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Title: Dynamics, Space, and Regional Inequality in Provincial China: A Case Study of Guangdong Province

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Dynamics, Space, and Regional Inequality in Provincial China: A Case Study of Guangdong Province

Abstract:

This paper investigates the regional inequality in one of the most developed provinces in China, Guangdong, from 1979 to 2009 and follows the multi-scale and multi-mechanism framework. We have found a new round of intensifying inequality in Guangdong since the early 2000s, which is attributed to the widening gap between the core region of the Pearl River Delta (PRD) and the rest of the province (periphery) and between the urban and rural areas. The authors also apply a distribution dynamics approach and spatial Markov chains to identify the spatial-temporal dynamics of regional disparities in Guangdong. The results show that there has been a progressive bias towards a poverty trap in the province and the effect of self-reinforcing agglomeration is evident. Using a multilevel model, the study further unfolds that the regional inequality in Guangdong is sensitive to the core-periphery hierarchy of multi-mechanisms and reveals the relative influence of decentralization, marketization and globalization. We argue that the policies towards inequality-reducing in Guangdong have been constrained by the geographical barriers and the effect of self-reinforcing agglomeration in the PRD, while marketization has potential to mediate the uneven development driven by the spatial concentration of foreign investment.

Key words: regional inequality, multi-scale and multi-mechanism, spatial Markov chains, GIS, multilevel modeling, Guangdong, China

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1. Introduction

Over the past three decades, China's gradual transition towards a market-oriented globalizing economy has generated a spectacular economic growth with an annual growth rate at 9.9 % (CSB, 2011). However, behind the economic success in China, the country also faces serious challenges arising from distinctive regional development trajectories, imbalanced growth, and intensifying social injustice (Wei, 2002; World Bank, 2005). Since regional inequality may threaten national unity and social stability, it has become a burning issue in China attracting considerable attention from policy makers and scholars (e.g. Wei, 2002; Fan & Sun, 2008; Fan, Kanbur & Zhang, 2011). Research has revealed an intensifying regional inequality in China and found the significance of globalization, institutional reforms, and local agents in regional development (Wei, 2002; Hao & Wei, 2010).

As China is characterized by vastness in size, regional inequalities not only exist among provinces or groups of provinces but are even more evident within provinces, triggering the research front of China's regional inequality to "scale down" to a finer-scale analysis at the intra-provincial level (e.g. Wei & Fan, 2000; Gu, Shen, Wong & Zhen, 2001; Wei, Yu & Chen, 2011). With the aid of the more rigorous GIS and spatial analysis methods, this strand of literature has found rich details of the dynamics, patterns and mechanisms of the uneven economic landscape in Chinese provinces (Yu & Wei, 2008; Wei & Ye, 2009; Wei, Yu & Chen, 2011).

Being China's leading powerhouse and a pioneer in the reform for the past three decades, Guangdong province is a representative of regional inequality in provincial China (Gu, Shen, Wong & Zhen, 2001; Lu & Wei, 2007). The development within the

province has been heavily focused on the core region of the Pearl River Delta (PRD) near Hong Kong while the rest of the province (periphery) has lagged far behind (Gu, Shen, Wong & Zhen, 2001; Lu & Wei, 2007). The research on the regional inequality in Guangdong, however, has mainly dealt with the situation in the 1980s and the 1990s (e.g., Fan, 1995; Gu, Shen, Wong & Zhen, 2001), while the changes in the 2000s have rarely been investigated.

Notably, in response to problems of economic polarization, since the early 1990s, the provincial government of Guangdong has shifted its development strategy from stressing the development of the PRD to promoting regional integration between the PRD and the periphery, coined as "the Mountain Area Development Program" in the late 1990s and the "Anti-Poverty Development for Rural Guangdong" in the early 2000s. The provincial government also invested heavily in the construction of the intercity highways connecting the PRD and the peripheral areas (Lu & Wei, 2007). Specifically, since 2005, under the administration of the new governor in Guangdong, the provincial government has initiated a "dual-track transformation" policy and built up a number of "industrial relocation parks" to foster the upgrading of the PRD and promote more equitable development through the relocation of low-end manufacturing from the PRD to the peripheral areas (Liao & Chan, 2011; Yang, 2012). The substantial efforts towards inequality-reducing in Guangdong has also attracted attention from the World Bank, who forecasted that Guangdong province has potential to lead the nation again for a more balanced and sustainable development in China (World Bank, 2011). Therefore, a timely assessment of the regional inequality in Guangdong also sheds light on the recent efforts working towards reducing inequality in the frontier of the Chinese economy.

Drawing upon a multi-scale and multi-mechanism framework (Wei, 2002), this paper attempts to update our understanding of the regional inequality in Guangdong. Employing the advanced GIS and statistical modeling methods, it particularly addresses the space-time complexity of regional inequality and the persistent core-periphery structure in Guangdong in the context of intensifying globalization. On the one hand, following a distribution dynamics model proposed by Quah (1993a, 199b, 1996) and the spatial Markov chains developed by Rey (2001), we move beyond the traditional σ- and β-convergence analysis to recognize the temporal and spatial dimensions of regional inequality in Guangdong. On the other hand, the underlying mechanisms of the uneven regional development in Guangdong are analyzed based on the triple-process conceptualization of China's transition, namely, globalization, decentralization and marketization (multi-mechanism); with a spatially explicit multilevel model, the analyses reveal the relative importance of such a triple process over space and time. This paper is organized as follows. The next section presents a brief review of the literature and the analytical framework. Then, we start with analyzing patterns of regional inequality at regional, municipality and county levels. This is followed by a detailed investigation of the distributional dynamics of regional inequality among 82 counties and cities in Guangdong with both traditional and spatial Markov chains. In association with Markov chains, the spatial-temporal hierarchy of the underlying mechanisms is further analyzed in a multilevel model. The paper concludes with major findings and policy implications.

2. Theoretical and contextual issues

Regional inequality is undoubtedly a central topic for economic geographers. The longstanding concerns with spatial inequality and the causative process of economic growth have generated a variety of schools, such as convergence (the gaps between rich and poor keep narrowing, and inequality will decline in the long run), divergence (inequality is persistent and the gap between rich and poor is widening) and evolutionary (the degree of inequality is contingent upon the development stages of the economy) (Kuznets, 1955; Smith, 1984; Barro & Sala-I-Martin, 1992). Represented by the neoclassical growth model of Solow-Swan, neoclassical economists maintain that regional inequality is a temporary phenomenon (Solow, 1956). Similar to the neoclassical thought of convergence, inverted-U theory holds that regional inequality is likely to rise during the early stages of development and tends to decline when the economy matures (Kuznets, 1955; Williamson, 1965). In contrast to the view of convergence, the empirical work in the 1960s and 1970s found a lack of convergence and regarded the persistence of poverty and inequality as an inevitable consequence of capitalism (Smith, 1984). Different from the neoclassical approaches, some scholars also focus on the role of government intervention and policies in the evolution of regional inequality. This strand of literature is represented by the top-down development and the growth pole policies advocated by Hirschman and Perroux in the 1950s and 1960s.

