis was applied to extract important factors for the evaluation of rural development inequality. The principal components and the

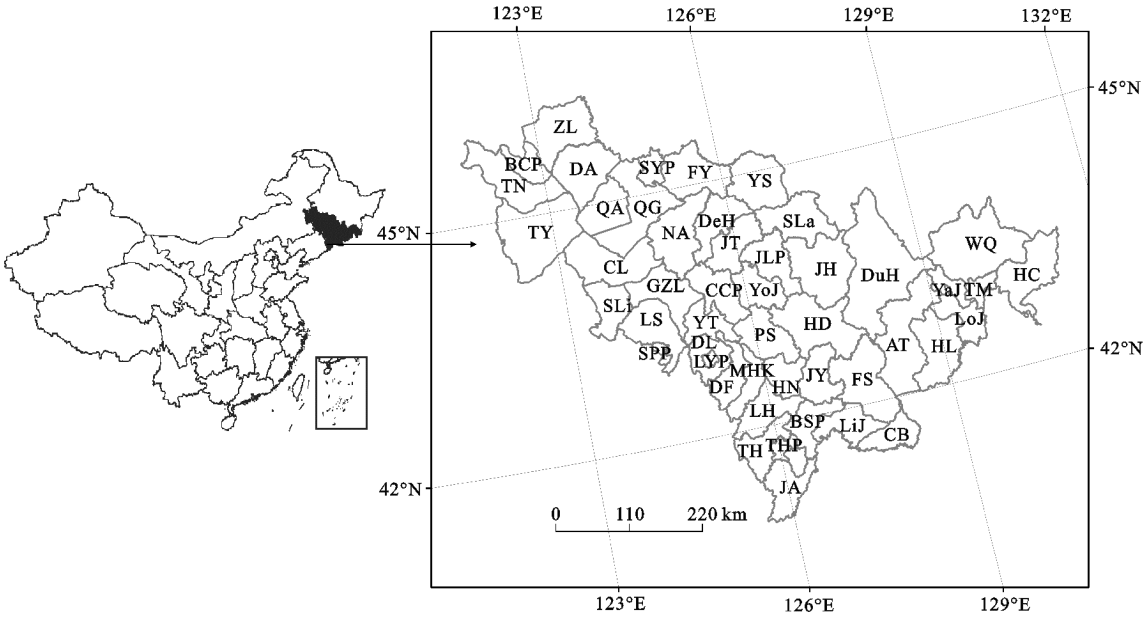

Fig. 1 Location of study area. CCP: Changchun Proper; JLP: Jilin Proper; SYP: Songyuan Proper; BCP: Baicheng Proper; SPP: Siping Proper; LYP: Liaoyuan Proper; THP: Tonghua Proper; BSP: Baishan Proper; ZL: Zhenlai; TN: Taonan; DA: Da′an; TY: Tongyu; QA: Qian′an; QG: Qianguo; FY: Fuyu; CL: Changling; SLi: Shuangliao; GZL: Gongzhuling; LS: Lishu; NA: Nongan; DeH: Dehui; JT: Jiutai; YS: Yushu; SLa: Shulan; YoJ: Yongji; HD: Huadian; PS: Panshi; YT: Yitong; DL: Dongliao; DF: Dongfeng; MHK: Meihekou; HN: Huinan; LH: Liuhe; TH: Tonghua; JA: Ji′an; LiJ: Linjiang; FS: Fusong; JY: Jingyu; CB: Changbai; AT: Antu; HL: Helong; LoJ: Longjing; TM: Tumen; YaJ: Yanji; DuH: Dunhua; JH: Jiaohe; WQ: Wangqing; HC: Hunchun

