PATHWAYS OF SUSTAINABLE URBAN DEVELOPMENT ACROSS CHINA

THE CASES OF HANGZHOU, DATONG AND ZHUHAI

medium
New pathways for sustainable urban development in China's medium-sized cities

Edited by
NATACHA AVELINE-DUBACH

This e-book gives an overview of the research work carried out within the framework of the MEDIUM project. Entitled "New pathways for sustainable urban development in China's medium-sized cities", the MEDIUM project was funded by the European Commission under EuropeAid program, and run for three years (09/2015—08/2018). Its main objective was to train European young researchers in the knowledge of urban China and to foster Sino-European scientific cooperation on urban development. Various means have been deployed to this end, including medium-term mobility schemes to conduct research in China, and by co-organizing a series of scientific events with Chinese universities.

https://mediumcities-china.org/

Published by Imago Editor
First Edition

https://imagoeditor.net
ISBN: 978-88-94384-71-0

Contents

Chapter 3. Spatial statistical analysis of GDP growth in Zhejiang province

Veronica Distefano, Irene Poli, Debora Slanzi

Veronica Distefano
European Centre for Living Technology, Ca' Foscari University of Venice, Italy.

Irene Poli
Professor at the Department of Management, Ca' Foscari University of Venice, Italy.

Debora Slanzi
European Centre for Living Technology, Ca' Foscari University of Venice, Italy.
Department of Management, Ca' Foscari University of Venice, Italy.

Abstract

In recent years China has experienced a rapid and strong economic development with high rates of growth of the GDP. This development, sustained by great public investments, may have produced, or changed, some territorial inequalities, focusing more in some regions with respect to others. With the aim to evaluate this process and possible effects on the Chinese society we conducted a spatial statistical analysis on regional inequalities in Zhejiang province, one of the most developed provinces of China. This spatial analysis is based on per capita GDP, here proposed as principal indicator of regional economic development, and is conducted both at prefecture level and at county level division, in the period 2010-2016. The choice of this regional units is motivated by the limited contributions in the literature on this territorial level, since most of the studies have been conducted on the whole provinces or macro regions. The provincial inequality is firstly measured with Gini coefficient and then the intra-provincial inequality is measured with spatial statistical techniques, which include Moran I index, spatial autocorrelation, GIS map. This analysis shows that in the period considered the overall inequalities are decreased, with a remarkable spatial dependence relation at the county level.

Keywords: Spatial statistical; data analysis; per capita GDP; Gini coefficient; Moran I index.

1. Introduction

Since the beginning of the reform of 1978, China's economy has achieved a rapid development in all the regions through a process of decentralization and globalization. This rapid economic growth in the era of reform is associated with a spatially uneven development with profound changes especially between coastal and inland China, as described by (Li and Wei 2010; Xue and Zeng 2016; Xue et al. 2016). The main factors that have characterized the unequal rate of growth are the differences in the level of infrastructure development, proximity to markets and coastal areas, natural resource endowments, demographic factors and regional policy (Stiglitz 2012). These factors in fact seem to have determined the economic wealth mainly in some regions of China. This regional inequality has been one of the most salient features of develop-

ment in China, and it may threaten national unity and social stability. Moreover, the presence of economic inequality between regions might have been an obstacle to the sustainable growth, as discussed in (Alesina and Rodrik 1991; Persson and Tabellini 2011; Zhang 2016). Wei and Fan (2000) have argued that "Inequalities exist within provinces, and the spatial transformation in China cannot be thoroughly understood without the study of intra-provincial inequality"(Graham and Ernstson 2012). Hence, China's government has been, and is committed to resolve this regional inequality based on different spatial scale-level (Yue et al. 2014; Wei et al. 2009; Chen et al. 2012), including at region-level (Lyhagen and Rickne 2013; Xu et al.2005; Fan et al. 2011), at province-level (Zhang et al. 2016; Zhang 2012), and intra-provincial-level (Chen 2012).