In the early 1990s, Barro and Sala-i-Martin (1991) put forward two important concepts, β-convergence and σ-convergence, to elaborate the regional development differentials in the U.S. and Europe. The β-convergence indicates that poorer regions will grow faster than richer regions at the initial stage and the σ-convergence assumes that due to the β-convergence, the overall degree of dispersion tends to decline in the long run.

However, like the other economic growth and regional inequality theories, the new convergence theory based on the notions of β- and σ- convergences has been challenged for its ignorance of scales, space and time (e.g. Martin & Sunley, 1998; Petrakos, Rodríguez-Pose, & Rovolis, 2005; Wei & Ye, 2009). Specifically, the new economic geography theory has provided strong evidence for the importance of geography in economic and regional development (Krugman, 1999). It posits that when the degree of trade openness increases, production factors are more likely to flow toward the advanced region where the returns are higher, which encourages the formation of a core-periphery economy (Krugman, 1991; 2011). Empirically, overwhelming evidence has also been found that the core-periphery structure has strong geographical foundations and is hard to change. In many transitional and developing economies, such core-periphery structures, such as the dominance of Moscow and the Siberian dilemma, are often maintained or even strengthened through new spatial division of labor, political struggle, and the integration of the core regions into the global economy (Bradshaw & Vartapetov 2003; Carluer, 2005; Wei & Fang 2006). In Asia, the core-periphery structure is still maintained and even intensified, although the degree of regional inequality has declined in some nations (Hill, 2002; Akita, 2003; Silva, 2005).

China's rapid economic growth and tremendous transitions in the past three decades have provided a good laboratory to deepen our understanding of the evolution of regional inequality in a transitional economy under globalization. First, the research on China's regional inequality has reached a consensus that there has been a rising gap between coastal and interior provinces, mainly because the coastal provinces have experienced a more rapid growth under globalization and liberalization (Chen & Fleisher,

1996; Yu and Wei, 2003; Sakamo and Islam, 2008; Hao and Wei, 2010). Scholars also questioned the effectiveness of governmental policies such as the "Go West" program, and argue that interior provinces are facing more challenges in regional development under globalization (Wei & Fang, 2006; Hao & Wei, 2010). Second, since China adopts a gradual and experimental approach to the reform, the evolution and magnitude of regional inequality are found to be sensitive to structural shocks in reforms such as China's accession into WTO in the early 2000s (Sakamo and Islam 2008). Third, with more rigorous spatial analysis techniques, geographers have demonstrated that space or geography does matter in shaping the uneven economic landscape in China. Spatial dependence, scale and hierarchy are all important for a better understanding of the complexity of regional inequality in China (Ying, 2000; Yu & Wei, 2003; Ke, 2010; Li & Wei, 2010a). They have found that the evolution of regional inequality in China is sensitive to scales (between provinces and between regions), which cannot be simplified into divergence or convergence, and the relative importance of underlying factors are also contingent upon the spatial hierarchy of regional inequality. Fourth, although the intensification of coastal (core) inland (periphery) inequality in China shares some common characteristics with other transitional economies such as Russia (Carluer, 2005), the mechanisms underlying the uneven development in China are complicated, which can hardly be explained by either market openness or governmental intervention (Wei, 2007). Wei (1999; 2002) conceptualized the China's transition into a triple process of globalization, marketization and decentralization, which has provided a more ground-based conceptual tool to synthesize the multiple stakeholders including global, state and local forces in China's regional development.

Lastly, in addition to a plethora of literature on the interprovincial inequality, given its diversity, dynamics and scale, provincial China has become a new frontier of research on regional inequality in China. Researchers also focus on the inequalities in China's most dynamic economic powerhouses including Jiangsu (e.g. Wei & Fan, 2000), Zhejiang (Ye & Wei, 2005; Wei & Ye, 2009) and to a less extent Guangdong (Weng, 1998; Gu, Shen, Wong, & Zhen, 2001; Lu & Wei, 2007) and Beijing (Yu & Wei, 2008). Similar to the coastal-inland divide at the national level, researchers have found rising core-periphery inequalities within many Chinese provinces. For example, in Jiangsu, the development is centered on the core region of *Sunan* (South Jiangsu) in the south close to Shanghai and the inequality between *Subei* (North Jiangsu)*, Suzhong* (Central Jiangsu) and *Sunan* has continued to worsen (Wei, Yu, & Chen, 2011). Evidence has also been found that the traditional north-south divide in Zhejiang has been transformed towards the coastal-inland divide in the reform era (Wei & Ye, 2009). The research on regional inequality in provincial China also provides rich details for the diverse development models in those thriving regions, which are represented by the *Wenzhou* model in Zhejiang (Ye & Wei, 2005), the PRD model in Guangdong (Lin, 1997; Lu and Wei 2007) and the *Sunan* model in Jiangsu (Wei, 2002).

The research on Guangdong, a province known for being "one-step ahead" in China's reform (Vogel, 1989), has identified a salient core-periphery economy centered on the PRD. However, given different scales of analyses and time spans, the findings about the evolution of regional inequality in Guangdong tend to be mixed. Studies focusing on the rural industrialization and market reform in the 1990s and 1980s have found a more balanced growth within the PRD, mainly because of the decline of the

original core city of Guangzhou (Weng, 1998; Lin, 2001). In contrast, others found the evidence of the widening gap between the core region of the PRD and the periphery areas in the 1990s and the 1980s, which was driven by the socialist market reform and the "local state corporatism" (Gu, Shen, Wong, & Zhen, 2001). With few exceptions (Fan, 1995), the regional inequalities at different spatial scales in Guangdong have rarely been analyzed. More importantly, the literature has analyzed the inequality in Guangdong during the 1980s and 1990s, while its changes in the 2000s have not been updated.

In order to explore the regional inequality in Guangdong with an emphasis on the changes in the 2000s, this paper draws on a multi-scale and multi-mechanism analytical framework proposed by Wei (2002) to address the space-time complexity of regional inequality in provincial China and synthesize its multiple driving forces. On the one hand, as displayed in Fig. 1, the regional inequality in China is sensitive to spatial scales and can be analyzed at the provincial, regional and the intra-provincial levels. Within a province, the patterns of regional inequality are manifested by the interregional inequality (in a province), inter-municipality and the inter-county inequalities. Specifically, the inter-county inequalities are also multifaceted including the inter-rural county, the inter-urban and urban-rural disparities (the urban areas refer to the urban districts (city) and the others are rural counties or equivalent level cities (county-level cities)).