Table 1 Index system for rural development evaluation

Group	Indicator	Explanation of indicator
Economic strength (ES)	Social consumption level (SCL)	Total retail sales of consumer goods /total population (10^4 yuan (RMB)/person)
	Gross output value of agriculture, forestry, animal husbandry and fishery (GOVA)	Summation of output value of agriculture, forestry, animal husbandry and fishery (10^4 yuan)
	Proportion of primary industry (PPI)	Output value of primary industry/GDP (%)
	Proportion of financial expenditure in agriculture (PFEA)	Agricultural financial expenditure/total financial expenditure (%)
Agricultural production (AP)	Grain yield per unit area (GYPUA)	Grain yield/grain sown area (kg/ha)
	Productivity of agricultural land area (PALA)	Output value of farming, forestry, animal husbandry and fishery/agricultural land area (10^4 yuan /ha)
	Productivity of agricultural labor (PAL)	Output value of farming, forestry, animal husbandry and fishery/agricultural population (10^4 yuan/person)
	Proportion of effective irrigation area (PEIA)	Effective irrigation area/gross cultivated area (%)
	Proportion of non-agricultural employee (PNE)	Rural non-agricultural employee gross rural employee (%)
Living conditions (LC)	Net income of per farmer (NIPF)	Net income/number of farmers (yuan/person)
	Medical level (ML)	Total beds in hospital/total population (unit/person)
	Per capita housing area (PCHA)	Housing area/ total population (km^2/person)

weight were refined according to the contribution rate and accumulative contribution rate of the selected indicators. The output of the principal components analysis is used to develop a RDI (Yılmaz *et al*., 2010). The equation is given as:

$$F = \sum_{i=1}^{p} W_i F_i \quad (1)$$

$$W_i = \lambda_i \Big/ \sum_{i=1}^{p} \lambda_i \quad (2)$$

$$F_i = \sum_{j=1}^{m} W_{ij} X_{ij} \quad (3)$$

where F refers to RDI; W_i, F_i and λ_i denotes the weight, value, and contribution rate of the principal component *i,*

respectively; m is the total number of variables; p is the total number of the selected principal components; X_{ij} and W_{ij} denotes the standardized value and the weight of the j variables of province i, respectively.

2.3.2 Exploratory spatial data analysis (ESDA)

ESDA is a method of spatial autocorrelation analysis to measure the spatial effect of a geographical phenomenon, of which the unique is to establish the spatial relationship among the units by spatial weight matrix and make sure of the state of neighborhood by spatial lag vector (Anselin, 1999). It has provided an effective tool for measuring the spatial autocorrelation of a geographical phenomenon. Moreover, it has been applied widely to explain the inequality of population, economy and rural-urban development (Zhu *et al*., 2001; Lu *et al*., 2002; Gallo and Ertur, 2003; Ma *et al*., 2004; Rey, 2004; Wu and Xu, 2004; Pu *et al*., 2005a; 2005b; Wu and Wang, 2008; Qiu *et al*., 2009; Cheng and Deng, 2010). In general, both the global spatial autocorrelation (e.g., Moran′s I or Geary′s C) and local spatial correlation (e.g., Moran scatterpot and Local indicator of spatial association (LISA) can be used to measure the spatial autocorrelation of regional inequality. In this paper, Moran′s I and LISA are applied to examine the spatial autocorrelation of the rural development inequality at county-level in Jilin Province.

Moran′s I can reflect the overall degree of spatial autocorrelation of rural development inequality among the units. The equation is given as:

$$I=\frac{n\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}\left(y_i-\bar{y}\right)\left(y_j-\bar{y}\right)}{\sum_{i=1}^{n}\left(y_i-\bar{y}\right)^2\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}} \quad (4)$$

where n refers to the number of spatial unit; y_i and y_j denotes the values of RDI of spatial units i and j, respectively; $\bar{y}$ is the average value of RDI of the spatial unit; W_{ij} is the spatial weight of spatial units i and j. The range of Moran′s I is between –1 and 1, and the significant of spatial autocorrelation can be tested by z statistics (Anselin, 1999). The equation is given as:

$$z=I-E(I)/\sqrt{\mathrm{Var}(I)} \quad (5)$$

where I is the Moran′s I, $E(I)$ and $\mathrm{Var}(I)$ denote the expectation value and the variance of Moran′s I, respectively. Under a given significant level, if z-value is significant and Moran′s I is positive, the units with higher or lower RDI are spatial agglomeration; if z-value is significant but Moran′s I is negative, the difference of RDI of among the unit and its adjacent units are obvious; if z-value is not significant and Moran′s I is closed to 0, the RDI among the units are independent and random distribution.