However, although most studies have been focused on the evolution of regional in-equality among Chinese provinces and groups of provinces (Li et al. 2010; Li and Fang 2014; Wei et al.2009; Fan and Sun 2008; Ye and Chen 2008) recently the research on the regional inequality in China has been extended to intra-provincial analysis of inequalities. Notably, this last aspect has been developed with the recent advancements in the GIS technology (Geographical Information System) and spatial statistical analysis (Berry et al. 1968), which have been provided to analyze spatial association, agglomeration and clustering (Bailey and Gatrell 1995).

Indeed, with the aid of GIS technology and spatial statistical methods, the patterns of regional inequality can be deeply explored at regional, municipal and county levels.

In this paper, GIS technology is integrated with spatial statistical methods for analyze regional inequality. In particular, applying this methodology we can investigate Zheijang province inequality at the county level using a dataset that include Percapita GDP based on resident population.

We employed the 89 counties of Zhejiang province as spatial data in two different period 2010 and 2016. The source of data have been collected from "Statistical Year-book Zheijang Province (2005, 2010 and 2016)". In this work, we investigated the intra-provincial inequality in Zheijang province to achieve a measure of inequality among the counties and evaluate the dynamics of this inequality in the period 2010-2016. With this aim, we adopted the Gini coefficient and the spatial autocorrelation indicators.

The results that we achieved show that per capita GDP inequality at county level in Zheijang province is decreased according to Gini coefficient. This decreasing inequality is characterized by a local dependence relation of per capita GDP increase, for which high levels of county per capita GDP affect the neighbor counties as wellas low levels of county per capita GDP affect the levels of the neighbor counties. This aspect of the inequality is confirmed by the spatial autocorrelation indicators. The paper is structured as follows: Section 2 presents a brief description of the study area of Zhejiang province; Section 3 describes the measures of intra-provincial inequality adopted such as Gini coefficient, for investigating the level of intra-provincial inequality, and Moran's index and GIS technology for studing spatial autocorrelation (Anse-

lin 1995; Anselin 1996). Section 4 presents the results of our study showing the intra-provincial inequalities dynamics in the period 2010-2016.

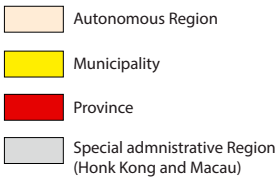
2. The Zheijang province

According to the Constitution of the People's Republic of China, currently in China there are three levels of administration, described below (china.org.cn):

- the first level includes provinces, autonomous regions and municipalities directly under the Central Government;
- the second level includes provinces and autonomous regions which are divided into autonomous prefectures, counties, autonomous counties and cities;
- the third level includes counties and autonomous counties which are divided into townships, nationality townships and towns;
-

With reference to the first administrative level there are 34 divisions, classified as 23 provinces, 4 municipalities, 5 autonomous regions and 2 special administered regions. The four municipalities are: Beijing, Shanghai, Tianjin and Chongqing, while the special administrative regions are Hong Kong and Macau. We describe this administrative level in Fig. 1.

Figure 1
The administrative level in China.



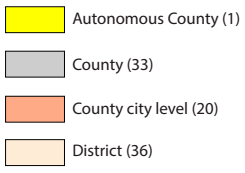
In this study we focus on Zheijang province. It is probably one of the provinces of China that has most benefited from the reform policies, and its economic and social growth reflects the economic trend of many other coastal provinces such as Jiangsu and Shandong. It covers approximately an area of 101.800 square kilometers, that is one of the smallest province of China (only 1.06% of total area of China). Moreover, the area of the province encompasses 70.4% territory in mountains and hills, 23.2% in plains and basins, and 6.4% in water surface. Zhejiang province is located on the east coast of China and it is bordered by Jiangsu Province and Shanghai municipality to the north, Anhui and Jiangxi Province to the west, and Fujian Province to the south. Hangzhou is the capital of Zhejiang Province, and Ningbo is directly under the jurisdiction of the national central government. In addition, more than 3061 islands (each with a land area of > 500 m2) are distributed in this coastal area.