(Fig. 1 about here)

On the other hand, China's reform can be understood as a triple transitional process of decentralization, marketization and globalization. First, the political economic context in China has shifted from idealistic egalitarianism to pragmatist uneven regional development with an emphasis on efficiency and output (Long & Ng, 2001). Local

governments have been granted more power in revenue collection and local spending (decentralization), and they have had more incentives to promote local economic development (Wang, 2010). At the same time, the market system is introduced in the original socialist planned economy and the state owned sector is exerting much less control over the economy (marketization) (Wei, 2002). Together with marketization and decentralization, globalization, manifested by market openness and China's integration into the global economy, has triggered a huge inflow of foreign direct investment (FDI), making China the most popular destination of FDI in developing countries (UNCTAD, 2011). These three broad processes—a triple-process of regional development in China—also have profound influences on regional inequality (Wei, 2002; Hao & Wei, 2010). Coastal localities where local governments have more resources and the investment environment is favored by investors have emerged as the biggest winners in the reform. At the same time, those traditional industrial bases dominated by state-owned enterprises have fallen behind (Wei & Ye, 2009). Based on the multi-scale and multi-mechanism framework, we hypothesize that regional inequality in Guangdong is sensitive to scales; the core-periphery inequality between the PRD and the periphery is intensified due to the triple process of China's transition from a socialist planned economy to a market-based capitalist economy.

3. Research Setting and Methods

3.1 Research Setting: Guangdong Province

As shown in Table 1, many Chinese provinces and in particular Jiangsu and Guangdong in the coastal area and Gansu in the inland area have encountered severe

challenges arising from the intensifying regional inequalities in the post-reform period (Table 1) and Guangdong is also one of the most imbalanced provinces in China.

(Table 1 about here)

As shown in Fig. 2, Guangdong province is located in Southeastern China and neighbors Hong Kong. With a population of 95.44 million in 2009, the province covers 179,800 square kilometers, occupying 1.9 % of China's territory (Table 2). Guangdong province is one of the most developed provinces in China and the size of Guangdong's economy measured by GDP surpassed Taiwan in 2007 (GSB, 2008). In 2009, Guangdong produced 3,948 billion yuan of GDP, ranking first in China's 31 provinces (CSB, 2010). Its GDP per capita also increased from 410 yuan (65USD) in 1979 to 41,166 yuan (6534USD) in 2009 with an annual growth rate of 11.2% (GSB, 2010a).

(Fig. 2 and Table 2 about here)

According to the administrative structure in Guangdong, in 2009, there were 21 municipalities and 82 county level spatial units including 21 urban districts (city) and 61 counties (rural counties and county-level cities) in the province (Fig. 2). Geographically, Guangdong is divided into two distinct regions including the core region of the PRD, the peripheral region including the North Guangdong (or mountain area), the East Guangdong, and the West Guangdong (Fig. 2). In general, the economic development in Guangdong follows a core-periphery gradient with the PRD the most developed area. With the rise of the PRD, the peripheral areas have lagged far behind, which intensified the regional inequality in the province. The ratio of GDP per capita in the PRD compared to that in the rest of Guangdong (periphery) doubled from 2.2: 1.0 in 1979 to 4.4:1.0 in 2009 (GSB, 2010b). In 2009, with a population of 47.86 million (49.66% of the

province), the PRD region produced 81.42% of the total GDP in Guangdong and it also dominates the exports and FDI in the province (Table 2).

In this study, the major indicator of the regional development status is the most commonly used per capita GDP (GDPPC). The municipality-level (21 municipalities) GDPPC data from 1979 to 2009 and county level GDPPC data from 1988 to 2009 are obtained from a report entitled "GDP Data in Guangdong, 1952-2005" and the statistical yearbooks of Guangdong (various issues from 1988 to 2010).[1] Both are published by the Guangdong Statistical Bureau.

In terms of the calculation of GDP per capita, due to the unique *hukou* (household registration) system in China, the population data in coastal provinces tend to be underestimated, since the temporal migrant population without *hukou* is often excluded in the population statistics (Chan & Wang, 2008). In Guangdong, this problem is more challenging due to the massive inflow of migrant workers in specific cities such as Shenzhen and Dongguan. In order to get more accurate population data, we used a report entitled "Guangdong's Development in the Reform Era" published by Guangdong Statistical Bureau in 2010, which released the municipality level migrant population from 1979 to 2009. Since the county-level *de facto* population (population including migrants without *hukou*) is still unavailable, according to the municipality level data, we adjusted the numbers of total population in the county-level units within specific municipalities, including Shenzhen, Dongguan, Zhongshan, Foshan, Zhuhai, and Guangzhou where the total population is more likely to be underestimated. Then, we computed the ratios of *de jure* population (population not including migrants without *hukou*) to *de facto* population

[1] In this report, the GDP data from 1979 to 2004 were adjusted according to the first national economic census conducted in 2004 and they are more consistent with the GDP data after 2005; it should be noted that the most reliable county level GDP data in Guangdong was firstly released in 1988.

(population including temporally migrants) for the other fifteen municipalities. We found that the resulting ratios ranged from 0.85 to 1.1, indicating that the biases in the total population of the counties within these fifteen municipalities can be acceptable for the following analyses, given the data limitation.

Besides the data of population and GDP, in order to measure the underlying factors of the uneven economic development in Guangdong, a set of county-level socioeconomic data were also collected, which included foreign direct investment (FDI), local fiscal expenditure, fix assets investment, and employment data. The GDP data were converted into the constant price in 1980 based on the provincial implicit GDP deflator. The GIS maps (shape files), referring to boundary files of the Guangdong province down to the county level, were downloaded from China Data Center (http://chinadatacenter.org).

3.2 Methods

As Fan and Sun (2008) summarized, in comparison with other indexes such as CV and Gini coefficient, a major advantage of the entropy indexes such as Theil index (Mean logarithmic deviation) is that they are readily decomposable.[2] In this research, Theil index is used to investigate the evolution and the sources of regional inequality in

[2] The Theil index is defined as

$$I(y:x) = \sum_{i=1}^{N} y_i \log(y_i/x_i)$$

where x_i is the share of population of county *i* in the province and y_i is the share of GDP of county *i* in the province. $I(y:x)$ can be decomposed into

$$I(y:x) = I_0(y:x) + \sum_{g=1}^{G} Y_g I_g\,(y:x)$$

where the first term on the right $I_0(y:x)$ measures interregional inequality, and the second term is a weighted sum of intraregional inequalities within *G* groups where $I_g(y:x)$ measures the inequality within the g^{th} region.

Guangdong. This study also adopts a distribution dynamics model (Quah 1993a, 1993b, 1996; Fotopoulos 2008), to identify the dynamics of regional inequality among counties in Guangdong.

To begin with, Kernel density estimation is applied to estimate the changes in the distributions of relative GDPPC (the ratio of GDPPC in each county compared to the mean value in the province). In comparison with the traditional histogram, Kernel density estimation can smooth the data but retain the overall structure.[3] However, although the Kernel density estimation allows characterizing the evolution of the distribution shape, it does not offer any information about the movements of the counties within the distribution. A possible way to remedy this inadequacy is to track the evolution of each county's position in the distribution shapes and examine the transition probability matrices in a Markov-chain like process (Le Gallo, 2004). The specific advantages of Markov-chain method are twofold. First, the Markov transition matrix enables us to characterize such spatial-economic asymmetries and highlights the performance of each region, as well as the nature of its mobility (both upward and downward), in detecting the trend of convergence, divergence, and polarization (Fingleton, 1997; Carluer, 2005). Second, the Markov-chain method is also realistic since it can identify the long-run properties towards some form of poverty-trap or convergence club (Fingleton 1997: p. 399-400), which cannot be deciphered by the β convergence analysis that relies on smooth time-trends approximation and suffers from the Galton's fallacy of regression toward mean (Quah, 1993a, 1993b; Fingleton, 1997).

