Demystifying the geography of income inequality in rural China: A transitional framework

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ARTICLE INFO

ABSTRACT

In this paper, we first detect the uneven distribution of regional inequality in rural China with the per capita net income data at county level, and then diagnose the various factors that contribute to this as well as its driving mechanisms using the four-dimension transitional framework. The results suggest that rural inequalities are clustered at the province level, and those most unequal regions tend to be geographically gathered. Stemming from the framework, the study reveals that the spatio-temporal disparity in rural inequality is deeply embedded in the quadruple-transition process of marketization, globalization, decentralization and urbanization. Employing both the pooled OLS and spatial regime models, the study further unfolds that influences of the transition processes are diversified across regions and study periods. We finally argue that human investment rather than economic growth plays the key role in reducing the rural inequality in eastern provinces, and that the formulation of policies in line with regional characteristics would be helpful to address or alleviate rural inequality.

1. Introduction

Income inequality has always been an important aspect of academic inquiry since the late 1980s and is one of the major concerns facing governments as it has negative social and political consequences, being at the root of problems including crime and instability (Rey and Janikas, 2005; Iammarino et al., 2018). Thanks largely to the uneven impact of the recent global financial crisis, the trends and impetus underlying inequality at multi-scales ranging from international, national, state and county to urban, have once again surged to the fore of debate (Dijkstra et al., 2015; Florida and Mellander, 2016; Lee et al., 2016). As the neoclassical growth model predicts, poor nations and states tend to catch up with their rich counterparts in terms of the level of per capita product or income, namely regional convergence, because of the homogeneity in technology (Martin and Sunley, 1998). Although some support this neoclassical theory, others find an absence of convergence and have suggested that inequality has, in fact, increased in developing economies (Ravallion, 2014; Xie and Zhou, 2014).

According to the new economic geography theory, production factors are more likely to flow towards developed regions where the returns are higher. This encourages the formation of a core-periphery economy or economic polarization (Martin and Sunley, 1996; Krugman, 2011; Storper, 2018). Empirically, overwhelming evidence has also been found that the core-periphery structure has strong geographical foundations and is difficult to change through a new spatial division of labor and political struggle, particularly in developing states (Beynon et al., 2016; Wei, 2017). In contrast, the postulation said that income inequality first increases and then decreases with regional economic development, tracing out a bell-shaped curve (Alonso, 1980; Bhattacharya, 2011). There was also a prevailing orthodoxy for decades that a period of increasing inequality was considered to be more or less inevitable and not something to worry about; thus, policy efforts to reduce

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inequality were likely to impede economic growth and (hence) poverty reduction (Ravallion, 2014).

Having witnessed decades of high-speed economic growth, China is now the world's second largest economy with its inequality reaching a level much higher than that in the US and ranking among the highest in the world (Xie and Zhou, 2014). Coupled with rapid urbanization, the share of non-agricultural income for rural household has been sharply increasing, which consequently led to a much more intense inequality in rural regions than that in urban China (Ravallion and Chen, 2007; Li et al., 2011; Liu et al., 2015). As Liu et al. (2017a,b) figured out, there were 70.17 million impoverished people in rural China living below the government's poverty line of RMB 2300 per capita annual net income, which is currently the biggest challenge to China's ambition of building a moderately prosperous society by 2020. In this regards, the widening gap in income, especially in rural regions, seems to be a dark lining to the extraordinary achievements of contemporary China (Li et al., 2015a). Notably, most existing literature on China's inequality primarily focus on the uneven patterns of economic development and investment among regions and, cities, or between urban and rural areas (e.g., Liu et al., 2013; Wei, 2015), with little attention being paid to rural inequality (Liu, 2006; Li et al., 2015a).

Regarding the impetus, studies have highlighted the important role of geography, nature, and institutions in explaining disparities in regional development (Sheppard, 2011; Rodríguez-Pose, 2013; Wei, 2015; Storper, 2018). Mohan and Mohan (2002), echoing an important current in contemporary social science, argued that social capital stemmed and cumulated from specific natural, historical and cultural backgrounds, and had significant regional differences (Pan and He, 2010; Liu et al., 2017a). From a methodological perspective, the commonly used Gini coefficient, Theil index, and the coefficient of variation, which all examine-well the temporal variations of regional inequality, have been challenged for their ignorance of geographical space (Liu, 2006; Li and Gibson, 2013). Specifically, we can hardly figure out exactly where the gap is, but merely know that there is a gap. Therefore, it is of great importance for both scholars and decision-makers to demystify the geography of inequality through the lens of rural per capita income (RPCI).

After this introduction, this paper first presents a brief review of the background and the conceptual framework within China's transition context followed by a discussion of the data and methodology. And then, we characterize the disparity of rural income inequality in different provinces by employing spatial autocorrelation analysis and hot spot analysis methods. Thereafter, underlying factors of provincial disparity in rural inequality are investigated with the help of the pooled OLS model and the spatial regime model (SRM). Finally, this article ends with a discussion of challenges faced by various regions in promoting balanced development and reducing rural poverty.

2. Background and conceptual framework

Economic literature identify several factors that contribute to an explanation of the uneven patterns of regional development: flow of market forces (e.g., capital and labor), economies of scale and agglomeration, and incentives offered by state policies and strategies (Bhattacharya, 2011; Florida and Mellander, 2016). Geographers argue that determinants of regional inequality vary at different spatial scales (e.g., Wei, 1999; Liao and Wei, 2015) and that a wide range of factors, including geographical locations, physical conditions, and industrial structures, are important to the uneven development (Rey and Janikas, 2005; Sheppard, 2011). At the provincial scale, scholars have widely illustrated that regional inequality in China is sensitive to development trajectories (Yu and Wei, 2003; Wei, 2007). In addition to the traditional factors, researchers have also identified the impact of globalization and institutional reforms on regional development (Fan, 1995; Wei, 2007; Mah, 2013). To sum up, a rich body of literature has been produced to evaluate the level of inequality (Wei, 2015), and plenty of frameworks

aiming at uncovering potential reasons for inequality have been proposed (e.g., Wan and Zhou, 2005; Wei, 2007).