LISA takes each spatial unit as the inspection object and analyzes its properties of spatial autocorrelation (Anselin, 1999). The equation is given as:

$$I_i=z_i\sum_{j\neq i}^{n}W_{ij}z_j \quad (6)$$

where I_i is the local autocorrelation index of RDI; $z_i$and z_j are the standardized values of RDI of spatial unit i and j, respectively, and refer the deviation degree of RDI of the units to its average value; W_{ij} is the spatial weight of RDI of units i and j.

3 Results and Analysis

3.1 Spatio-temporal characteristics of rural development inequality

Based on the statistical software of SPSS 16.0, the data of the 12 variables of the 48 units are standardized processing. The characteristic value, contribution rate and accumulative contribution rate of the 12 principal components are achieved by using the principal components analysis (Table 2). The Kaiser-Meyer-Olkin (KMO) is a statistic to test the correlation of the variables, which is defined as the ratio of correlation coefficient and partial correlation coefficient. In general, if the KMO value is higher than 0.5, it is suitable to carry out the principle components analysis. In this study, the KMO value is 0.728, which indicates that there exists a strong correlation among the variables, and this method can be applied to extract the principle components of RDI. As shown in Table 2, accumulative contribution rate of the former six principal components is above 86.6%, reflecting more than 80% information of the original data. Therefore, the six principal components are selected to develop a multi-regression model of RDI, where takes the proportion of the contribution rate of each principal component to the accumulative contribution ratio of the six principal components as the weight and six principal component (F_1, F_2, F_3, F_4, F_5, and F_6) as the independent variable. The equation is given as:

$$F = 0.414\,F_1 + 0.211F_2 + 0.122F_3 + 0.113F_4 + 0.077F_5 + 0.065F_6 \quad (7)$$

Based on the multi-regression model, the RDI of the 48 units in Jilin Province in 2000, 2005 and 2009 are calculated, respectively (Fig. 2).

Table 2 Results of principal component analysis

Principal component	Characteristic value	Contribution rate	Accumulative contribution rate
1	4.300	35.837	35.837
2	2.190	18.250	54.087
3	1.264	10.537	64.624
4	1.172	9.763	74.387
5	0.795	6.626	81.013
6	0.671	5.593	86.605
7	0.480	4.001	90.606
8	0.363	3.027	93.633
9	0.283	2.362	95.995
10	0.225	1.874	97.869
11	0.157	1.312	99.180
12	0.098	0.820	100.000

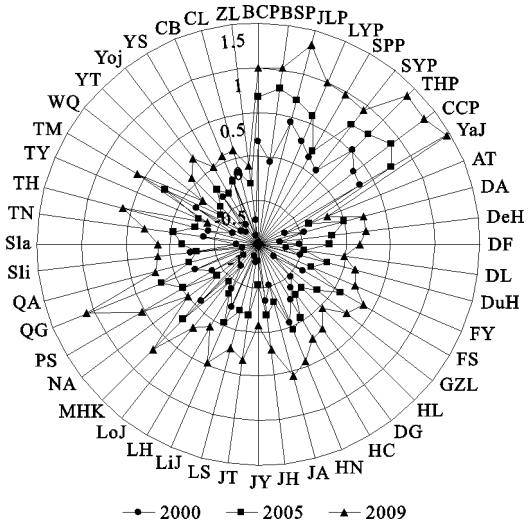

Fig. 2 Rural development index (RDI) of units in 2000, 2005 and 2009. The abbreviations of units are consistent with Fig. 1