[3] Similar to Le Gallo (2004), the densities are calculated non-parametrically using a Gaussian kernel and the bandwidth is selected as suggested by Silverman (1986, section 3.4.2).

The basic approach of the Markov chains is to classify different spatial units (counties) into various subcategories based on the relative GDPPC and examine their transition probabilities for a given period (Quah, 1993a, 1993b, 1996). First, a matrix F_t is constructed to store the cross-sectional distribution of county level relative GDPPC at time point *t*. A set of *K* different GDPPC classes are defined. Therefore, a transition probability matrix *M*, can be established, which has a dimension of *K* by *K*, where *K* is the number of subcategories. A typical element of a transition probability matrix $m_{(i, j, t)}$ indicates the probability that a county that is in the class *i* at time *t* ends up in class *j* in the following period. Formally, the (*K, 1*) vector R_t, indicates the frequency of the counties in each class *j* at time *t*, is following the equation below:

$$R_{t+1} = M^* R_t \quad (1)$$

where *M* is the (K, K) transition probability matrix representing the transitions between the two distributions. If transition probabilities are stationary, that is if the probabilities between the two classes are time-invariant, then

$$R_{t+P} = M^p * R_t \quad (2)$$

Under the assumption of time-invariant matrix ($t \rightarrow \infty$), the properties of this Matrix can be further examined to determine the Ergodic distribution (or the long-term distribution) of R_t to indicate if the regional system is converging or diverging.

By adopting the Markov chains, researchers also attempt to incorporate the spatial dependence or autocorrelation in determining the transition probability matrices. Quah (1996) used spatial conditioning and Ray (2001) proposed a more explicit spatial Markov-chain to examine the magnitude of spatial dependence in the Markov-chain framework. The transition matrix is expanded and the transition probabilities of a region

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are conditioned on the GDPPC class of its spatial lag for the beginning of the year. In doing so, we can obtain a spatial transition matrix and expand the traditional *K* by *K* matrix into *K* conditional matrices of dimension *(K, K)*. In other words, we categorized the spatial lags into the same number of groups as GDPPC. Therefore, a *K* by *K* by *K* three-dimensional transitional matrix is constructed. The element of such a matrix, $m_{ijt}(k)$, represents the probability that a region in category *i* at the time point *t* will converge to category *j* at the next time point if the region's spatial lag falls in category *k* at time point *t* (k=1,……, K; t= 1, ……, T).

In this study, the GDPPC data is categorized into four groups (rich, developed, less developed and poor) using quartile method and the cut-off values are selected so that the overall distribution in the entire sample of the relative GDPPC prove to be close to being uniform. This discretion based on the gridlines in uniform-distribution generally follows the previous empirical studies using Markov chains (Quah 1993a; Sakamoto & Islam, 2008) and it also better corresponds to the core-periphery structure in Guangdong in line with the geographical notions of core, semi-core, semi-periphery, and periphery (Wei, Yu & Chen, 2011). The time interval of the Markov-chain transition matrix is one year and the spatial lags are defined by the queen contiguity matrix. The Markov chain-based analysis was carried out in a software called PySAL (Open Source Python Library for Spatial Analytical Functions) developed by the GeoDa center at Arizona State University (Rey & Anselin, 2010).

To further understand the regional inequality in Guangdong, multilevel regression modeling is applied to examine the mechanisms behind the uneven regional development. As argued by Li and Wei (2010a), most studies of regional inequality neglect the

hierarchical characteristics in the dataset. A possible consequence of neglecting the hierarchical structure is the underestimation of standard errors of regression coefficients, resulting in an overestimation of statistical significance (Subramanian, Duncan & Jones, 2001). Multilevel modeling, however, overcomes the limitation by allowing for residual components at each level in a hierarchy (individual, group, sub-groups, etc.) (Mercado & Páez, 2009). Despite the wide usage of multilevel modeling in the fields of public health, demographic, and transportation geography (Li & Wei 2010b; Subramanian, Duncan & Jones, 2001; Mercado and Páez 2009), the application of multilevel modeling in the study of regional inequality is still limited (Li & Wei, 2010a). In this research, we coupled the Markov chains with the multilevel modeling to test the spatial-temporal hierarchy of development mechanisms down to the county level in Guangdong. In doing so, we attempted to better understand the relative importance of the triple-process in Guangdong's regional development. The multilevel regression analysis was performed using MLwiN 2.24 software (Rasbash, Steele, Browne & Goldstein, 2009).

Our model has three levels. The one-level model is a pooled regression using county-level data regardless of the core-periphery and temporal hierarchies. The two-level model adds the core-periphery continuum as suggested in the Markov chains, which allows us to control for the geographical and structural effects within the four groups (core, semi-core, semi-periphery and periphery). The three-level model further controls for the time points (1988, 1993, 1998, 2003, 2008), which takes the between-year variations into account. Such time points were selected based on the data availability.

$$y_{ijt} = \beta_0 + \beta_1 x_{ijt} + v_{0t} + \mu_{0jt} + e_{ijt} \quad (3)$$

As shown in equation (3), the y_{ijt} refers to the dependent variable (GDPPC) in county *i* that belongs to the core-periphery continuum *j* defined by the Markov chains at year *t*; and x_{ijt} is the independent variables in county *j* at year *t*; v_{0t} is the error term at year *t*; μ_{0jt} is the error term of core-periphery continuum *j* at year *t*; e_{ijt} is the error term of *i* county in core-periphery continuum *j* at year *t*.

We selected a number of exploratory variables based on the multi-mechanism that conceptualizes Guangdong's regional development as an aforementioned triple-process of globalization, marketization, and decentralization.

1. Globalization (FDIPC): Guangdong's development over the past three decades has been fueled by the export oriented economy and inflow of FDI. So the per capita FDI (FDIPC) is the most commonly used indicator to measure the extent of globalization (Gu, Shen, Wong & Zhen, 2001).
2. Marketization (NSOE): Guangdong's development is also based on the establishment of socialist market system and the retreat of the state owned enterprises (SOE) in the economy (Gu, Shen, Wong & Zhen, 2001). The share of non-SOE enterprises in the total employment (NSOE) is employed to describe the influence of marketization.
3. Decentralization (DECEN): The decentralization process is captured by the ratio of local budgetary spending per capita to the provincial government's budgetary spending per capita. It mainly reflects the degree of fiscal decentralization and the shift of power from upper level governments to local governments (Hao & Wei, 2010; Wang, 2010).

4. Investment (FIXPC): It has been widely acknowledged that socialist economies are traditionally investment driven, and the per capita fixed asset investment (FIXPC) is selected to represent whether the development is driven by the investments particularly from the central government (Yu & Wei, 2008).