However, the economic transition of China can hardly be explained by the orthodox neoclassical or equilibrium frameworks, but better conceptualized as a triple process of marketization, globalization, and decentralization (Wei, 2001). Economic landscapes are largely driven by a multiplicity of forces and agents unleashed by the triple process, the components of which have interactively and jointly (re)shaped the uneven pattern of development in China (Mah, 2013; Li et al., 2015b; Gao and Yuan, 2017). In addition, the government of China released the *National New Type Urbanization Plan* in 2014, which forms an important model in relation to the urban-rural integration and economic growth in the coming decades (Bai et al., 2014), and is viewed as an efficient path to reducing rural poverty and promoting urban-rural equality (Liu et al., 2016). Although the framework runs well in explaining patterns of total inequality among provinces and between core and periphery areas (Wei, 2007; Liao and Wei, 2012), its effectiveness in interpreting the location or geography of inequality, particularly in rural China, has not been well tested yet. Stemming from the literature, this study develops in Fig. 1 a four-dimensional conceptual framework to demystify the geography of rural income inequality in transitional China.

2.1. Marketization and rural inequality

Since 1978, China has witnessed the transition from a centrally planned economy to a market-oriented one (Wei, 2001). In the mandatory planning economy, governments distributed resources and decided the prices of products. Executors of state orders rather than market prices have taken over as major determinants of the supply and demand curves of products in the pre-reform period (Li et al., 2015b). By the mid-1980s, the political economic context shifted from idealistic egalitarianism to pragmatist uneven regional development with an emphasis on efficiency and output (Long and Ng, 2001). Thereafter, rural households became independent market bodies with the control of element mobility and commodity exchange being relaxed. This ultimately promoted the income mobility.

Additionally, a profound institutional fix was engineered by the state through a scalar reshuffling of the power of decision-making and became another important factor that changed the geography of income inequality in rural China (Long and Woods, 2011). The new household responsibility system greatly increased agricultural productivity (Sicular, 1995) and was successful in relieving labor from farm work and enabling it to undertake nonagricultural work. As Long and Woods (2011) illustrated, township and village enterprises (TVEs) have contributed significantly to the increase in rural income and employment by making full use of local resources.

Fig. 1. Conceptual framework of economic transition and rural inequality in China. *Source:* drawn by the author.

2.2. Globalization and rural inequality

Another significant change in transitional China is the increasing integration of its economy into the global system (Wei, 2007; Long and Woods, 2011). In particular, China's entry into the World Trade Organization in 2001 directly subjected its rural economy to open global market and competition. Given that the majority of China's rural households are small holders of tiny plots of land, it might cost more to produce certain types of grain domestically than to import (Fewsmith, 2001). Imports of cheap grain in large quantities have thus further depressed rural income growth in China (Li et al., 2015b). In other words, exposure to global markets has had serious consequences for the domestic production system in rural regions and has widen the income gap between agricultural and nonagricultural households.

In addition to the direct impact of overseas imports on domestic markets, comparative advantages in fields of labor supply, land price, and environmental regulation in China have made it the "world's factory" with a huge amount of foreign investment swarming in since the late 1980s (Mah, 2013). In order to ensure the profit maximization, foreign investment has tended to gather in suburban or rural regions with development zones at various levels (Gao et al., 2015). Inward foreign investment has not only brought a large number of employment opportunities to surplus farm labors, it has also improved the marginal revenue of rural land use; this has further contributed to the increasing income disparity in rural areas.

2.3. Decentralization and rural inequality

Since the onset of reforms, the central government has been able to provide sufficient incentives and restrictions to local governments through economic decentralization and political centralization, which deeply changed the traditional central-local relation in China (Mah, 2013). In particular, the tax reform in 1994 increased revenue sharing and decentralized fiscal responsibilities to local authorities (Gao et al., 2014). Thereafter, provinces, according to their socio-economic conditions, would implement various measures (e.g., fiscal budgetary expenditure and financial subsidy for agriculture, investment in rural fixed assets, and wide application of agricultural machinery, etc.) to promote the rural economy, which consequently increased rural income disparities across regions (Liu et al., 2013; Li et al., 2015b).

Decentralization, on the other hand, attempts to reduce the central control of decision making and provide benefits and incentives to provinces (Wei, 2001). As a result of the decentralizing reforms, local authorities gained considerable powers with regard to both decision making and resource allocation (Gao and Yuan, 2017). And local authorities could increase their revenue by obtaining rural land to expand developed areas, namely the "land finance" strategy (Wu et al., 2015). In practice, local officials tended to lease rural land for manufacturing or other urban purposes at low prices - partly because the revenue was critical for generating gross domestic product (GDP) - a crucial factor for their political promotions (Chen et al., 2017). Coincidently, the decentralization of decision-making in China is uneven within its special administrative system. And higher administrative ranks tend to correspond with stronger policy-making power and larger administrative territory for land conversion. In this regard, it can be recognized that the "land finance" strategy and political tournaments among local officials also influence the geography of income inequality in rural China.

2.4. Urbanization and rural inequality

Driven by the aforementioned process of transition, China is currently undergoing an unprecedented urbanization, which has led to a total remaking of its pre-existent urban-rural system through urban land expansion and rural population migration (Liu et al., 2013; Bai et al., 2014). High rates of urban expansion over the past decades have resulted in a huge loss of cropland, which has fundamentally impacted the income of rural households surrounding the megaregions (Gao et al., 2015). At the same time, these residents have enjoyed more employment opportunities in the urban regions, which has expanded their non-agricultural income and, in turn, widened the income gap between them and their counterparts in remoter rural regions (Beynon et al., 2016). In addition, urban sprawl has contributed to the relocation of firms to townships - or even rural regions - a process that has changed the accessibility of rural labors to non-agricultural jobs (Gao and Yuan, 2017).

