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Balanced development: Nature environment and economic and social power in China

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ABSTRACT

Uneven spatial distribution of population and human activity still remain an inevitable problem for China's urbanization strategy and regional policies. The geographical detector technique was employed to re-investigated "Hu Line", an important population dividing line in China, and impact factors of population distribution from 1953 to 2010. Different from traditional views, we believe that rapid population concentration driven by social and economic factors leads to increasing similar spatial patterns between two sides of the "Hu Line". This trend offers a chance to realize a more balanced development by focusing on small-scale population concentration areas such as urban agglomerations. However, due to fundamental influence of some natural factors, gap among large-scale regions hard to be eliminated in China.

1. Introduction

There are some geographic dividing lines on the surface of the Earth, which have fundamental influence on spatial distribution of population and economic activities. For instance 11 of the world's 15 cities with more than 10 million people are located in the area at low elevations near coastlines (Cohen and Small, 1998); the per capita income in the temperate regions has four times that in the non-temperate regions (Sachs, 2001); nearly half of the world's population– approximately 3 billion people —— lived within 200 km of a coastline (Creel, 2003); most of countries with exceptional dense population are located in the area between 20°N and 40°N (Kummu and Varis, 2011). The facts show natural environment leads to uneven distribution of human activities and imbalanced development. Environmental determinism, developed in 19th century, emphasizes the significance of natural environment on development and human activities. However, with the decline of environmental determinism and rapid development of technology in 20th century, people believe that the key decisive factors on distribution of human activities are economic but natural factors such as incomes. That arise the questions: whether human is able to break the limit of geographic environment and achieve a more even development in a macro-scale space?

The question was that Chinese Premier Li Keqiang wondered. In 2014, Premier Li Keqiang hoped to break a famous dividing lines in the field of population geography in China and promote urbanization and modernization in the central and western regions of China. The dividing line–the setback to Premier's hope–is "Hu Line". "Hu Line" was discovered by Hu Huangyong, a famous Chinese geographer in 1935(Hu, 1935). The "Hu Line" starts from Aihui County (now, Heihe City, Heilongjiang Province) to Tengchong City (Yunnan Province) (Fig. 1). This line geographically divides the country's sparsely populated regions from its densely populated regions and clearly and accurately depicts uneven spatial distribution of population: the east is dense, while the west is sparse. China was in the stage of a traditional agricultural society in 1935. So "Hu Line" in a large extent reflects the impact of natural environment on population distribution in China.

However, balanced development among regions, the Premier hope, caused a huge controversy in China. Some argued that the impact of natural environment is so fundamental that "Hu Line" cannot be broken, while others argued China have made substantial progress in technology, infrastructure and economy, so proper regional policies can break the limit of "Hu Line" and achieve more

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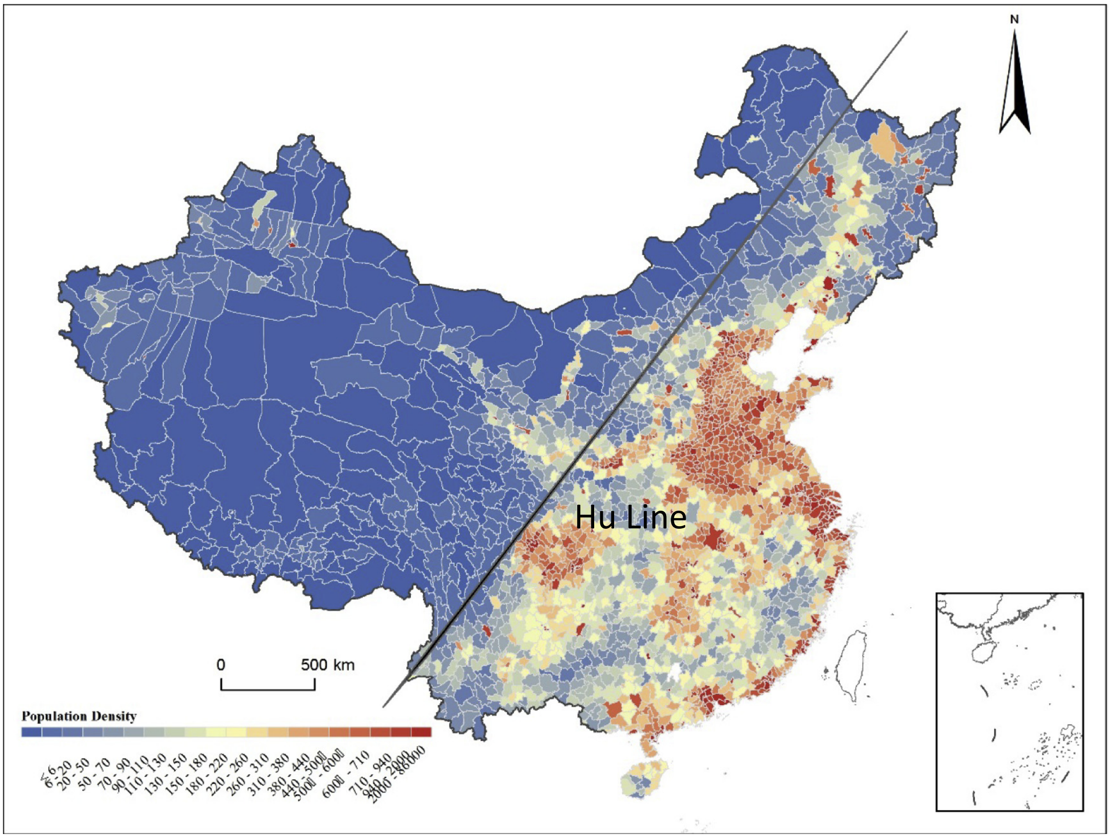