5. Urban-rural divide (URBAN): China's regional development policy is also biased toward the urban area, which has intensified the urban-rural inequality (Chen, Liu & Zhang, 2010; Long, Zou, Pykett & Li, 2011). A dummy variable URBAN is employed to reflect the impact of urban-biased development. If the spatial unit at the county level is an urban district, it is coded by 1, otherwise it is a 0.

6. Topography (MOUNTAIN): in Guangdong, most of the plain area is located in the PRD, while mountain counties are mostly located in the periphery. A dummy variable (MOUNTAIN) is used to investigate the impact of physical topographical conditions on the economic development in Guangdong.

4. Findings and Interpretation

4.1 The multi-scalar regional inequality in Guangdong

In this section, a multi-scale decomposition analysis is undertaken to portray a holistic scenario about the evolution of regional inequality in Guangdong over the past three decades. Fig. 3 shows that the regional inequality in Guangdong is sensitive to the geographical scales. The average numbers of the inter-county inequality, the inter-municipality inequality, and the interregional inequality are 0.25, 0.21 and 0.14 respectively. The regional inequality is more significant at finer spatial units.

(Fig. 3 about here)

Fig 3 also reflects a general trend of rising inequalities at the three geographical scales in Guangdong during the study period. Both of the inter-municipality inequality and inter-county inequality showed a U-shape pattern since the early 1990s. By contrast, the interregional inequality displays a more consistently upward trend despite a slightly decrease in the early 1990s. Therefore, the regional inequality has not shown persistent divergence or convergence trajectories while these changes are responsible to the different stages of reforms.

First, a more dramatic rising trend of inter-municipality inequality in the 1980s can be observed, which is consistent with Fan's (1995) study using per capita gross value of industrial and agricultural output (PCGVIAO). The rise of regional inequality in this period was driven by the development of Shenzhen and Zhuhai, two special economic zones (SEZ) located at the border between Guangdong and Hong Kong or Macau (Fig. 2). Second, in the early 1990s, Dengxiaoping's South China tour in Guangdong had stimulated a new round of "Socialist Marketization" reform in the province that was ceased after the 1989 Tiananmen incident. Since then, the implementation of open door policies and market reform had been expanded to the whole province, while the influence of the SEZ policies in the 1980s gradually faded, which narrowed the gap between other municipalities in the province and the SEZ municipalities. In particular, since the early 1990s, the municipality of Zhuhai, a SEZ municipality located in the western part of the PRD, has been in a backward status. In comparison with other municipalities in the eastern part of the PRD (Fig. 2), the municipality of Zhuhai is relatively far from Hong Kong, which is the motor of the economic development in this area. Its development was also constrained by the heavy burden of debt as a result of unwise infrastructure

investments such as the airport construction in the early 1990s (Yang, 2006b). Third, since the early 2000s, the regional development in Guangdong has been driven by a new round of inflowing FDI after China's entry into WTO (Yang, 2006a). At the same time, the development of a knowledge-based economy in the PRD has also been accelerated (Lu & Wei, 2007). Such a transformation has provided more resources in favor of the specific municipalities in the PRD and intensified the regional inequality in the province. Fourth, there has been a slightly declining inequality since 2006. This is greatly attributed to the relative slow-down of economic growth in Shenzhen. In recent years, Shenzhen has encountered more challenges in its development due to the limited resources such as land (the land area of Shenzhen is one-third of Guangzhou, which is another largest municipality in Guangdong and the capital of the province) and its economy was more significantly influenced by the global financial crisis (Sina News, 2006).

In order to unfold the relationship between multi-scalar inequalities in Guangdong, we decompose the overall inter-county inequality into the inequality between the PRD and the rest of the province (the periphery) and the inequalities within the PRD and the peripheral region, which resembles the core-periphery structure in Guangdong. As illustrated in Fig 4, the contribution of the core-periphery inequality between the PRD and the rest of the province increased from 56.81% in 1990 to 66.02% in 2009. Another important source of regional inequalities in Guangdong is the urban-rural divide. Fig. 5 shows that the urban-rural inequality has consistently accounted for over 50% of the overall inter-county inequality in Guangdong. The persistent rural-urban disparity is also related to the core-periphery inequality, since most of the rural counties in Guangdong (46 out of 61, or 75%) are located in the periphery while nearly half of the

urban districts are in the PRD. In short, the proceeding analysis finds that the uneven economic development in Guangdong is sensitive to the time dimension and geographical scales. It is also related to changing policies such as the SEZ policies in the 1980s and the early 1990s as well as China's entry into WTO in the early 2000s. However, the provincial level inequality-reducing policies initiated since the late 1990s could barely achieve its goal and Guangdong has experienced a new round of economic polarization in the 2000s in the context of further globalization.

(Fig. 4 and Fig. 5 about here)

4.2 Distributional dynamics of regional disparities

In this section, the dynamics that underline regional inequality or the "long-run" properties of convergence or divergence across 82 counties and cities in Guangdong are analyzed with a distribution dynamics model and in particular the Kernel density estimation and Markov chains (Quah, 1993a, 1993b, 1996). As illustrated in Fig. 6, the shape of the distribution for the county level GDPPC has changed considerably over time. The density plots clearly suggest a skewed distribution shape of the relative GDPPC in Guangdong. In comparison with the years of 1988 and 2000, more counties reported below half of the average GDPPC in 2009, and only a small subset of counties transited towards above average. This result may reflect that a substantial proportion of counties near the average GDPPC have become relatively poorer since the early 2000s.

(Fig. 6 about here)

Table 3 contains the transition probability matrices over the period between 1988 and 2009, as well as in the two sub-periods—the 1990s (socialist market system reform)

and the 2000s (China's accession into WTO). The results of the Markov chains analyses more clearly point out the system dynamics in Guangdong's regional development, which are sensitive to the different stages in the course of the reform. In general, the transition probabilities along the dialog are high. In other words, if a county falls into the specific class (rich, developed, less-developed, and poor), the probability of its being in the same group is at least 82.1%. The transition frequency between different groups is low, and the highest transition frequency is only 12.6% (Table 3). The results also show that it is very difficult for a county to leapfrog from poor to rich or from less developed to rich, and vice versa, indicating the stable structure in Guangdong's regional development and the persistence of core-periphery inequality.

In the 1990s, the Ergodic distribution, the long-run property of the distribution, was relatively stable. In this period, the richest group and poorest group occupy 25% and the shares of intermediate groups remain 50% (Table 3). There was no clear evidence of convergence or divergence in the 1990s despite the fact that some developed counties had become poorer. However, for the second time-span between 2000 and 2009, the share of the richest groups in the Ergodic distribution shrinks to 13% and the share of the poorest group increases more significantly to 60%. Therefore, the analysis of distribution dynamics can supplement the analysis based on the Theil index, which mainly focuses on the "global" dispersion patterns. It reveals that a new round of polarization in Guangdong in the 2000s is greatly attributed to the disappearing intermediate groups and the formation of some form of a "poverty trap" in the semi-core and semi-periphery areas. Clearly, the dynamics of convergence or divergence within Guangdong are time-specific and do not follow the neoclassical β-convergence hypothesis.