Zheijang province in the year 2016 includes 11 cities at prefecture level and 89 county level (36 districts, 20 county-level cities, 33 counties). In particular, the 11 cities are classified in two sub-provincial cities, namely Hangzhou and Ningbo and nine prefecture-level cities, namely Wenzhou, Huzhou, Jiaxing, Shaoxing, Jinhua, Quzhou, Zhoushan, Taizhou and Lishui.

The administrative structure of Zheijang province is presented in Fig. 2 where Fig. a) describes the prefecture administrative level while the Fig. 2 b) describes the county administration level.

Finally, the Zhejiang province is traditionally divided into northeast (Hangzhou, Ningbo, Jiaxing, Huzhou, Shaoxing, Zhoushan) and southwest (Wenzhou, Jinhua, Quzhou, Taizhou, Lishui)..

Figure 2
The administrative division of Zheijang province: a) prefecture administration level (11 prefectures) and b) the county administration level (89 counties).



3. Inequality measures

To develop a study on economic inequality among counties in the Zheijang province, we used the following inequality measures:

- Gini coefficient to evaluate the level and the dynamics of the inequality in the period 2010-2016;
- the Moran index, the spatial autocorrelation and GIS maps to study the local dependence among the counties, adopted spatial autocorrelation indicator.

3.1 Gini coefficient of inequality

As a measure of inequality we adopted Gini coefficient since it is a very well know and commonly used indicator for evaluating the wealth and income inequality (Sen 1997; Cowell 2000).

The Gini coefficient is defined as follows (Gini 1912)::

$$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j|}{2n^2 \sum_{i=1}^{n} x_i}$$

where xi and xj in this analysis represents the value of per capita GDP in county i and county j, respectively, and n is the number of counties. This coefficient takevalues from 0 to 1, where 0 indicates perfect equality, namely the total income is distributed evenly between counties, and 1 indicates a perfect inequality situation whit only one county gets whole income. Gini coefficient can be viewed as a indicator that allows to measure how equity has changed in a given situation over time, in particular how per capita GDP changed among all the counties in Zheijang province in the period considered.

3.2 Moran's index and spatial autocorrelation

TThe Global Moran's index is a measure of spatial clustering (Cliff and Ord 1981; Upton and Fingleton 1985) and it is used to detect global and local spatial dependence and autocorrelation among regions. In general, the index provides a formal indication of the degree of linear association between the spatial units and their neighbors. Considering Zhejiang Province divided in n counties Moran's I index takes in the following form::

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

wwhere xi and xj represents in our study per capita GDP for counties i and j, y is the mean of the value of the n counties; and wi j is the spatial weight matrix element that measures the strength of the relationship between two spatial units. The spatial weights are used to measure the spatial contiguity or

neighborhood of a given county.

The values of the Moran's I range from −1 to +1. Positive values suggest the presence of spatial clustering of similar values (positive spatial autocorrelation) while negative values indicate spatial clustering of dissimilar values (negative spatial autocorrelation). A value equal to 0 means a random spatial pattern.

In literature several methods to define the spatial weights matrices have been proposed. These methods can be based on distance between neighbors or spatially contiguous neighbors.

In this work, the spatial weights matrix is based on territorial contiguity of the counties. Therefore, wi j is a binary weight matrix, such that, wi j= 1 if the i-th object is adjacent to the j-th object (share a boundary) , wi j= 0 otherwise. Usually, the spatial weights matrix is row-standardized such that the elements wi j in each row sum to 1.