3.1.1 Temporal evolution dynamics

It can be seen from Fig. 2 that RDI of almost all of the 48 units tended to increase from 2000 to 2009, which indicated that the rural areas in Jilin Province have been experiencing a gradual transition and rapid development in recent ten years. However, it is not difficult to find that rural development level of most units are still in a lower status, for the number of the units whose RDI below the average level were 28, 30 and 32 in 2000, 2005 and 2009, which accounted for 58.3%, 62.5% and 66.7% of the total units in Jilin Province, respectively. It can be concluded that the lower level areas will lead the full process of regional rural development, and the rural inequality among the units will be increasing for a long term. Moreover, in order to reveal the temporal evolution dynamics of rural inequality more clearly, the natural break method was applied to cluster the RDI of the forty eight units into four levels (Table 3), namely, level I—undeveloped areas, level II—lower developed areas, level III—moderately developed areas, and level Ⅳ—developed areas.

In 2000, there existed an obvious rural inequality in Jilin Province. Most of the rural areas did not develop so well, and 64.6% of the units fell into level I and level II, which accounted for 43.0% and 34.7% of the total areas of Jilin Province, respectively. Only 35.4% of units reached the moderately developed or developed level, which accounted for 22.3% of the total areas of Jilin Province.

By 2005, changes were obvious in both level I and level II. Numbers and areas of the undeveloped counties decreased 12.5 and 15.2 percent points than that of 2000, respectively; while numbers and areas of the lower developed counties increased 8.3 and 8.2 percent points, respectively. However, level III and level Ⅳ changed relative stabilization. Numbers of the counties of both the two levels increased 2.1 percent points, while their areas increased 6.9 and 0.1 percent points, respectively.

In 2009, changes were still obvious in both level I

Table 3 Basic statistical characteristics of each level

level	2000			2005			2009		
	Number of unit	Proportion of unit (%)	Proportion of area (%)	Number of unit	Proportion of unit (%)	Proportion of area (%)	Number of unit	Proportion of unit (%)	Proportion of area (%)
I	18	37.5	43.0	12	25.0	27.8	9	18.8	26.2
II	13	27.1	34.7	17	35.4	42.9	21	43.8	48.8
III	10	20.8	14.5	11	22.9	21.4	8	16.7	13.3
Ⅳ	7	14.6	7.8	8	16.7	7.9	10	20.8	11.7

Note: I. undeveloped areas; II. lower developed areas; III. moderately developed areas; and Ⅳ. developed areas

and level II. Numbers and areas of the undeveloped counties decreased 6.2 and 1.6 percent points than that of 2005, respectively; while numbers and areas of the lower developed counties increased 8.4 and 5.9 percent points, respectively. Therefore, Numbers and areas of the moderately developed counties decreased 6.2 and 8.1 percent points, respectively, while numbers and areas of the developed counties increased 4.1 and 3.8 percent points, respectively.

3.1.2 Spatial dynamic patterns

In order to further understand spatial dynamic patterns of rural development inequality, ArcGIS is applied to display the spatial distribution of the four levels in 2000, 2005 and 2009 (Fig. 3). As shown in Fig. 3, most of the units were undeveloped area in Jilin Province, only Changchun Proper and the proper of seven prefecture-level cities reached developed level. Spatial dynamic patterns of rural development inequality in Jilin Province were obvious from 2000 to 2009. In 2000, the developed area scattered in Jilin Province, including the Changchun Proper, the proper of seven prefecture-level cities and a few counties. The undeveloped area and lower developed areas were centralized in the central and western Jilin Province as the block shape. By 2005, the lower developed areas took on a trend of spatial expanding from the middle-eastern to western Jilin Province. The undeveloped counties revolved around the lower developed counties as a crushing shape. In 2009, the lower undeveloped counties expanded from the eastern to western regions, while the undeveloped counties scattered in the eastern mountains areas and parts of the central province.