Fig. 1. The “Hu Line” and population density in 2010.

even development across the China. The investigations of “Hu Line” and changes of key factors on population distribution are helpful to deal with controversy. More importantly, the study is meaningful to understand balanced development across the world and make regional development policies. Although most of countries is different from China with diverse natural conditions, it is obvious that differences in natural conditions leads to imbalanced development across the world. Like China, can we break the limit of natural environment to get a more even world that deserve deep thought.

2. Literature research

Spatial distribution of population and human activities, one of major aspects in balanced development, has attracted a lot of attention. Main factors on spatial distribution can be classified into two categories: natural environment, which is intrinsic and unchanged to one site (at least in the short term), and economic and social development, which is acquired and changed rapidly. Researches on macro-scope tend to focus on natural environment factors. Cohen and Small (1998) found there was a negative correlation between elevation and population density, based on 19,032 administrative subdivisions with elevations across the world in 1994. As elevation decreases, the population density increases rapidly to more than 500 people/km2 below 100 m above sea level from 100–200 people/km2 at elevations above 300 m. Altitude were even a significant factor in human health in the 18th century (Riley, 1987; Dobson, 1997). Temperature zones and latitude are considered to be key natural factors on human economic activities. Many studies have shown a high correlation distance from the equator and economic performance (Theil and Chen, 1995; Hall and Jones, 1999). Sachs believed that poor performance in agriculture and health led to substantial lower income in tropical zone than that in temperate zone. The impact of environment conditions such as rainfall on migration has become a hot topic in recent years. Henry et al. (2004) found people living in areas with low rainfall were more likely to have a rural–rural migration than those living in areas with great rainfall. Drought and desertification were regarded as major drivers of migration in the Sahel, Ethiopia, Argentina, Brazil, Syria and Iran (Hammer, 2004; Leighton, 2006; Piguet, 2008; Hunter et al., 2013).

Although climate change leads to a large number of environmental refugees that has attracted lots of attention, economic and social development has important influence on population movement, especially in small scale space such as movement from rural to urban area. Economists have long discovered a tight correspondence between industrialization stage and labor mobility (Kuznets, 1968; Rostow, 1971). Plenty of literature has confirmed the impact of wage differential and employment opportunity on migration (Neto and Mullet, 1998; Yankow, 2003; Lehmer and Ludsteck, 2011). Evidences have also shown the gap between rural and urban in income and productivity contributed to rural–urban migration in China (Fan, 2008; Chan, 2012). Recently, the impact of public health on migration has attracted some scholar's attention in China (Hu et al., 2008; Chen, 2011). They believed that more even distribution of public service would relieve the pressure of big cities from migration.

There are lots of studies on distribution of human activities and migration. However, few have been yet made of which factors are dominant and how change with the progress of technology and society. For the significance of environment and economic factors, the assessment is far from agreed up. Hall and Jones (1999) argued high correlation between latitude and economic performance is merely because this variable is a good proxy for social infrastructure; while McKenzie et al. (2010) using data from Tonga-New Zealand migration find all conventional estimation methods clearly overestimate the income gains from migration. Moreover, literature has turned a blind eye to changes of key factors at different development stages.