3.3 Moran graph

The information that we can achieve from Moran's index can be described in a graph where it is reported the spatially lagged variable (Wy) on the y-axis and the original variable observed on the x-axis (Anselin 1995).The Moran graph gives an indication of the degree of linear association between the observed values and the spatially lag of the variable observed. In the Moran graph data are dispersed in four quadrants that provide an easy way to categorize the spatial autocorrelation. In particular, the positive autocorrelation involves a distribution of counties in the 1st and 3rd quadrants of the graph. While, the negative autocorrelation involves a distribution of counties in the 2nd and 4t h quadrants of the graph. Therefore, plotting the counties of Zheijang province by using the Moran graph we can evaluate how the economic growth of a county can affect the economic growth of contiguous county developing a contagious process.

4. The decreasing inequality and the local economic growth dependence

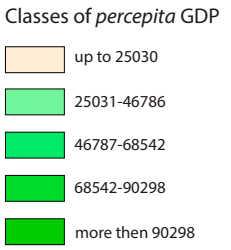
In order to measure the economic growth inequality in Zheijang province through per capita GDP, we consider data from "Statistical Yearbook Zheijang Province (2005, 2010 and 2016) "and select two geographical scales the prefecture and county level divisions. In this province the population increased from 48.98 (millions of people) of 2005 to 55.9 (millions of people) of 2016. Moreover, in this period the urban resident population is increased from 27.42 (millions of people) in 2005 to 37.45 (millions of people) in 2016, whereas its rural population is decreased from 21.52 (millions of people) to 18.45 (millions of people) in the same period. This rapid growth of urban areas is the main result of two factors: the natural increase in population and China's urbanization policies which requires a strict control of permanent migration to large cities [4].In Fig. 3 we present the spatial distribution of per capita registered in

2005, 2010 and 2016, for the 11 prefectures (or municipalities as they are traditionally called) of Zhejiang province.

This representation shows that the value of per capita GDP is increased in all prefectures, in the period 2005-2016. According to this representation the five prefectures located in the north of Zheijang province recorded a great growth: Hangzhou, Shaoxing and Ningbo achieved the higher per capita GDP in 2016, followed by Huzhou and Jiaxing with the second highest per capita GDP growth. The prefectures located in the south of Zheijang province were instead poorest, but they experienced an increasing growth in this period. We evaluate the intra-provincial economic inequality by computing the Gini coefficient.

This indicator decreases from 0.29 in 2010 to 0.18 in 2016, indicating a reduction of the intra-provincial inequality, as described also in Fig. 3.

Figure 3
Thematic map of the per capita GDP for 2005, 2010 and 2016 in Zheijang province.



To evaluate a possible contiguity dependence of the per capita GDP growth we derived the spatial autocorrelation and the Moran Index. On these data the Moran index value of 0.13 for 2010 and of 0.46 for 2016. These values are both positive expressing a GDP dependence relation between contiguous counties. The increasing values from 2010 to 2016 show also an expanding local dependence process, mostly due to economies of scales derived from the proximity of the counties. In fact, high (low) developed counties affect the growth rate of contiguous counties in the positive relation but also in the negative relation.

In Fig. 4 we notice that most counties fall in the 1st and 3rd quadrants indicating positive spatial autocorrelation. From 2010 to 2016 we also notice an increasing dispersion of the values involving a greater presence of counties with high and low values.

Figure 4
Moran graph for per capita GDP, in the years 2010 and 2016.

For instance in 2010, the counties as Xiaoshan, Xinchang and Shengzhou were collocated in the 2nd quadrant then in 2016, these counties changed their position in the graph and they moved to 1st quadrant. On the other hand, from 2010 to 2016 in the 3rd quadrant were collocated counties as Linshai, Ruian, Jingning and Taishun which present a lower economic growth.

Figure 5
GIS map corresponding in the years 2010 and 2016.

In Fig. 5 we can see the GIS map that represents the geographic distribution corresponding to the Moran graph. The GIS map reveals that high income counties are clustered in the north while low GDP are clustered in the south, in both years considered.

Observing the dynamics between 2010 and 2016 we notice that the cluster of counties with high GDP increases as well the cluster of counties with low GDP, confirming the contagious process for the rich counties (red) can help contiguous counties to increase their GDP; but poor counties can also affect their neighbor to became even poorer.