Rural-urban migration is an important contributor to the mobility of rural income (Li et al., 2015b). Since the mid-1980s, the reform of household registration (*hukou*) system has driven mass migration from rural to urban regions and, through so doing, has changed the income source of rural households and entitled villages with modern industrial civilization (Liu et al., 2013). To date, a total of 274 million rural migrant workers (*nongmingong*) in China have been attracted to cities by the higher wages and job vacancies therein, but they have been excluded from or had limited access to urban jointly contributed to the evolution of income inequality in rural China.

3. Research setting

3.1. Data and measures

Two groups of indices of rural income inequality and four-dimensional transition of 31 provincial regions (excluding Taiwan, Hong Kong and Macau) in China, from the year 2000–2015, were selected in this paper (Table 1). The inequality index of Gini coefficient is calculated with the data of rural per capita net income at the county-level, which is derived from China Statistical Yearbook for Regional Economy, China County Statistical Yearbook, and statistical yearbooks of the aforementioned 31 regions. The transition variables stem from the aforementioned framework and are acquired from the China Statistical Yearbook and other professional yearbooks (i.e., Land and Resources Statistical Yearbook, City Statistical Yearbook, and Agriculture Yearbook). The Gini coefficient, a popular measurement of inequality defined mathematically based on Lorenz curve, is applied in the investigation of rural inequality among counties within particular provincial level regions. The Gini coefficient can incorporate all the data, which ensures the most accurate computation of the coefficient. The Gini coefficient also allows the direct comparison between units with different population sizes (Wei et al., 2017). In addition, we list definitions and measurements of other independent variables in Table 1.

Considering its ignorance of geographical space, we herein use the county-level data to calculate the Gini coefficients for each provincial region over the years. And then the uneven pattern of rural inequality is detected. In other words, we can figure out which province is the most uneven (i.e., with the highest Gini) in rural China by demystifying the geography of inequality. Given that there might be peak or inflection points of inequality with the increase or decrease of the aforementioned explanatory variables, we can hardly find expected linear relations between the dependent and independent variables. Fortunately, the relative rank of these variables should, theoretically, be linked with each other; otherwise, they are not significantly correlated (Gao et al., 2014). We therefore use the rank rather than the original value of each variable in the following models.

3.2. Analytical methods

To detect the exact location of rural inequity, the Getis-Ord General *G* and Getis-Ord *Gi** tools are employed to analyze the global and local patterns of Gini coefficients with the help of ArcGIS 10.1 software. To be specific, the former is an inferential statistic, that is, the results of the analysis are interpreted within the context of the null hypothesis. The null hypothesis for this statistic states that there is no spatial clustering of feature values (i.e., Gini coefficients). When the *p*-value returned by

Table 1
Data source, variable definition, and measurement.

Category	Variable	Definitions and measurements	Data source
Dependent variable	Inequality	Gini coefficient at the county-level of each provincial level regions is applied in this study.	Statistical Yearbook for Regional Economy and China County Statistical Yearbook
Globalization	APImport	The agricultural products import indices is given as the ratio of the total value of imports of agricultural products to that of the whole imports and exports.	China Agriculture Yearbook and China Statistical Yearbook
	PFDI	Performance indices of foreign investment can be presented as the ratio of FDI proportion to that of GDP.	China Statistical Yearbook
Marketization	RCPrice	Rural consumer price indices (1999 = 100) is used to observe the impact of change in retail prices of consumer goods and service prices on rural household income and consumption expenditure on living.	China Statistical Yearbook
	NFLabor	Income structure indices is employed to demonstrate the trend and degree of rural non-farm labors. The indices can be presented as the ratio of wage income to the total income (i.e., wage, business, property, and transfer incomes) of rural household.	China Agriculture Yearbook
Decentralization	RExpen	Proportion of general public expenditure used for rural items.	China Statistical Yearbook
	RLTran	The ratio of land transfer fee and land rent, as extra-budget revenues, to the general public budget revenue.	China Land and Resources Statistical Yearbook and China Statistical Yearbook
Urbanization	DUrban	Demographic urbanization can be presented as the proportion of people dwelling in cities and towns.	China City Statistical Yearbook
Control variable	PGDP	Per capital gross domestic product (GDP).	China Statistical Yearbook
	Transport	Density of road is calculated using the ratio of road length to the area of the territory.	
	Education	Ratio of entrants of normal courses and short-cycle courses to the total amount of population.	
	Rainfall	The yearly precipitation is used as one of the indices to the first nature of regions.	

this tool is small and statistically significant, the null hypothesis can be rejected. If the null hypothesis is rejected, then the sign of the *z*-score (i. e., the standard deviation) becomes important. If the *z*-score value is positive, the observed value of the General *G* index is larger than the expected value, indicating high values of rural inequality are clustered in the study area; otherwise, low values are clustered. Although the Getis-Ord General *G* is a useful summary measure of global inequality, a limitation is that they tend to cancel each other out when both the high and low values cluster. Thus we applied the tool of Getis-Ord *Gi**, widely used to identify statistically significant hot spots and cold spots.

To better understand the impetus of rural inequality across China, we use the SRM, which can explicitly recognize the heterogeneity of driving mechanisms in different regimes or units (Cravo and Resende, 2013). We treated the Gini coefficients of 31 provincial level regions at the county-level as the dependent variable, and sixteen time-points from 2000 to 2015 were included in our panel dataset. The independent variables selected for this study are listed in Table 1. We firstly expand the pooled OLS model by considering the regional structure in China, and therefore add three spatial regimes (i.e., eastern, central, and western China) in the pooled OLS model. The pooled OLS and SRM can be respectively expressed as follows:

$$y_{it} = \beta_{it} X_{it} + v_{it} \tag{1}$$

$$\begin{bmatrix} y_{it}, e \\ y_{it}, c \\ y_{it}, w \end{bmatrix} = \begin{bmatrix} X_{it}, e & & \\ & X_{it}, c & \\ & & X_{it}, w \end{bmatrix} \begin{bmatrix} \beta_{it}, e \\ \beta_{it}, c \\ \beta_{it}, w \end{bmatrix} + \begin{bmatrix} v_{it}, e \\ v_{it}, c \\ v_{it}, w \end{bmatrix} \tag{2}$$

where y_{it} is N × 1 column vector with observations for the Gini coefficient of province i in year t; X_{it} is the N × k matrix containing a constant term and the independent variables for each regime; β_{it} and v_{it} are vectors of model coefficients and the error term, respectively. And the subscripts *e*, *c*, and *w* indicate the three regimes: subregions of the eastern, central, and western China (Fig. 2).