3.1.3 Spatial autocorrelation characteristics

Generally speaking, all attribute values on a geographic surface are related to each other, but closer values are more strongly related than distant ones (Tobler, 1970; Anselin and Getis, 1992). In order to examine the spatial autocorrelation of RDI of the 48 units in Jilin Province, Moran′s I of RDI of the units in 2000, 2005 and 2009 are calculated by using the method of ESDA on the base of the software of GeoDa (Table 4). It can be seen from Table 4 that Moran′s I of RDI were 0.01, –0.16, and –0.06 in 2000, 2005 and 2009, respectively, and all of the *z*-values were insignificant, which indicated that there did not exist obvious spatial agglomeration of higher and lower level regions of RDI, and most of the units tended to random distribution due to the discreteness spatial distribution of the developed areas. Moreover, Moran′s I of RDI of the units changed from positive to negative in 2000–2009, which indicates that rural development inequality among the units had been enlarged continuously during this period.

Moran′s I of RDI in each section can reflect the static characteristics of spatial autocorrelation of the units, but can not explain its dynamic process. In order to examine the spatial dynamics of the spatial autocorrelation of RDI, Moran′s I of RDI were also calculated in 2000–2005, 2005–2009, and 2000–2009 (Table 4). As shown in Table 4, Moran′s I of RDI was 0.19 in 2000–2009, and the *z*-value was significant, which indicates that there existed obvious spatial autocorrelation of RDI among the units since 2000, while it took on different characteristics in the period of 2000–2005 and 2005–2009. On the one hand, Moran′s I of RDI in the first period was 0.24, and the *z*-value was significant, which indicated that the developed areas and lower developed areas trended to spatial agglomeration. On the other hand, Thought Moran′s I of RDI in the second

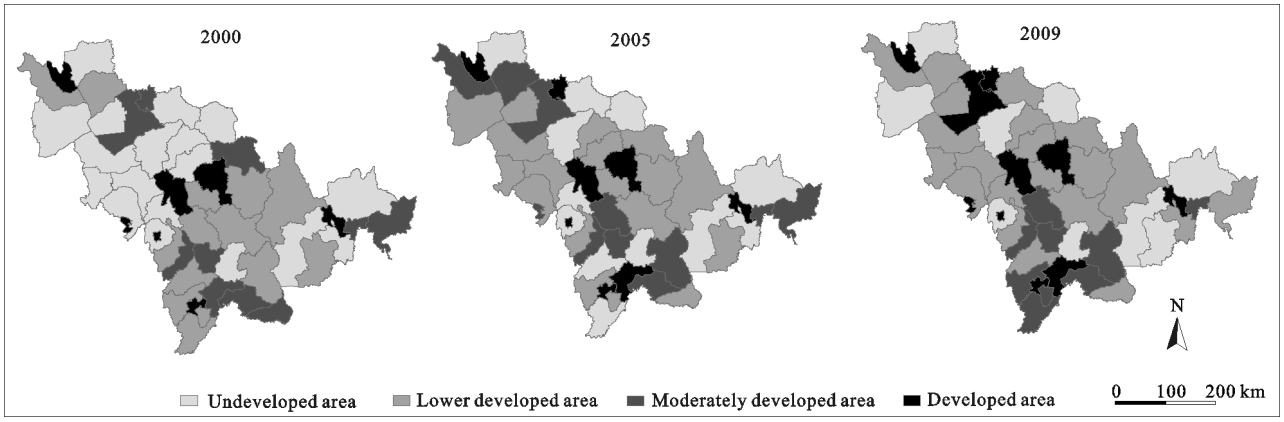

Fig. 3 Spatial dynamic patterns of rural development inequality in Jilin Province

period was 0.08, while the *z*-value was insignificant, which indicated that spatial agglomeration of developed areas and lower developed areas were not obvious in recent five years.

For further understanding the spatial autocorrelation of RDI of the units in Jilin Province from 2000 to 2009, four categories were clustered by using of the LISA (Table 5), namely, Category I—HH (both the units and its adjacent units have higher development level), category II—LH (development level of the unit is lower than that of its adjacent units), category III—LL (both the unit and its adjacent units have lower development level), category Ⅳ—HL(development level of the unit is higher than that of its adjacent units). Furthermore, ArcGIS is applied to display the spatial patterns of rural development inequality of Jilin Province in 2000, 2005 and 2009 (Fig. 4).