Besides, methods of investigation of population distribution are usually ignored. Simple measures like population ratios may be problematic. Take population distribution in China, for instance. Empirical researches have confirmed that the population ratio either side of the "Hu Line" has remained at roughly 94:6 for more than eight decades since 1935 (Hu, 1990; Qi et al., 2016). However, rapid surges in migration have occurred in China in recent decades, especially since the "reform and opening up" policies of the late 1970s. From the 1980s onwards, governmental rural-urban migration policies were eased and the economy began to experience rapid growth. In response, the size of the country's floating population grew rapidly, exceeding 50 million people in the mid-1990s and accounting for up to 20% of the total population of some large cities such as Beijing (Chang, 1996; Goodkind and West, 2002; Chan, 2012). Increases in the size of China's floating population inevitably produced changes in the spatial patterns of China's population. The fact that the steady population distribution pattern described by the "Hu Line" was maintained at the same time that the country experienced mass internal migration seems, at the outset, to be inconsistent. Simple population ratios should be blamed and it, as in this case, can fail to reflect changes in the macro-spatial patterns of population. More complex measures like the geographical detector method have been helpful in better addressing such complexity. This method also identify the significance of each factor.

In this study, we employed new method to reinvestigate population zones produced by the "Hu Line" and other geographic dividing lines, in the view of spatial stratified heterogeneity. Moreover, we identified the significance of natural and economic factors on China's population distribution and their changes from 1953 onwards. These changes would imply some general tendencies with social development, which are meaningful to achieve more even development not only for China but also for countries in the rest of the world.

3. Data and methodology

3.1. Data

In this study, three categories of dataset were employed. Firstly, we collected county-level population data from the national census datasets for 1953, 1982, 1990, 2000, and 2010, using a map of administrative districts for 2002. We revised the population data in accordance with adjustments in administrative boundaries over the years studied. Secondly, the three natural factors of altitude, climate, and landform were used to test the influence exerted by the natural environment on population distribution. These data were derived from natural environment zones published by Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences (RESDC). Although natural environmental factors such as rainfall changed over the years studied, these changes were minimal and had little impact on this investigation, which addressed the national level. Finally, variables describing China's economic and social development were collected from the China Statistical Yearbook. These variables included: the level of industrialization, the level of economic development, employment opportunity, the level of public service and food supply capacity. Since it was difficult to find historical data of economic and social development at the county level, investigations of economic and social development at the province level were used to make the annual data comparable. Using these data sources, this research was able to identify changes in the influence exerted by both natural and economic factors during a period of more than eighty years.

3.2. Methodology

The "Hu Line" divides mainland China into two regions: one made up of densely populated regions, and one made up of sparsely populated regions. The suitability of this division can be judged by the heterogeneity between two areas. The geographical detector technique is one of few methods that are able to determine the significance of the degree of spatially stratified heterogeneity. This method, proposed by Wang et al. (2010), has been widely used in analyzing the effects of underlying factors. Wang et al. (2016) have, using the free software GeoDetector, also proved that the q-statistic is a good indicator of stratified heterogeneity effects. The formula that forms the basis of the technique is as follows:

$$q_{D,U} = 1 - \frac{1}{N\sigma^2}\sum_{h=1}^{L} N_h \sigma_h^2$$

where $q_{D,U}$ is the indicator of the degree of stratified heterogeneity of population; N_h is the sample size of the sub-regions; N is the total sample size; L is the number of sub-regions; σ^2 is the global variance of county-level population in mainland China; and σ_h^2 is the variance of county-level population in one sub-region.

In simple terms, $q_{D,U} = 1 -$ (the sum of the variances in all sub-regions/the global variance in mainland China). When sub-regions are divided according to one factor, such as "Hu Line", the value of $q_{D,U}$ shows the degree of the impact of "Hu Line" on population distribution in mainland China. The value of $q_{D,U}$ lies in $[0, 1]$; when $q_{D,U} = 0$, this indicates that "Hu Line" has no impact on population distribution, when $q_{D,U} = 1$, this indicates that cities with a large population and cities with small scale population are wholly separated by "Hu Line". As such, as the value of $q_{D,U}$ increases, the division improves and exerts a heavier impact on population distribution.

Therefore, besides of changes of classification system suitability over time, the geographical detector technique can also be used to detect the effects of natural or economic factors on population distribution. Each factor divides mainland China into several sub-regions, as "Hu Line" does. According to the value of q, we know the degree of impact of factors on population distribution.

Compared with traditional econometric models, the geographical detector is free from the collinearity problem between independent variables. In essence, it reflects the effect of independent variables through comparing the consistency of spatial patterns between dependent variable and independent variables. There was very little possibility that space boundaries and ranges of sub-regions divided by different independent variables are the same. For each factor, the value of q indicates that the explanatory power of population distribution is 100*q%.