4. Results

4.1. General trends of income inequality in rural China

Since its beginning in 1978, China's economic reform has led not only to a dramatic growth in rural household income but also a large increase in its inequality. Fig. 3 plots the interprovincial Gini coefficient of per capital net income in rural China from 1978 to 2015. From this it can be seen that the overall increase came with ups and downs and a sharp decrease from 2008 to 2015. The large rural inequality in the early decades could be attributed to the reform initiated by Xiaoping Deng, who argued that a small increase in inequality would substantially increase efficiency (Wei, 1999). Additionally, the sudden turning of inequality in 2008 might have been partially caused by the slowdown of economic growth since the global financial crisis. As Chan (2010) noted, the global slump tended to have a significant impact on the shrinkage of the income gap in rural China because of the shutdown of local enterprises on one hand and the decline of export sectors on the other. Both of these factors resulted in a record number of migrant lay-offs in developed provinces and further decreases in income inequality among provinces.

The accumulation of national wealth did not necessarily lead to an increase in equity, or even a widening of the income gap in rural regions. Fig. 4 presents our estimates of the correlation between economic development and rural inequality in different provinces since the turn of the millennium. It is evident that the Gini coefficients of rural income were not significantly correlated with increases of per capital GDP until it surpassed 24,000 RMB, which is roughly equivalent to the bottom end of the upper-middle income (4036 USD) bracket. A partial explanation for this observation is that economic development was efficiency-driven rather than equity-oriented in those less developed provinces or in the
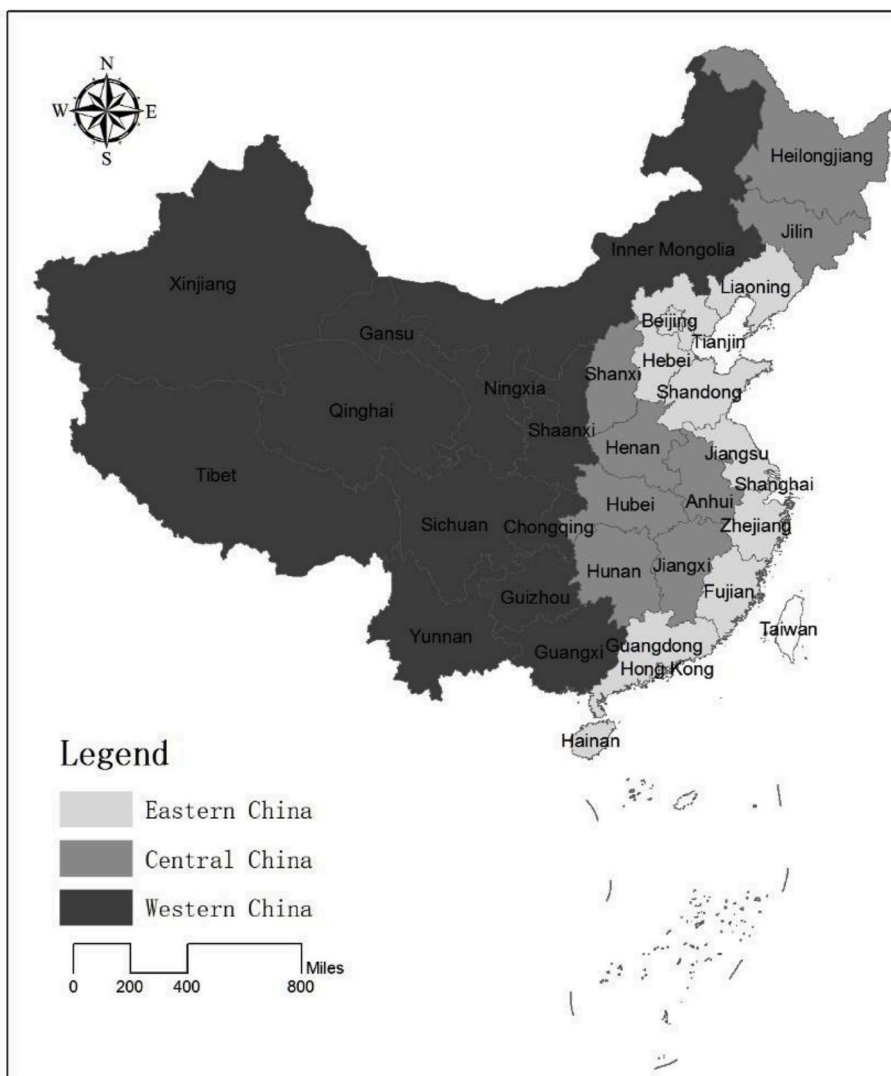
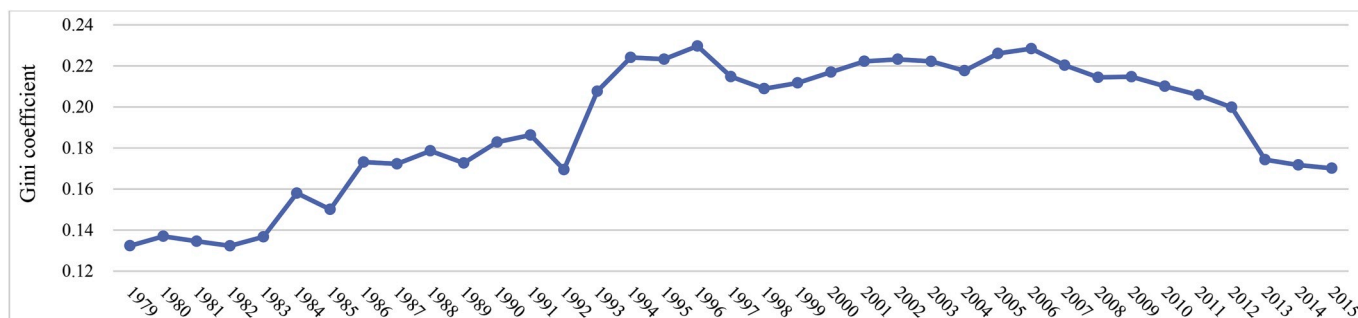**Fig. 2.** Study area and the spatial organization.