(Table 3 about here)

4.3 Changing spatial patterns of development and spatial dependence of dynamics

The analysis of the evolving spatial patterns of regional development and spatial Markov chains provide more details for the economic geography of inequality dynamics in Guangdong. Fig. 7 shows that the core-periphery pattern of regional development based on the divide between the PRD and the rest of Guangdong is salient: most of the counties in the rich category are the counties in the PRD; as the distance to the PRD increases, counties are more likely to become poor. In comparison with the map in 1988, the 2009 map has shown that the statuses of many counties in the periphery have declined. Moreover, the boundary of the richest counties has changed slightly: the originally less developed counties in the eastern part of the PRD such as the counties in Huizhou municipality moved upward, while the counties in the Zhaoqing and Jiangmen municipalities in the western part of the PRD deteriorated into backward statuses (Fig. 2 and Fig. 7). The revealing fact that the eastern PRD located closer to Hong Kong develops faster implies that the core-periphery structure of development in Guangdong is also attributed to the globalization forces channeled through the external core of Hong Kong (Weng, 1998; Ng & Tuan, 2003; Yeung, 2006). With respect to the periphery area, our results echo Gu, Shen, Wong and Zhen's (2001) study that many counties in the original developed industrial municipalities driven by state owned sectors in the peripheral regions, such as the counties in Shaoguan in the North Guangdong and Zhanjiang in the West Guangdong, have declined in the post-reform period. In contrast, as found in a recent report from the World Bank, a small subset of counties or districts in

the periphery area particularly in the Qingyuan municipality neighboring the northern part of the PRD (Fig. 2 and Fig. 7), have moved upward (World Bank, 2011). The development in these specific counties is greatly fueled by their abundant land resource and lower cost of labor as well as the recently surging cost of production in the PRD (Liao & Chan, 2011; Yang, 2012).

(Fig.7 about here)

We also computed the global Moran's *I* to capture the overall tendency of geographical concentration of regional development in Guangdong (Fig. 8). Different from the U-shape trajectory of the inter-county inequality measured by the Theil index, the resulting global Moran's *I* increased from 0.469 in 1988 to 0.551 in 2009 and all are significant at the 0.01 level. This result implies that when the spatial dependence is taken into account, the inequality measured by Moran's *I* is less sensitive to the fluctuations at specific time points and provides a holistic picture of the increased regional inequality in Guangdong.

(Fig. 8 about here)

The results of the spatial Markov chain analysis are shown in Table 4. They provide more details about the possible association between the direction and probability of transitions and the neighborhood context. For example, for the richest counties, the probability of a downward transition is affected the economic development of neighboring counties. As shown in Table 3, richest counties in general have a 3.0% tendency of moving downward. However, if a rich county is surrounded by other richest counties, the tendency of moving downward drops to 2.3%. Meanwhile, if the neighbors are relatively poorer counties, such as the developed counties, the tendency of moving

downward increases to 5.6% (Table 4). This neighborhood effect is also evident for the upward transitions of poor counties. The chance of a poor county moving out of the bottom averages 7.6% (Table 3). However, if its neighbor is poor, it has lower probability of moving upward (6.5%). In contrast, those poor counties surrounded by relatively richer counties such as the less developed counties are more likely to be richer (8.6%). We also find that the transitions in the intermediate groups are also influenced by the neighbourhood context. For instance, for a developed county, the probability of moving upward towards a rich county is 3.7%. But if its neighbour is a rich county, it has a higher chance (5.2%) of becoming a rich economy. At the same time, if a less developed county is surrounded by poor counties, the tendency of moving downward doubles from 10.8% regardless of its neighbourhood status (Table 3) to 23.7% (Table 4).

(Table 4 about here)

4.4 The core-periphery hierarchy of underlying mechanisms of regional inequality

In association with the Markov chains, the underlying mechanisms of the uneven regional development are examined in a multi-level model with a consideration of the core-periphery structure of regional development in Guangdong. The multicollinearity test based on the one-level model (or pooled regression) shows none variables reported a VIF higher than 2.5, indicating the explanatory variables do not suffer from the problem of multicollinearity (Yu & Wei, 2003). The results of one-level, two-level, and three-level regression models are reported in Table 5 and discussed as follows. First, based on the results of likelihood ratio tests, the one-level model can explain 82.9% of the total variances of the county level GDPPC, and there is a significant reduction in deviances

from both the one-level model to the two-level model ($p<0.001$), and from the two-level model to the three-level model ($p<0.001$) (Table 5). This result indicates that the core-periphery hierarchy of regional inequality as suggested by the Markov chains exists and regional inequality is also sensitive to different time points.

(Table 5 about here)

Second, the results differ from Li & Wei (2010a)'s study also using multi-level modeling, which found that the FDI is a singular factor that causes regional disparities at the provincial level in China. The model shows that local governments, foreign investors, and the state collectively affect the local economic development in Guangdong. Many development agents in China's regional development are actually operating at the lower levels (city or county) under provinces and their roles are likely masked by the analysis of large spatial entities such as provinces (Wei & Fan, 2000).

Third, the influence of marketization is significant in the one-level model but insignificant and marginally significant ($p=0.12$ and $p=0.06$) in the two-level and three-level models. In other words, the multilevel modeling avoids exaggerating the effect of marketization on the regional inequality in Guangdong. It implies that, among the triple processes, globalization coupled with decentralization has become the most important mechanism that causes regional disparities between counties and between the core and the peripheral areas as well as between different time points in Guangdong (Table 5). However, our results contradict Gu, Shen, Wong and Zhen's (2001) study based on the data before the mid-1990s, which suggested that the FDI was an auxiliary factor underlying the regional inequality in Guangdong. In fact, as an indicator of globalization, FDI has been increasingly important in the economic development in Guangdong,

especially after China's accession into the WTO in the early 2000s. Notably, FDI has strong policy and geographical preferences and is characterized by path dependence (Ng & Tuan, 2003). As shown in Table 1, the peripheral area only accounted for 10% of the FDI in Guangdong while most of the FDI is concentrated in the PRD. The uneven distribution of FDI has become an important, rather than auxiliary, factor causing the regional disparities in Guangdong. On the other hand, our findings confirm the positive relationship between fiscal decentralization and the uneven development in Guangdong. The fiscal decentralization in the reform era has encouraged local governments in Guangdong to actively engage in local economic development (Lin, 1997). With the changes of fiscal capacity, local governments can finance infrastructure development and public goods to promote economic growth and attract investors. This process, however, often results in the greater development in the already affluent regions and the detriment in the poor areas (Wang, 2010). Fiscal decentralization also reinforces the local governments' reliance on local revenue, which encourages the local protectionism and has weakened the capability of the regional level government to redistribute resources for an equity objective. Therefore, fiscal decentralization, despite its effectiveness in creating a growth-oriented environment in Guangdong, tends to have a negative impact on the equitable development and indirectly aggravates regional inequality. Multilevel modeling also deepens our understanding of the impact of marketization on the regional inequality in Guangdong. In comparison with globalization and decentralization, marketization has no longer been a significant factor accounting for the uneven economic development in Guangdong where the socialist market reform was initiated earlier than the other provinces in China (Gu, Shen, Wong & Zhen, 2001). In addition, the domestic private

enterprises have experienced remarkable growth in Guangdong, and their distribution tends to be more balanced in comparison with the overly concentrated foreign invested enterprises (Lin & Hu, 2011). Therefore, development of the non-state owned sector or domestic private enterprises has potential to mediate the uneven development in Guangdong driven by the unevenness of FDI.