Taking several sub-regions as independent variables means independent variables are type variables rather than numerical variables in the geographical detector. So the data of natural and economic factors need to be further handled by classification or discretization. For three nature factors, we classified them according to wildly accepted natural zonings. Specifically, there were three altitude zonings according to the Three Gradient Terrains: the First Gradient Terrain is the area below 600 m, the Second is between 600 and 2600 m and the Third is above 2600 m; landform types were grouped into 4 groups: plains, mesas, hills, and mountains, based on 26 categories of landform from RESDC; rainfall zones were also able to be classified into four by three isohyetal lines of 200 mm, 400 mm, and 800 mm. For economic and social factors, four in five factors needed to be discretized: the level of economic development, employment opportunity, the level of public service and food supply capacity. The level of economic development was represented by per capita GDP, which is highly correlated with income level; the latter three variables were represented by the scale of employment, the number of doctors per ten thousand and per capita grain output respectively. These four factors were discretized by natural break method. Each factor was discretized into five classes, producing five regions in mainland China based on the classification of each factor. The process of industrialization are divided into five stages: pre-industrialization, initial industrialization, mid-stage industrialization, late industrialization and post-industrialization, according to Kuznets's theory of industrial structure.

4. Re-investigation of the “Hu Line” and its confirmation

4.1. The decline of stratified heterogeneity in both sides of “Hu Line”

Generally, imbalanced population distribution characteristics, shown by “Hu Line”, still exists in mainland China. The densely populated region in the southeast (on the right of “Hu Line”) occupied 36% of the land mass, but 96% of the population; the sparsely populated region in the northwest (on the left of “Hu Line”) comprised of 64% of China, but only 4% of the population in 1933. As the national boundary of China has changed and is different from that in 1933, the shares of population in the densely and sparsely populated regions are about 94% and 6% respectively according to new national boundary. Although population densities have increased significantly in both regions, the ratio of total population between these two regions has kept at roughly 94:6 since 1953 (Table 1). The share of the densely populated region in the southeast has merely decreased about 1% during nearly 60 years from 1953 to 2010.

The “Hu Line” has reflected the fundamental influence of natural conditions on spatial distribution of human activities. There is a good correspondence between nature conditions and human activities: populous southeastern China is warm and rainy and relatively flat, while most are cold and arid mountainous areas in the northwest. However, as dismantling migration barriers after the reform, expanding of the developmental disparity among regions lead to a large number of floating population. Migration has changed population spatial pattern in China. Just because most of people migrated at the inside of the densely populated regions in southeast China. So simple ratio of population between southeastern and northwestern regions covered up the changes. The geographical detector well reveals these changes through stratified heterogeneity of population in both sides of the “Hu Line”.

Re-investigation of the “Hu Line” by stratified heterogeneity have highlighted changes of population distribution patterns since 1953. The results show that the value of the q-statistic (the indicator of stratified heterogeneity) increased from 0.0974 in 1953 to 0.1210 in 1982, a period that was followed by an obvious decrease and the figure was just 0.0223 in 2010. A significant decline was witnessed between 1990 and 2000. The value of the q-statistic sharply decreased from 0.1024 to 0.0231 in this period. It means heterogeneity between densely and sparsely populated regions on the whole declined after 1982, especially 1990. In other words, the spatial distribution pattern of cities with a large population and cities with a small population became increasingly similar in both regions.

Therefore, the results of re-investigation indicate a radical change during 1990s in China. Importantly, this change leads to a decreasing significance of the zones set out through the “Hu Line”, from the perspective of the clustering patterns of large and small cities. These findings are inconsistent with traditional view. To confirm the results of re-investigation through the geographical detector, an exploratory spatial data analysis (ESDA) was thus employed in order to investigate what happened to the population distribution in the decades following the 1990s in China.

4.2. Changes of spatial patterns of population in China

When population data is aggregated data based on administrative districts just like our case, Local Moran's I is a proper method to show characteristics of population distribution (Anselin, 1995). So Local Moran's I is employed to plot clustering characteristics of population and their changes during the period from 1953 to 2010.

LISA maps shows that in southeastern China, population spatial distribution transformed from a relative even distribution to a highly concentrated pattern. The degree of population concentration was low for a long time before 2000 in the southeast. As areas with large populations shrank sharply after the 1990s in some smaller regions such as the Yangzi River Delta and the Pearl River Delta, population distribution was highly concentrated in space (Fig. 2). In northwestern China, the changes witnessed were not as dramatic. Lanzhou, Xining, and Hohhot, and their surrounding areas were always the most concentrated areas, with the largest populations in the northwest.