Fig. 3. Interprovincial income inequality in rural China, 1978–2015. *Data source:* China statistic yearbook, 2016.

pre-growth stage. Fortunately, we can fight for the balance between equity and efficiency when the GDP at per capital level increases to the upper middle income level.

All in all, the data of per capita income reported by the NBS reveals more inequality in rural China than 30 years ago, with increasing inequality among provinces. Notably, progress was uneven over time and across provinces (Ravallion and Chen, 2007). Table 2 presents the inequality measured by the Gini coefficient for five provincial level regions at the top and bottom of the rank order. Unsurprisingly, it is found

that regions in the west always have the most unequal income distribution. The regions with the lowest levels of overall inequality tend to be those eastern developed or middle provinces and cities. This result is consistent with Ravallion (2014)'s argument that higher rates of growth in average incomes have not put upward pressure on inequality worldwide. Instead, growth has generally widened the absolute gap in living standards between the rich and the poor in growing economies (Wei, 2017).
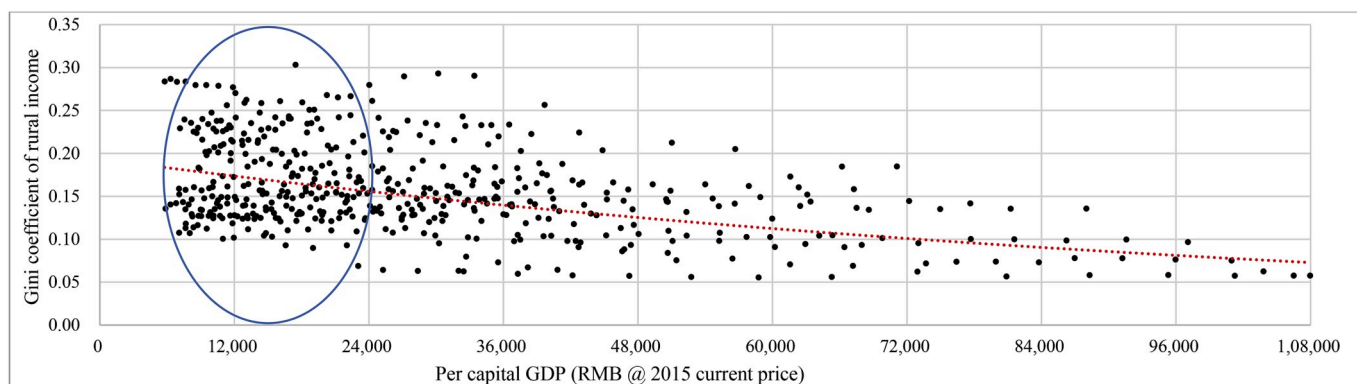
Fig. 4. Correlation between economic development and rural income inequality in China. *Data source:* China statistic yearbook, 2001–2016.

Table 2
Most and least unequal regions: Gini coefficients of rural income in 2000, 2005, 2010, and 2015.

Year	Most unequal			Least unequal		
	Rank	Region	Gini	Rank	Region	Gini
2000	1	Gansu	0.2838	27	Henan	0.1072
	2	Xinjiang	0.2560	28	Fujian	0.1042
	3	Ningxia	0.2381	29	Beijing	0.1041
	4	Yunnan	0.2293	30	Shanghai	0.0976
	5	Shaanxi	0.2252	31	Tianjin	0.0689
2005	1	Gansu	0.2796	27	Fujian	0.1091
	2	Shaanxi	0.2509	28	Shanghai	0.0981
	3	Xinjiang	0.2404	29	Jilin	0.0929
	4	Yunnan	0.2379	30	Beijing	0.0707
	5	Heilongjiang	0.2294	31	Tianjin	0.0579
2010	1	Hunan	0.2897	27	Jilin	0.1021
	2	Gansu	0.2608	28	Shanghai	0.1003
	3	Shaanxi	0.2414	29	Fujian	0.0979
	4	Heilongjiang	0.2249	30	Beijing	0.0731
	5	Xinjiang	0.2189	31	Tianjin	0.0622
2015	1	Shaanxi	0.2330	27	Fujian	0.0933
	2	Gansu	0.2261	28	Hainan	0.0643
	3	Hunan	0.2243	29	Shanghai	0.0625
	4	Qinghai	0.1877	30	Beijing	0.0575
	5	Inner Mongolia	0.1848	31	Tianjin	0.0575

4.2. Geography of income inequality in rural China

In this section, we discuss the spatial and temporal clustering patterns of rural income inequality within the aforementioned 31 provincial regions, through the global Getis-Ord General *G*. As Table 3 tabulates, the observed values of *G* are greater than the mathematical expectation (0.1307) and increase with the ups and downs over the study period. Furthermore, the changes in the *z-scores* and their statistical significance test are in line with the changes in observed *G* values. The results imply that rural inequalities are clustered at the province level, and the most unequal regions tend to be geographically gathered in China.