3.2 Driving factors of rural development inequality

Jilin Province, as a typical agricultural region and a main grain production base in China, has its unique characteristics in rural development inequality. The domain factors may be different from the whole nation and the eastern coastal areas. Reviewing the process of rural development in Jilin Province, it can be found that positive progress has been achieved in rural areas since 2000, but the patterns of rural development inequality has not changed radically, that is, almost 70% of the units are still in undeveloped and lower developed levels, and the gap of rural development inequality among the units trended to be further increase. However, the changing

Table 4 Results of spatial autocorrelation analysis (Global Moran′s I)

		2000	2005	2009	2000–2005	2005–2009	2000–2009
Moran′s I	Value	0.01	–0.16	–0.06	0.24	0.08	0.19
	Expected	–0.0212	–0.0212	–0.0212	–0.0212	–0.0212	–0.0212
	Variance	0.00846	0.00838	0.00840	0.00850	0.00816	0.00849
	z-value	0.33	–1.54	–0.45	2.81***	1.10	2.27**

Note: ***, **, * denote significant levels at 0.01, 0.05 and 0.1, respectively

Table 5 Basic statistical characteristics of each category

Category	2000			2005			2009		
	Number of unit	Proportion of unit (%)	Proportion of area (%)	Number of unit	Proportion of unit (%)	Proportion of area (%)	Number of unit	Proportion of unit (%)	Proportion of area (%)
HH	10	20.8	19.2	4	8.3	7.4	7	14.6	7.5
LH	12	25.0	34.2	16	33.3	40.5	18	37.5	47.3
LL	15	31.3	33.0	13	27.1	31.6	13	27.1	32.6
HL	11	22.9	13.6	15	31.3	20.5	10	20.8	12.6

Notes: HH. both the units and its adjacent units have higher development level; LH. development level of the unit is lower than that of its adjacent units; LL. both the unit and its adjacent units have lower development level; HL. development level of the unit is higher than that of its adjacent units

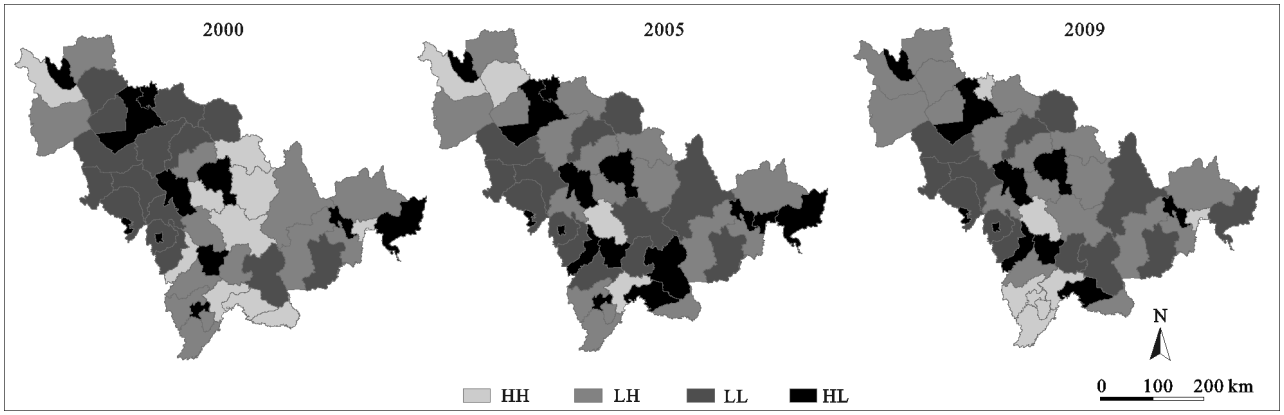

Fig. 4 Spatial autocorrelation of rural development inequality in Jilin Province

characteristics and reasons of the spatial patterns of rural development inequality were different in 2000–2005 and 2005–2009. Therefore, in order to identify the domain factors and explain their influences on rural development inequality in these two periods, a multi- regression analysis model was developed between the RDI and 12 specific variables of the forty eight units in Jilin Province. The equality is given as:

$$Y = c + \sum_{i=1}^{12} \beta_i x_i \tag{8}$$

where Y denotes the RDI; β_i is the regression coefficient of variable i; x_i is the standardized value of variable i; c is a constant.