Results from measurement of the Gini coefficient further confirmed these findings. While the value of the Gini coefficient rapidly increased—from 0.367 to 0.508 during the decades of 1990–2010—in the southeast, the figure still kept above 0.450 in 2010 in the northwest, despite of a gradual decline from 1953 onwards, as Fig. 3 shows. Moreover, the share of population living in large cities remained steady in the northwest. The top 5% biggest cities accommodated more than one fifth and even up to 23.44% of the total population in 2000. The decrease of share of population in medium-sized cities and the increase of share in small cities led to a gradual decline of concentration of population.

The results from both LISA map and the Gini coefficient further

Table 1
Demographic changes on both sides of the Hu Line, 1953–2010.

Year	Densely populated region in southeast China			Sparsely populated region in northwest China		
	Total population (100 million)	Ratio(%)	Population density (n/Km2)	Total population (100 million)	Ratio(%)	Population density (n/Km2)
1953	5.71	94.80	139.51	0.31	5.20	5.83
1982	9.45	94.23	230.25	0.58	5.77	10.82
1990	10.64	94.13	259.00	0.66	5.87	12.40
2000	11.67	93.89	283.98	0.76	6.11	14.18
2010	12.49	93.68	303.92	0.84	6.32	15.72

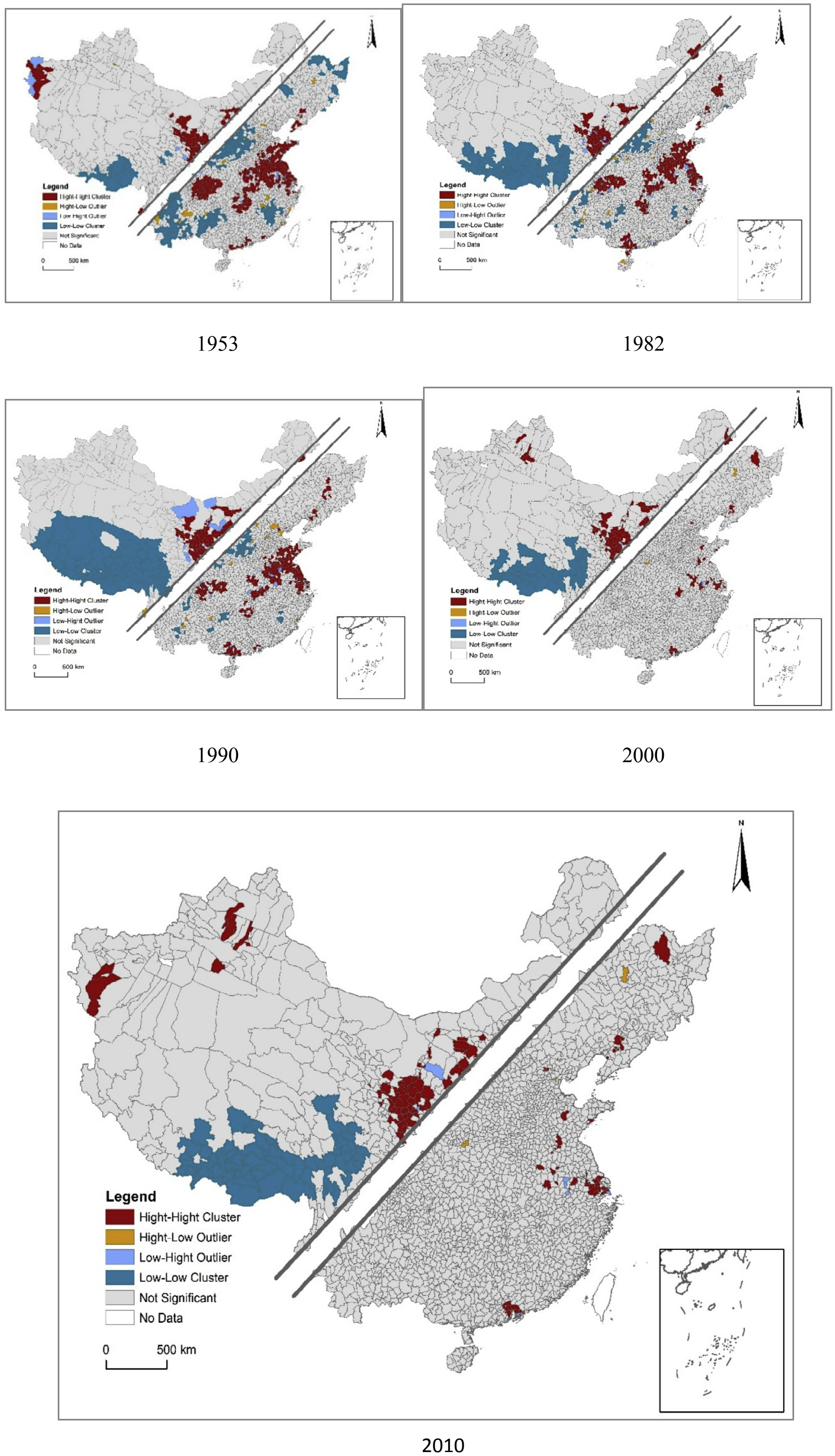

Fig. 2. Changes in the agglomeration pattern in southeastern and northwestern China.