To unfold the patterns and distributions of income inequality in rural

China, we further computed the local Getis-Ord G_i^* values in four calendar years (i.e., 2000, 2005, 2010, and 2015) to show the locations of the hot spots (most unequal) and the cold spots (least unequal) of inequality. As Fig. 5 illustrates, the map in 2000 implies a clustered distribution of rural income inequality, and significant hot spots of high inequality are most visible in western China, and particularly the majority of "Third Front" (*sanxian*) including Sichuan, Qinghai, and Gansu provinces. Those southeastern regions including Shanghai, Zhejiang, Fujian, Anhui, Jiangxi, Guangdong, and Jiangsu, are however regarded as cold spots with a low level of inequality. In 2005, no obvious change was observed in the core areas of the hot and cold spots. However, the regions at the second-high and low levels of inequality, respectively, enlarged in the west and east with the insignificant areas sharply shrinking. By 2010, the clustered distribution pattern of rural inequality became less evident, and only Gansu and Sichuan remained as hot spots. Additionally, the two central provinces of Anhui and Jiangxi were the least unequal. Others provinces were either hot or cold spots and less statistically significant. The cluster map for 2015 shows that Shaanxi and Chongqing are added to the rank of hot spots, whereas Henan and Liaoning became statistically highly significant hot spots. Hunan and Xinjiang, on the other hand, became cold spots.

To summarize, the result of hot spot analysis bears a close resemblance to the global clustering analyses, and both reveal a pattern of rural inequality, which is, to a large extent, geographically determined. The less developed provinces are confirmed as hot spots of rural income inequality, by contrast with the eastern coastal counterparts that constitute regions/cities of relatively lower rural income inequality. Specifically, the pattern of intra-provincial rural income inequality in the early years was divided by the northeast-southwest "Hu line", which has been a geo-demographic demarcation line. Along with the institutionally driven development of rural economy in the first decade, the hot spot areas of rural income inequality shrank, suggesting a less clustered pattern of inequality. In the recent past, the pattern of inequality reclustered in central China, with the expansion of migrant rural labor from the inland regions. This result is in line with findings of Benjamin and colleagues (2005), regarding the impact of increasing non-farm incomes on the gaps between those with and without access to
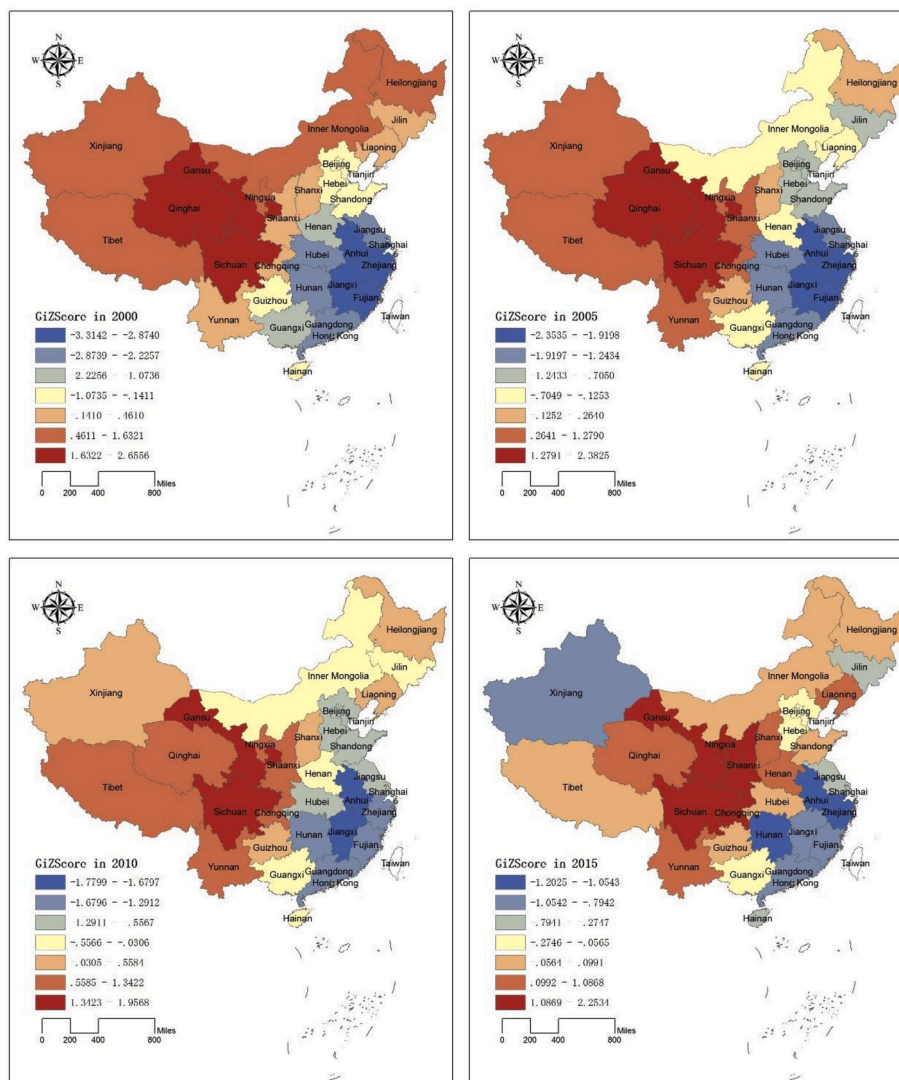
Table 3
The Global Getis-Ord General *G* of rural income inequality in 31 provincial level regions, 2000–2015.

Year	2000	2001	2002	2003	2004	2005	2006	2007
Observed G	0.1626	0.1652	0.1675	0.1659	0.1664	0.1654	0.1652	0.1674
z-score	2.8942	2.9373	3.2779	3.1283	3.1895	3.1136	3.0924	3.3360
p-value	0.0038	0.0033	0.0010	0.0018	0.0014	0.0018	0.0020	0.0009
Year	2008	2009	2010	2011	2012	2013	2014	2015
Observed G	0.1685	0.1659	0.1678	0.1699	0.1719	0.1689	0.1695	0.1732
z-score	3.4419	3.1968	3.3373	3.5006	3.6495	3.5519	3.5072	3.7452
p-value	0.0006	0.0014	0.0008	0.0005	0.0003	0.0004	0.0005	0.0002

Fig. 5. Hot spots of rural income inequality in China, 2000–2015.