Fourth, the results also show that fixed asset investments have exerted strong influences on the regional development in Guangdong and it is consistently significant in the multilevel model (Table 5). These results demonstrate that the economic development in Guangdong relies greatly on investments, while the distribution of fixed-asset investments is imbalanced and focused on the PRD (Table 1), exerting significant influences on the rising regional disparities. Fifth, the resulting multilevel model indicates that the urban-rural variable is marginally significant in the one-level model; however, when the core-periphery hierarchy is taken into account, the urban-rural divide significantly affects the regional inequality in Guangdong. In this sense, the application of multilevel modeling provides a more nuanced understanding that the rural industrialization in the PRD is still far from alleviating the overall economic inequality in the whole province. Lastly, the topography variable (MOUNTAIN) is insignificant in the multilevel model and its coefficient is negative. Therefore, the economic developments in these counties are constrained by their physical and topographical conditions, which also intensify the regional inequality in the province.

5. Discussion and conclusion

This paper has analyzed the regional inequality in one of China's most developed provinces, Guangdong, in the post-reform period and confirms the applicability of a multi-scale and multi-mechanism framework in the empirical research on China's regional inequality at the intra-provincial level. We find that regional inequality in Guangdong is sensitive to geographical scales and such structural changes in the post-reform period as China's accession into the WTO. By emphasizing the distinctive distributional dynamics in different stages of economic reform, this study also corresponds to the increasing interests of economic geographers in the transformation of economic landscape from an evolutionary perspective (Martin & Sunley, 2007).

Overall, Guangdong has experienced a new round of polarized development since the early 2000s under further globalization, which is greatly attributed to the widening gap between the PRD and the periphery, as well as the urban and rural areas. It is worth noting that only a small subset of counties or cities in the periphery have benefited from the spillover from the PRD while a large number of the counties or cities in the semi-core and semi-periphery areas have experienced a progressive bias towards a "poverty trap" in the 2000s. With global Moran's *I* and spatial Markov chains, we have demonstrated the significance of spatial dependence and self-reinforcing agglomeration in Guangdong's regional development, which is consistent with the findings in the recent studies of regional development in Zhejiang (Ye & Wei, 2005) and Jiangsu (Wei, Yu & Chen, 2011).

The results of multilevel modeling are capable of better explaining the factors underlying the regional inequality in Guangdong over space and time. We have found that many development agents such as the local governments, foreign investors and the

central state are functioning at the low levels under provinces, which are likely to be concealed in the analysis of large spatial aggregates such as provinces and groups of provinces (Wei & Fan, 2000). More importantly, in the case of Guangdong, the uneven distribution of foreign investment, coupled with decentralization, has become the most crucial driving force behind the uneven regional development.

The above findings thus contribute to the literature and suggest meaningful theoretical and policy implications. First, as suggested by the new economic geography literature (Krugman, 1991, 2011), the importance of space revealed in these intra-provincial studies reiterate the pervasive evidence of agglomeration toward a core-periphery model operating at local scales. The persistence of core-periphery inequality also challenges the neo-classical growth theory, which emphasizes free mobility of capital and celebrates the long-term convergence. As found in this study, given the geographical and political preferences of the global capital, the uneven development in Guangdong has been intensified in the context of globalization. Second, the results of this study clearly point out that the efficacy of inequality-reducing policies in Guangdong has been constrained by the geographical barriers and the effect of self-reinforcing agglomeration. The recent efforts towards inequality reduction have also not achieved the expected effects because these policies such as the construction of "industrial relocation parks" were biased towards the specific localities in the periphery especially the urban districts, which had a limited impact on the reduction of overall inequality in Guangdong and worsened the urban-rural inequality. Given the results of multilevel modeling, institutional reform is needed to strengthen the role of provincial government and foster cooperative relationships among local governments, so as to minimize the negative

impact of decentralization on regional disparities. The resulting multilevel model further provides a basis for the regional development policy to promote the spontaneous development of domestic private enterprises, which are spatially more balanced and locally embedded, and that they have potential to play a role in mediating the polarized development in Guangdong that is driven by the overly uneven distribution of the globalization force.

From a methodological perspective, this study underscores the promising aspects of employing GIS and spatial analysis techniques such as spatial Markov chains and multi-level modeling in understanding regional development processes. Besides spatial Markov chains, other techniques such as geo-visualization have been developed to investigate the dynamics of regional inequality in the U.S. (Rey, Murray & Anselin, 2011). Applying these rigorous GIS and spatial analysis methods is of great potential in the future research. Recent advances in spatial statistical techniques such as geographically and temporally weighted regression (GTWR, Huang & Barry, 2010) and spatial panel models (Elhost, 2003) have also tried to incorporate the time dimension in spatial econometric models. The applications of these space-time modeling techniques might also generate more insights in the triple process of regional development in China and Guangdong. Our empirical analysis of Guangdong also demonstrates that the multi-scale and multi-mechanism framework is an appropriate ground-based conceptual tool for analyzing regional inequality in China and Chinese provinces by addressing its spatial-temporal complexity and the underlying triple process (globalization, decentralization and marketization). We believe that this framework is not only relevant to specific coastal provinces like Guangdong. Applying this framework to the regional inequalities in inland

provinces is also of great significance for a more comprehensive understanding of the varied patterns, dynamics and mechanisms of regional inequality in China. Finally, besides the economic inequality, other aspects of inequality such as education, health and social inequalities should deserve attention from policy makers and scholars in future research.

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Tables

Table 1 Regional inequalities in selected provinces in China (CV), 1990-2009

	1990	1995	2000	2005	2009	Total numbers of counties
Guangdong	0.71	0.70	0.72	0.84	0.82	82
Zhejiang	0.45	0.54	0.56	0.56	0.51	67
Jiangsu	0.63	0.75	0.78	0.91	0.92	65
Henan	-	0.62	0.60	0.58	0.56	127
Gansu	-	0.94	1.04	1.11	1.23	86

Source: GSB, 1991-2009, 2010a; ZSB, 2010; JSB, 2010; HSB, 1996-2010; GaSB, 1996-2010.
Notes: the calculation in this table is based on current prices. CV = coefficient of variation

Table 2 Development indicators of Guangdong Province, 2009

	GD	% of China	PRD	% of GD	Periphery	% of GD
Population (million)	95.4	7.2	47.9	50.2	47.6	49.9
Land Area (sq. km)	179800	1.9	54733	30.4	125067	69.6
GDP (billion yuan)	3948.3	11.8	3214.7	81.4	733.6	18.6
Investment in fixed assets (billion yuan)	1335.3	5.9	960.4	71.9	375.0	28.1
Exports (US $billion)	359.0	29.9	341.8	95.2	17.2	4.8
FDI (US $billion)	19.5	21.7	17.5	89.6	2.0	10.4
Local Fiscal Expenditure (billion yuan)	433.4	7.2	288.2	66.5	145.2	33.5
Local Fiscal Revenue (billion yuan)	365.0	11.2	252.2	69.1	112.8	30.9

Source: GSB 2010a.
Note: GD = Guangdong.