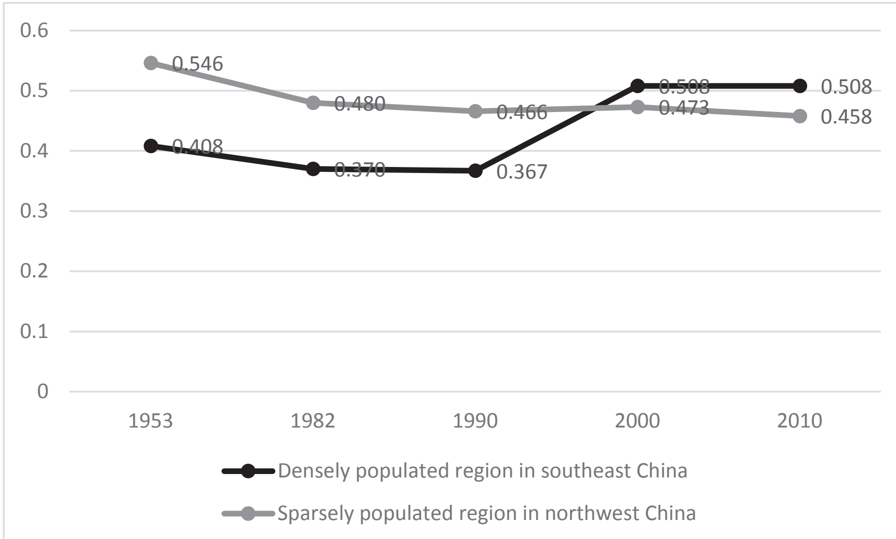

Fig. 3. Changes in the demographic Gini coefficient on both sides of the Hu Line.

confirm the findings of stratified heterogeneity. As people rapidly concentrated into few regions after 1990, spatial patterns of population tended to similar and stratified heterogeneity significantly declined in both sides of the "Hu Line" between 1990 and 2000. Therefore, for China, the most notable difference will lie in the difference between urban agglomeration areas characterized by dense concentrations of population and those areas that remain sparse in terms of their population, rather than between the southeast and the northwest in the present.

5. Economic and social factors vs natural factors in relation to population distribution

The decline of stratified heterogeneity and changes of spatial pattern of population in both sides of the "Hu Line" indicate that the driving force of population distribution is changing. Before the reform in 1978, China was still a largely agricultural society and merely less than 1/5 of people lived in the cities. The dominant power in an agricultural nation is natural condition. Significant differences of the natural condition causes remarkable imbalanced development between southeast and northwest China. After the reform, the gap of total population was still very wide in both sides of the "Hu Line", but spatial patterns of population distribution were increasingly resembling. It means, to a certain degree, the level of imbalanced development is reduced between regions. The reform fundamentally changes economic and social condition but has little impact on natural environment. So economic and social factors probably promote movement of population between the urban and rural sectors and between regions and reduce the imbalance in China.

On the part of literature review, we find that three nature factors including elevation, landform and rainfall are closely related to population spatial distribution; four economic and social factors including income, employment, public service and the level of industrialization have impact on population mobility. In the study, per capita GDP and the number of doctors per ten thousand population are used to represent income and public service respectively. Besides, per capita grain output is also put into the model. This variable reflect the food supply capacity in a region. The food supply is a decisive factor to regional population size, especially in the agricultural society with a poor transportation system. The geographical detector technique is used to answer not only which factors are important in one stage but also how the effect of these factors change in different stages. The latter question is the key to balanced development in China.

5.1. Economic and social power increases while the effect of natural condition decreases

Generally, the relative significance of the natural environment was found to have gradually decreased, while the influence exerted by economic development factors became increasingly important in relation to the distribution of population in mainland China. The total explanatory power of determinant (PD) values, calculated by summing the q-values of the three natural factors or five economic factors, indicate clearly this change process. According to Table 2, the total PD of the three natural factors, namely the sum of q-values of elevation, landform and rainfall, was 0.2879 in 1953, while that of the five economic factors, namely the sum of q-values of the level of industrialization, per capital GDP, employment, the number of doctors and per capita grain output, was only 0.2502. However, by 2010, the former value had decreased to 0.0866 and the latter increased to 0.1385. Although the absolute values of the economic factors also decreased, the impact of economic development on population distribution is notably larger than the impact of the natural environment.