As shown in Table 6, the regression equation and almost all of the variables (except PFEA) are significant in statistic. The modified coefficient of the model is 0.99, and the test value of *DW* is between 1.5 and 2.5 (Table 6), which indicated that the fitting effect of the simulation was good, and it showed a weak correlation among the variables. So, it is reasonable to explain the main factors of rural development inequality using the simulation results of the multi-regression model. It can also be found from Table 6 that β coefficient of GYA and PEIA are 0.427 and 0.399 in 2000–2005, respectively, and they are the uppermost factors influencing rural development inequality in this period. As a famous commodity grain production base, rural economic development of Jilin Province depends mainly on the crop production, and about 61.5% of farmers′ net income comes from the primary industry. The large- scale construction of farm irrigation facility and land arrangement in the middle-western regions in recent years has improved agricultural conditions of soil and water resources greatly, as well as grain productivity. Moreover, the Chinese central government implemented the policies of the direct grain subsidy and subsidies for growing superior grain cultivators since 2004, which excited greatly the farmers′ enthusiasm to cultivate grain crops, and improved the continuous increase of grain yield in Jilin Province. Analyzing the changing characteristics of spatial distribution of GYA and PEIA, we can find that the counties with obvious change are located in the central plain areas of Jilin Province (e.g. Lishu, Shuangliao, Gongzhuling, Changling, Qianan, Nongan and Dehui), which were anastomotic closely with the higher growth areas of rural economy. Additionally, β coefficient of PNE, NIPF, ML and PCHA were 0.271, 0.164, 0.409 and 0.335, respectively, which also play important roles in rural development inequality. But in 2005–2009, with rapid development of rural economy in Jilin Province, RCL achieved great improvement, and became the uppermost factor influencing rural development inequality. GYA and PEIA still have important influence on

Table 6 Estimation and test results of domain factors on rural development inequality (2000–2009)

Explanation variable	2000–2005			2005–2009		
	β	t	p	β	t	p
Constant C	–4.46E-17	0.000	1.000	3.78E-17	0.000	1.000
SCL	0.121	9.750	0.000	0.500	114.900	0.000
GOVA	0.041	2.910	0.006	0.031	5.623	0.000
PPI	–0.278	25.100	0.000	–0.332	65.910	0.000
PFEA	0.011	0.968	0.340	0.013	2.890	0.007
GYA	0.427	22.300	0.000	0.269	54.260	0.000
PALA	0.052	4.300	0.000	0.217	38.180	0.000
PAL	0.065	4.972	0.000	0.082	13.760	0.000
PEIA	0.399	29.800	0.000	0.379	78.900	0.000
PNE	0.271	25.900	0.000	0.123	26.700	0.000
NIPF	0.164	10.800	0.000	0.199	39.960	0.000
ML	0.409	34.000	0.000	0.389	85.800	0.000
PCHA	0.335	31.600	0.000	0.143	34.700	0.000
	Number = 48; DW = 2.214; F = 865.2; R^2 = 0.995			Number = 48; DW = 1.605; F = 5559.5; R^2 = 0.999		

Note: The abbreviations of explanation variable are consistent with Table 1

rural development inequality, but became weaker than that of the first period. Additionally, with the overall propulsion of ″building a new countryside″ and improvement of social security system, the regional difference of rural medical and housing conditions trended to be decrease to some extent, which reduced the influence of ML and PCHA on rural development inequality in Jilin Province, while other factors (e.g. NIPF and PALA) still have important influence on rural development inequality of the province.