Table 4
Results of spatial regime model (SRM) and pooled OLS regression.

Variables	Pooled OLS regression				Spatial regime model (SRM)		
	Pre-crisis	Post-crisis	2000–15	VIF	Eastern	Central	Western
PFDI	−0.1271**	−0.2197***	−0.1831***	1.73	−0.0144	−3.0823***	−0.3267
APImport	−0.1624***	−0.1952***	−0.1908***	1.07	0.0369	−0.1135	−0.0799*
RCPrice	0.0254	0.0148	0.0671*	1.30	0.0404	0.1029	0.0316
NFLabor	0.0126	0.1745**	0.0891*	2.37	−0.1944**	1.0194***	0.1224*
RExpen	0.4325***	0.0809	0.2120***	1.79	0.0950	0.1117	0.0179
RLTran	−0.1090**	−0.0243	−0.0657*	1.34	0.0923**	−0.3723***	−0.0620
DUrban	0.1624	0.6353***	0.3325***	6.77	0.1423	1.7805***	0.6780***
PGDP	−0.2553	−0.6586***	−0.3995***	5.05	−0.1596	−0.9618***	−0.8523***
Transport	−0.1159	−0.1326*	−0.0622	2.83	−0.1340	−0.1376	−0.1265
Education	−0.1607	−0.4417***	−0.3308***	2.95	−0.5346***	−0.2838	−0.0254
Rainfall	−0.2054***	−0.0964*	−0.1560***	1.46	−0.1103	−0.1697**	−0.3632***
Constant	0.1210	0.1935*	0.0788		−0.3461***	−0.4078*	0.3449**
Adjust R^2	0.4632	0.4461	0.4258		0.6274		
Observations	248	248	496		176	128	192

Note: ***p-value < 0.01; **p-value < 0.05; *p-value < 0.10. Crisis here denotes the global finical crisis in 2008, and we therefore use pre- and post-crisis to present the periods of 2000–2007 and 2008–2015, respectively.

nonagricultural employment opportunities.

4.3. Determinants of income inequality in rural China

Employing multiple approaches from different perspectives, we created a clear understanding of the geography of income inequality in rural China. The next question is what may account for these patterns of inequality, or why one place rather than others locates the hot spot of inequality. In association with theoretical and contextual issues, we first investigate the pooled panel analyses of interprovincial data to understand why income inequality presents the aforementioned pattern in rural China. Table 4 presents the results based on the pooled OLS regression and the SRM. Multicollinearity is not a problem because the VIF estimates are all less than 7.0. From the results, we easily generalize that the determinants of income inequality in rural China are diversified across regions and study periods.

From a temporal perspective, variables representing marketization, globalization, decentralization, and urbanization explain more of the total variance in the pre-crisis era (2000–07) than in post-crisis years (2008–15). This result well meets the decline of Gini with the deepening of economic transition (see Fig. 3). Foreign investment and imports of agriculture products as factors of globalization have an increasingly significant influence on the balanced development within the provinces, indicating that households in rural China become more open and that foreign investment has deeply embedded in China rather than merely focusing on urban areas. Marketization, however, plays a positive role in widening the income gap, which is inconsistent with our theoretical hypothesis. Particularly, the proportion of non-farm labor, coupled with demographic urbanization, has a positively significant influence on the inequality in the post-crisis stage. This indicates that the rural economy in China remains passively embedded in - rather than actively committed to - the market, which is in line with the findings of Liu (2006) pertaining to the changing nature of regional inequality in rural China from 1980 to 2002.

With reference to decentralization, uneven governmental investment, particularly in the pre-crisis years, is another significant impetus of income inequality in rural China. Fortunately, this phenomenon improved with the increase in domestic demands after the 2008 crisis. However, land transfer, as an important source of local revenues, is negatively related to rural inequality in the pre-crisis years. This confirms its positive impact on the rural households income growth, at least in the short-term, and partially refutes the argument on the negative effects of land finance (Wu et al., 2015). Regarding our expectation, the development of per capital GDP, transportation, and education, which are insignificant in the pre-crisis model, have strongly negative impacts in the post-crisis model. This means a developed socio-economic system will help the province to achieve a balanced development in rural regions. The decreasing significance of the negative correlation between rainfall and Gini partially meets the argument that the second nature, rather than the first, creates the uneven geographies on a uniform bio-physical backcloth (Sheppard, 2011).

When viewed from a spatial perspective, it can be seen that the influence of the quadruple-transition processes vary across regions. First, globalization factors are not as significant for income inequality in eastern China as they are in the central or western regions, which, as Wei (2007) has highlighted, is resulted from the gradual and uneven process of transition. The trend toward localization and local embeddedness of foreign firms in coastal regions narrows the gap of investment among counties, and therefore leads to an insignificant impact on the intra-province inequality. Regarding marketization, the proportions of rural non-farm labor have varied effects on the uneven development in eastern provinces and others. To be specific, the proportion of non-farm labor has a positively significant impact on the rural inequality in inland China, which has been uncovered across the country. However, an expected negative impact on the uneven development is disclosed in the east.

Coincidently, land transfer plays a negatively significant role in the central region, which is consistent with its aforementioned positive effect on the income growth of rural households. Notably, a positive effect is detected in the east, indicating that the high compensation for land expropriation may widen the income gap between land-deprived peasants and their counterparts. This result might be closely associated with the skyrocketing land prices in the suburbs of coastal cities, which has been uncovered by urban geographers (e.g., Ding and Zhao, 2014). In respect to the dimension of urbanization, more people dwelling in cities, especially in the interior, results in a higher level of rural inequality.

For the control variables, at least two interesting findings are notable (Table 4). First, as measured by *p*-value, the uneven development in rural areas is significantly affected by the increase of per capital GDP in central and western China, which has been recognized as efficiency promoting fairness. Second, rural inequality in coastal regions is more related to their human investment - represented by education in this study - with the role of geography becoming fuzzy. By contrast, regional disparities of rural income in inland provinces remains geographically determined, suggesting that transition processes tend to be more influential in the rural development of the coast, where socialist market reform was initiated much earlier than in the hinterland.