In particular, in the 2016 more than 17% of the 89 counties are spatial clusters in (in red in GIS map), focusing on Yangtse River Delta that includes Shaoxing, Jianxing, Hangzhou, Ningbo, Huzhou. In particular, this spatial cluster located in the north of Zheijang is economically developed and the counties are highly dynamic. The large companies and the high-techzones are located in Hangzhou and Ningbo, whereas the textile production industry leading to the creation of a large enterprise center are located in Shaoxing and Jiaxing.

The cluster of low GDP counties (in blue in GIS map) is concentrated around Wenzhou and Taizhou prefectures. Several reasons can explain the gap, but in particular the financial crisis that started in Wenzhou in 2011 bankrupted several firms.

5. Conclusions

In this paper, we investigated the per capita GDP inequality in one of China's most developed provinces, the Zheijang province. In particular, the analysis has been developed in two steps: we evaluated the inequality among counties in the Zheijang province by using the Gini coefficient as measure of inequality . Its value gives an indication of the level and dynamics of this inequality in the considered period. We then evaluated a possible local dependence of GDP levels between one county and its neighbours. The results have shown a reduction in the time of the intra-provincial inequality, since the Gini coefficient decreases from 0.29 in 2010 to 0.18 in 2016. In addition, the values of the Moran's index and the spatial autocorrelation have shown a strong relationship of contiguity dependence, confirming the described contagious process where the rich counties affect neighboring counties to increase their GDP; whereas the poor counties affect contiguous counties to decrease their GDP. Therefore, this dynamic highlights the gap between north and south of Zhejiang province.

References

- Alesina, A., Rodrik, D. (1991). Distributive Politics and Economic Growth. *Q. J. Econ, 109,* 465–490.
- Anselin, L. (1995). Local indicators of spatial association-LISA. *Geogr. Anal, 272,* 93–115.
- Anselin, L. (1996). The Moran Scatterplot as an ESDA Tool to Assess Local Instability in Spatial Association. In M., Fischer, H., Scholten and D., Unwin (Eds.), *Spatial Analytical Perspectives on GIS* (111-125). London: Taylor and Francis.
- Avraham, E., Yaohui. Z. (2005). *T*racking rural-to-urban migration in China: Lessons from the 2005 inter-census population survey.Population Studies. *Population Studies,* DOI: 10.1080/00324728.2015.1065342.
- Bailey, T. C., Gatrell, A.C. (1995). *Interactive Spatial Data Analysis.* Harlow, Essex: Longman Scientific Technical.
- Berry, B. J. L., Marble, D. F. (1968). *Spatial analysis: A reader in statistical geography.* Upper Saddle River: Prentice Hall.
- Chen, P.Y., Zhu, X.G. (2012). Regional Inequalities in China at Different Scales. *Acta Geogr. Sin, 67,* 1085–1097.
- China Internet Information Center (n.d.). The Local Administrative System. *China's political system.* Retrieved from www.china.org.cn.
- Cliff, A.D, Ord, J.K. (1981). *Spatial processes, models and application.* London, UK: Pion.
- Cowell, F. A. (2000). *Measuring Inequality.* Third edition, Oxford: Oxford University Press.
- Fan, S., Kanbur, R., Zhang, X. (2011). China's regional disparities: Experience and policy. *Rev. Dev. Financ., 1,* 47–56.
- Fan, C. C., Sun, M. (2008). Regional inequality in China, 1978–2006. *Eurasian Geogr. Econ., 49,* 1–18.
- Gini, C. (1912). *Variabilità e Mutabilità.* Bologna, Italy.
- Graham, M., Ernstson, H. (2012). Comanagement at the Fringes: Examining Stakeholder Perspectives at Macassar Dunes, Cape Town, South Africa—At the Intersection of High Biodiversity, Urban Poverty, and Inequality. *Ecol. Soc., 17,* 1571–1582.
- Li, G., Fang, C. (2014). Analyzing the multi-mechanism of regional inequality in China. *The Annals of Regional Science, 52*(1), 155–182.
- Li, Y., Wei, Y. H. D. (2010). The spatial-temporal hierarchy of regional inequality of China. *Applied Geography, 30,* 303-316.
- Liao, F.H., Wei, Y.D. (2015). Space, scale, and regional inequality in provincial China: A spatial filtering approach. *Appl. Geogr., 61,* 94–104.
- Lyhagen, J., Rickne, J. (2013). Income inequality between Chinese regions: Newfound harmony or continued discord? *Exp. Econ. 47,* 93–110.