Economic reform seems a significant turning point. The effects of three natural factors have begun to decline since 1982. Up to 1990, the power of the economic factors studied generally surpassed that of the natural factors in relation to population distribution. The total PD of the five economic factors investigated was found to be 0.3225, while that of the three natural factors was 0.2920 in 1990.

5.2. The increase of effects of five social and economic factors were not simultaneously

There is periodic characteristics of social and economic factors: the most influential factors are different in various development stage. Employment and per capita grain output are the two economic factors that were found to first increase then decrease in their relative significance. The significance of per capita grain

Table 2
The changes of relative effect of natural and economic factors.

Year	Natural factors				Economic Factors					
	Elevation	Landform	Rainfall	The total PD	The level of industrialization	Per capita GDP	Employment	The number of doctors per ten thousand population	Per capita grain output	The total PD
1953	0.1548	0.0617	0.0714	0.2879	0.0485	0.0547	0.0880	0.0371	0.0219	0.2505
1982	0.1940	0.0721	0.0813	0.3474	0.0118	0.0442	0.1008	0.0713	0.0864	0.3145
1990	0.1625	0.0653	0.0642	0.292	0.0697	0.0716	0.1039	0.0385	0.0388	0.3225
2000	0.0447	0.0263	0.0167	0.0877	0.0263	0.0258	0.0283	0.0179	0.0030	0.1013
2010	0.0438	0.0275	0.0153	0.0866	0.0314	0.0380	0.0238	0.0249	0.0204	0.1385

output increase fast and was greater than that of per capita GDP and the number of doctors per ten thousand people in the initial of the reform. But, since 1990, per capita grain output became one of the least important factors. Moreover, employment was also found to decrease in significance in relation to China's population distribution after the turn of the century; before this point, however, its relative significance steadily ranked second place. In fact, until 2000, employment was the most significant economic factor in relation to population distribution, a finding that indicates that job opportunities were in fact more important than income and wage levels for domestic migration in the initial period of industrialization (Table 2).

The level of industrialization, per capita GDP, and the number of doctors per ten thousand people became more influential after 1980s. For per capita GDP, the q-value ranked 7th among 8 factors investigated in 1982, while it was just second to the q-value of elevation in 2010. Another two economic factors– the level of industrialization and the number of doctors per ten thousand population –also steadily increased from 8th place in 1982 and 1990 respectively to 3rd and 5th in 2010. Our results also reveal that the relative significance of these three economic factors studied gradually increased after 1982. This finding indicates that with the implementation of the reform, the impact of the industrial structure, income levels and public service levels increased in relation to population distribution and migration. Some differences can be noted in the increasing impact of these three factors in temporal terms. Changes in the relative significance of the industrialization level and per capita GDP were particularly close—these two factors both had little effect before 1990 (in fact, they were the least important factors in 1982) before increasingly rapidly in significance after the 1990s in order to become the most powerful factors in 2010. In comparison, the relative significance of the number of doctors per ten thousand people began to increase significantly after 2000. This finding possibly implies that the importance of public service gradually becomes apparent at a point when income and economic development have reached a certain level.

5.3. *Elevation was still the most important factor until nowadays*

The relative significance of the majority of the natural factors addressed in this study showed prominent decreases after China's reform. Rainfall, which is traditionally considered to be the most important factors for China's population distribution, also witnessed a marked decrease in its significance for population distribution during the study period. Elevation and landforms also had a steady decline in influence from 1982 onwards.

However, the factor of elevation remained the most important determinant among all of the eight factors on China's population distribution until 2010. Therefore, although the significance of natural environment has declined due to great achievements in economic, technological, and infrastructural development since the reform, some nature factors are still fundamental and decisive to China's population distribution. Human activities are hard to completely free from the limitations imposed by the natural world.

6. Conclusion and discussion

In this research, we used the geographical detector technique to re-investigate a famous geographic line dividing China's sparsely and densely populated regions—namely, the “Hu Line.” The findings of this study deviate from those of previously published studies. The Hu Line is usually believed to be almost unchanged, and still important for China's population distribution, because the population ratio has remained at roughly 94:6 between the two regions divided by this line, for over 80 years. Although the results of this study again confirm this ratio, the findings also show that the importance of Hu Line had gradually decreased in relation to China's population distribution. The degree of spatially stratified heterogeneity of population between the two sides of the Hu Line witnessed a steady decline from 1982 onwards and evidenced a dramatic decline between 1990 and 2000. This indicates that the spatial pattern of population, as it was distributed between the two regions divided by Hu Line, progressively tended to become more similar, especially after 1990s.