4 Discussion

Rural China has been experiencing a rapid overall transformation of economy, society and cultural, with severe restructuring of rural elements and industrial reconstruction. Continuous nonagricultural tendency of agricultural elements has seriously affected the sustainable development of agriculture and rural area in China (Liu, 2007; Han, 2007; Long *et al*., 2009). Hence, how to solve the issues of agriculture, rural area and farmers and alleviate the rural development inequality is not only a significant strategic issue in relation to the overall situation of China's reform and opening up and socio-economic development, but also an important practical issue longstanding during the course of whole China's modernization (Long *et al*., 2010a). As one of the most important commodity grain bases in China, Jilin Province has made predominant contribution to China′s food security in the last three decades, and shall play a very important role in the middle and long-term strategy of national food security. However, affected by such factors as similar and unbalanced agricultural structure, hysteretic agricultural infrastructure, and slow growth of farmer′s income and agricultural benefit, almost all of the counties named commodity grain base have appeared to be the ′new northeast phenomenon′, which were represented as large amount of grain yields, undeveloped industry and poor finance. Jilin Province has become one of the most serious provinces facing the issues of agriculture, farmer and rural area in China (Liu Yansui, 2005; Cheng *et al*., 2010). Under the macroscopic background of full establishment of a ′moderately well-off society′, ′coordinated urban-rural development strategy′ and ′building a new countryside′, how to improve the rapid rural transition and alleviate rural inequality is not only a huge challenge for Jilin Province during the cause of balanced urban-rural development, but also an important scientific issue to which more attention should be paid. On the one hand, further studies on the process, pattern and mechanism of rural development should be strengthened, so as to provide theoretical support and scientific bases for sustainable rural transformation. On the other hand, the local government should take well-proven methods to promote the overall development of rural areas on the base of the objective practice, the momentous issues and the tendency of rural development. The local government should make full use of the opportunity to spur rural transition by strengthening industrial association, transposition network links and population flow to accelerate the construction of local central cities (e.g. Songyuan, Liaoyuan, Siping), and improve the quality of the cities and small towns to reconstruct a reasonable rural economy, society and cultural space. Besides, it is necessary to speed up the development of rural industry and services, especially the agricultural processing industry, so as to promote agricultural benefit and farmers′ income. Moreover, aiming at the strategic target of guaranteeing the national food security, it is also very important to implement the planning of increasing billions of pounds of grain yields and the western land arrangement continuously, so as to improve the grain production capability and land output stably.

5 Conclusions

Aiming at one of the most important grain productions in Northeast China, this study attempts to examine the spatio-temporal dynamic patterns of rural development inequality in Jilin Province. The results show that the rural areas in Jilin Province has been experiencing a gradual transition and rapid development since 2000, however, most of the rural areas are still in a lower development levels. The numbers of the units whose RDI were below the average level of the province accounted for 58.3%, 62.5% and 66.7% of the total units in 2000, 2005 and 2009, respectively, and rural inequality among the counties became increasing obvious. Firstly, though the numbers and areas of developed area increased 6.2 and 3.9 percent points from 2000 to 2009, respectively, the total numbers and areas of undeveloped area and lower developed areas still accounted for 62.6%and 75.0% of the total counties in Jilin Province in 2009.

Secondly, spatial patterns of rural development inequality changed obviously from 2000 to 2009. Though the developed areas scattered mainly in Changchun Proper and the seven proper of prefecture-level cities, the lower undeveloped units expanded from the middle-eastern areas to western Jilin Province, and the undeveloped units, as a crushing shape, distributed in the eastern fringe areas and eastern mountainous areas surrounding the lower undeveloped units. Finally, the domain driving factors were different during the course of rural development, and the GYA and PEIA were the uppermost factors impacting on the rural development inequality in 2000–2005, while RCL became the leading factor that impacted on rural development inequality in 2005–2009. Besides, such factors as PNE, NIPF, ML, PCHA and PALA, have important influences on rural development inequality in Jilin Province since 2000.

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