- Persson, T., Tabellini, G. (2011). Is inequality harmful for growth? *Am. Econ. Rev, 16,* 600–621.
- Philip, S. (2013). A Changing China: Implications for Developing Countries. *World Bank - Economic Premise, The World Bank,* (118), 1-9.
- Sen, A. (1997). *On Economic Inequality.* Oxford, UK: Clarendon Press.
- Stiglitz, J. E. (2012). *The Price of Inequality: How Today's Divided Society Endangers Our Future.* New York, NY: W.W. Norton and Company Publishing.
- Upton G., Fingleton B., (1985). *Spatial data analysis by example.* New York: Wiley.
- Wei, Y.D., Ye, X. (2009). *B*eyond convergence: Space, scale, and regional inequality in China. *J. Econ. Soc. Geogr., 100,* 59–80.
- Xue, D., Zeng, X. (2016). Evaluation of China's urbanization quality and analysis of its spatial pattern transformation based on the modern life index [J]. *Acta Geographica Sinica, 71*(2), 194-204.
- Xu, H., Yang, H., Li, X., Jin, H., Li, D. (2015). Multi-Scale Measurement of Regional Inequality in Mainland China during 2005–2010 Using DMSP/OLS Night Light Imagery and Population Density Grid Data. *Sustainability, 7,* 13469–13499.
- Ye, H., Chen, X. (2008). *T*he analysis of the regional economic inequality in Zhejiang in recent 16 years. *Explor. Econ. Probl., 2,* 59–65.
- Yue, W., Zhang, Y., Ye, X., Cheng, Y., Leipnik, M. (2014) Dynamics of Multi-Scale Intra-Provincial Regional Inequality in Zhejiang, China. *Sustainability, 6,* 5763–5784.
- Xue, D., Liang, J., Huang, G. (2016). Globalization and the evolution and charac-teristics of spatial distribution of transnational institutions in Guangzhou (1949-2012). *City Planning Review, 40*(10), 44-51, 64.
- Zhang. W., (2012). Quality of Urban life and Culture: A case study of Hangzhou. *Beijing: The social sciences Academic Press*, China ISBN 9787509735398 7509735394.
- Zhang, J., Deng, W., (2016). Multiscale Spatio-Temporal Dynamics of Economic Development in an Interprovincial Boundary Region: Junction Area of Tibetan Plateau, Hengduan Mountain, Yungui Plateau and Sichuan Basin, Southwestern China Case. *Sustainability, 8*(3), 1-18.
- Zhang, W., (2016). The concept of Urban Governance: the sustainable Development and policy Challenge. *The third forum of Zheijang Urban governance.*

This project is funded by the European Union.

This eBook has been produced with the assistance of the European Union under the project EuropeAid MEDIUM GA ICI+/2014/348-005.
The contents of this eBook are the sole responsibility of MEDIUM partners and can in no way be taken to reflect the views of the European Union

https://mediumcities-china.org/

Photo Credits

The images on the following pages have been realized by:
Valentina Anzoise: eBook cover, pp. 11, 58, 123;
Judith Audin: p. 49.

Every attempt has been made to gain permission for the use of the image in this book.
Any omission will be rectified in future editions.

Published in 2018 by Imago Editor
Via Cerruti 1, 15050 Avolasca, Italy

https://imagoeditor.net
First Edition
ISBN: 978-88-94384-71-0