It seems that the 1990s is a vital period of transition. In that time, with the significant decline of degree of spatially stratified heterogeneity, the total PD of social and economic factors exceeded that of nature factors. Besides, the 1990s have also witnessed the increasing number of“floating” population in China. Some scholars have argued that labor migration flows in the 1990s were closely bound to huge disparities in wages between the urban and rural sectors and between regions in China (Cai, 1999; Fan, 2008). Although our results show the number of job position was more important than income level in 1990s, there is no doubt that economic factors have also played a dominant role in the process of population redistribution and migration since then. Population mobility and concentration driven by economic factors lead to a similar population distribution patterns in the two sides of “Hu Line”. Importantly, this kind of similarity provides a chance to develop more evenly in China, where natural conditions are far different among sub-regions.

Urban agglomeration areas are the key for balanced development in China. Rapid convergence of population has contributed to some urban agglomerations with dense populations in both Eastern and Western China. It is clear that those urban agglomerations are located in the regions such as the Yangzi River Delta in the eastern China. Despite of a little decline of demographic Gini coefficient in the western China, the share of population in the top five percent of cities also had a modest increase after the reform. Depending on rich resources and policy support from central governments, these large urban agglomerations in the west have chance to catch up the counterparts in the east. In part, because micro-scale cities are not affected seriously by natural environment.

However, the situation in large-scale regions is entirely different. Due to fundamental influence of some natural factors, gap among regions possibly could be narrowed a little but hard to be eliminated on a macro scale. For China. Three Gradient Terrains, divided by the altitude, has always been the single biggest determinant for population distribution in China, and even now. Besides, plenty of researches have confirm that altitude has affected infectious diseases, human reproductive physiology and other physiological functions (Merler et al., 1996; Cogswell and Yip, 1995; Ghio et al., 1996). So balanced development strategy should focus on large cities and urban agglomeration areas but regions.

Those policies, drafted to realize balanced development, should consider the diversified trend and periodic characteristics of economic and social factors. The findings showed that job opportunities were the most important factor in the initial period of the reform, followed by incomes and wages; it was only when income reached a certain level that public services began to play an important role in population migration (Fig. 4). On the one hand, with the development of the society, more and more economic and social factors begin to impact on human activities. In other words, when migrating, people takes into account more and more factors. So urban agglomeration areas should take a comprehensive view of development to meet diversified demand, rather than just offering massive jobs with low wage or focusing on economic growth but neglecting public service. Actually, the diversified trend is also one potential reason that led to the power of all factors decrease dramatically after 2000. The growing fluidity and diversity of life have impact on residential mobility (Coulter et al., 2016). Evidence has also been presented that suggests changes in the hukou system, gender, and marriage have impacted on China's migration (Chan and Zhang, 1999; Fan, 2008; Lin and Zhu, 2015).

On the other hand, the sequence of changes in these economic factors means that the most influential factors are different in various stages of development. For urban agglomerations in the western China, income and industrial structure, especially the former, started to reshape the spatial pattern of population at this stage. So simply improving public services may have a limited impact on migration if incomes have not reached a sufficient level.

There still be one questions: why economic factors seemed little effect in the initial period of the reform. Brown (1997) notes that even early on in Russia's transition, economic factors like average wages determined migration. The population migration pattern seen during China's transition differs in this sense from that witnessed during similar transitions in other countries such as Russia. Besides of unique household registration system, the massive rural industrialization of China should be blamed. Rural industrialization led to a heavily decentralized economy in the beginning of the country's reform. At that time average wages and income levels in urban areas were not significantly higher than those in rural area. China's rural industrialization had begun already in 1953 (Sigurdson, 1977)—as such, the impact of the natural environment on population distribution even increased in the period 1952–1982.

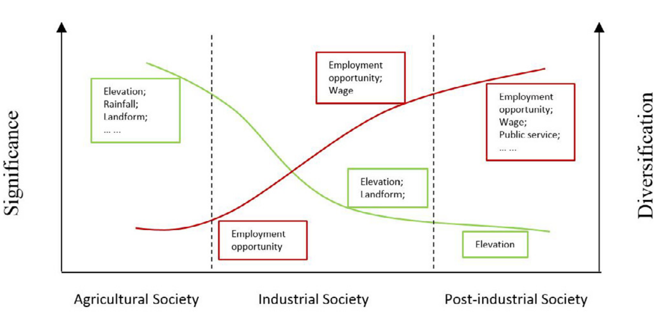

Fig. 4. Changes of impact of natural environment and economic and social power on spatial distribution of human activities.

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