5. Discussion and conclusion

In this paper we investigated the geography of income inequality in rural China, with particular attention given to its transitional mechanisms. We conclude by discussing the key findings, some of which enhance our understanding of the influences of economic, social, institutional and external transitions on uneven development. And other findings more generally relate to understanding of the disparity in rural inequality across China.

Existent literature has indicated that China's rural regional inequality followed an increasing trajectory from the late 1970s (Liu, 2006). This article, however, confirms the bell-shaped curve with the finding that Gini indices in rural China decreased since 2008. This implies that provincial governments encouraged certain counties to 'get rich quick' and imitated the central state in successfully encouraging and realizing direct foreign investment. In addition, the changes in correlation between Gini and per capital GDP indicates that rural development will not enter an equilibrium of equality until the average surpasses the bottom line of the upper-middle level. This suggests a similar trajectory with the development that has been recorded in urban regions disclosed by economic geographers (e.g., Florida and Mellander, 2016; Lee et al., 2016; Wei, 2017).

With reference to the uneven patterns of rural inequality in China, this paper has demonstrated the significance of spatial dependence and self-reinforcing agglomeration. By mapping the pattern of rural inequality in coastal and inland provinces, we argue that inequality at the rural level is clearly different to national level inequality (Mah, 2013). Indeed, it reflects the spatial sorting of people with different characteristics into different places. These empirical findings also invite reflection on regions caught between rural inequality and economic transition. The spatio-temporal disparity in the rural inequality of provinces in China has been deeply embedded in its quadruple-transition process of marketization, globalization, decentralization, and urbanization. The influences of these factors are, however, different across regions and study periods.

Commenting further, we conclude that the process of globalization is more influential in those less globalized hinterlands than in their coastal counterparts; this is inconsistent with the findings of Wei (2007), and indicates that the benefit of globalization on the equal development in rural China is gradually expanding from the forefront of opening up (Long and Woods, 2011) to the hinterlands. Contrastively, marketization can hardly effectively narrow the gap between the rich and the poor counties - at least in rural sections, which confirms the argument that rural economy is still passively embedded in - rather than actively

committed to - the market in China (Long et al., 2012). This also echoes findings within the pioneering works undertaken by rural geographers over the last decade who suggested that performed in the last decade, when rural geographers suggested equalized development between the urban and rural regions was not equal (Liu et al., 2009; Woods, 2009; Long et al., 2011). The most striking result of this study is that rural inequality is less closely associated with the price fluctuation of agricultural products. This regarding indicates that the productivity rather than the price of products matters more in affecting China's rural inequality. This argument is reinforced by the aforementioned negative impact of rainfall in central and western China.

Decentralization, as a structural force behind the change of inequality in rural China, has to some extent exacerbated the income inequality in the past decade. This had also been illustrated by Fan (1997)'s study focusing on the uneven development policies. Coincidently, the logic of 'entrepreneurial government' (Wu, 2003) in urban geography seems to be relevant to understanding the uneven rural investment of local government. That is, local governments - like profit-seeking enterprises - tend to weigh the pros and cons before making a decision regarding public investment in rural regions, which is more evident in the rapid growth years. However, the income increase effect of land transfer for rural households was confirmed in the central regions and for the short term. This consequently falsified the debate on the negative effect of land finance (Wu et al., 2015). It is unexpected that rapid urbanization, particularly in the inland provinces, may widen the gap between the rich and the poor in rural regions. This might be the reason why Bai and colleagues (2014) suggested an optimum rate of urbanization to address or at least alleviate the issue of inequality.

From a policy perspective, we argue that policies in line with regional characteristics should be proposed to cope with the inequality as well as subsequent social problems. Since the late 1970s, provinces in China have witnessed a gradual and uneven process of transition in both internal and external dimensions. As a result, patterns of inequality in different provinces are widely divergent. Accordingly, both the central state and local governments have issued plenty policies/strategies (e.g., national strategies of "Western Development" and "Rise of Central China") to solve this problem. According to the strategy of 'countryside revitalization', recently delivered by President Jinping Xi at the 19th National Congress of the Communist Party of China, prompting a balanced and adequate development in rural region is established as a normative objective of building a moderately prosperous society. However, from the standpoint of local authorities, balanced rural development means not only a short-term welfare increase (Zhou et al., 2018), but also a long-term sustainable development (Liu et al., 2017b). We therefore argue that a unified market for rural property rights trading across the country and the further deepening of opening to the outside world in the hinterland provinces might be crucial to rural inequality and poverty alleviation. This research reminds policy-makers that there is a need to rethink whether the poverty in remote rural regions is due to the lack of natural endowments, poor geographic conditions and fragile ecological environment or the lag of institutional transformation during the fantastic rural restructuring (Long and Liu, 2016; Liu and Li, 2017). This research also identifies that further research is required on which of the aspects of urban and rural inequalities matters more or has greater influence over the whole regional inequality.

The research presented here has several limitations, and future improvements could focus on at least two aspects. First, given the relatively short temporal range and rough spatial scale in this study, further investigations at finer scales are still needed in the future to get a better understanding on the geography and evolution trajectories of rural inequality. By incorporating temporal effects in the traditional geographically weighted regression model, the spatially varying relationship between rural inequality and the transitional factors in different years can be captured in a more rigorous multi-variant environment. In addition, this specific comment is obviously part of a concern for the representativeness of statistical data. Although the data of per capita net income has been widely employed in the analysis of regional inequality (e.g., Ravallion, 2014; Paredes et al., 2016), it only include average information of administrative regions with the disparity among households being ignored. Scholars has documented that inequality based on officially statistical figures tends to be underestimated (Xie and Zhou, 2014), others however argue that much of the apparent increase in China's regional inequality is a statistical artifact (Li and Gibson, 2013). Apart from the unclear debate, the need to examine the detail inequality based on household survey data through further research is required.

Acknowledgment

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