Table 3 Markov-chain transitional matrices for county level GDP per capita, 1988-2009

	P [<=58.4]	L[58.5-79.3]	D[79.4-102.5]	R[>=102.6]
1988-2009				
P (422)	0.924	0.076	0.000	0.000
L (434)	0.108	0.834	0.058	0.000
D (436)	0.000	0.085	0.878	0.037
R (430)	0.000	0.000	0.030	0.970
Ergodic distribution	36.33%	25.44%	17.27%	20.96%
1988-2000				
P (198)	0.874	0.126	0.000	0.000
L (283)	0.099	0.841	0.060	0.000
D (255)	0.000	0.090	0.863	0.047
R (248)	0.000	0.000	0.040	0.960
Ergodic distribution	24.28%	30.99%	20.64%	24.08%
2001-2009				
P (224)	0.969	0.031	0.000	0.000
L (151)	0.126	0.821	0.053	0.000
D (181)	0.000	0.077	0.901	0.022
R (182)	0.000	0.000	0.016	0.984
Ergodic distribution	60.73%	15.08%	10.33%	13.85%

Notes: P= poor (periphery); L=less developed (semi-periphery); D=developed (semi-core); R=rich (core); the numbers in the parentheses are total numbers of transitions.

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Table 4 Spatial Markov-chain transition matrix for county level GDP per capita in Guangdong, 1988-2009

			2009			
Spatial lag	1988	N	P	L	D	R
P	P	124	0.935	0.065	0.000	0.000
	L	38	0.237	0.737	0.026	0.000
	D	11	0.000	0.091	0.909	0.000
	R	10	0.000	0.000	0.000	1.000
L	P	162	0.914	0.086	0.000	0.000
	L	127	0.142	0.819	0.039	0.000
	D	96	0.000	0.052	0.917	0.031
	R	45	0.000	0.000	0.044	0.956
D	P	123	0.919	0.081	0.000	0.000
	L	245	0.078	0.853	0.069	0.000
	D	195	0.000	0.123	0.846	0.031
	R	72	0.000	0.000	0.056	0.944
R	P	13	1.000	0.000	0.000	0.000
	L	24	0.042	0.875	0.083	0.000
	D	134	0.000	0.052	0.896	0.052
	R	303	0.000	0.000	0.023	0.977

Note: P= poor (periphery); L=less developed (semi-periphery); D=developed (semi-core); R=rich (core); N refers to the numbers of transitions.

Table 5 Results of the multilevel regressions

	One-level (county)		Two-level (county & core-periphery)		Three-level (county & core-periphery & time)	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
FDIPC	8.472	0.0253	8.106	0.0053	7.305	0.0113
DENCE	213.062	0.6687	1678.574	0.0001	1716.451	0.0001
NSOE	13425.501	0.0001	4548.353	0.1170	5646.382	0.0593
FIXPC	1.725	0.0001	0.380	0.0001	0.370	0.0001
URBAN	1640.425	0.1065	1934.463	0.0062	2097.407	0.0027
MOUNTAIN	-655.637	0.4149	-555.074	0.3290	-330.837	0.5569
-2loglikelihood	8361.751		8110.889		8096.617	
R square	0.829		Likelihood ratio test	<0.001	Likelihood ratio test	<0.001

Figures

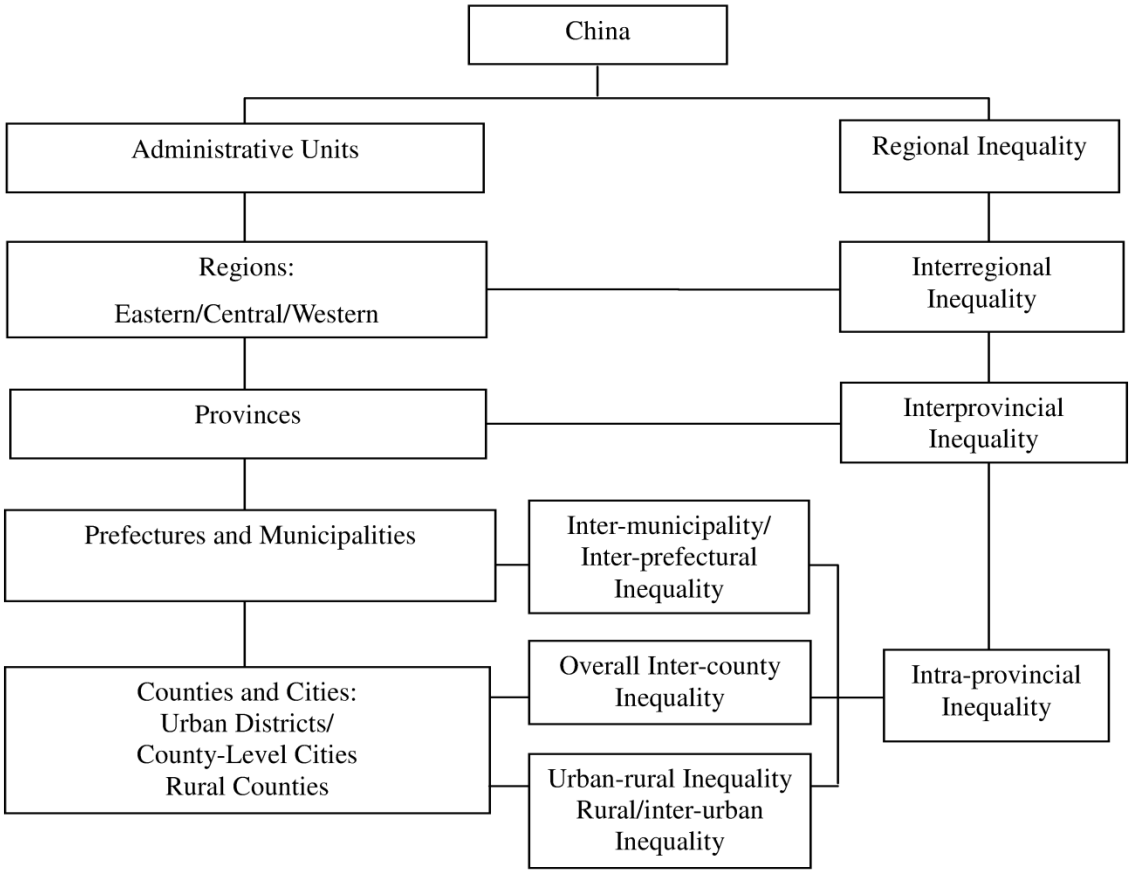

Fig. 1 A typology of multi-scalar regional inequalities in China
Source: Adapted from Wei and Ye (2009).

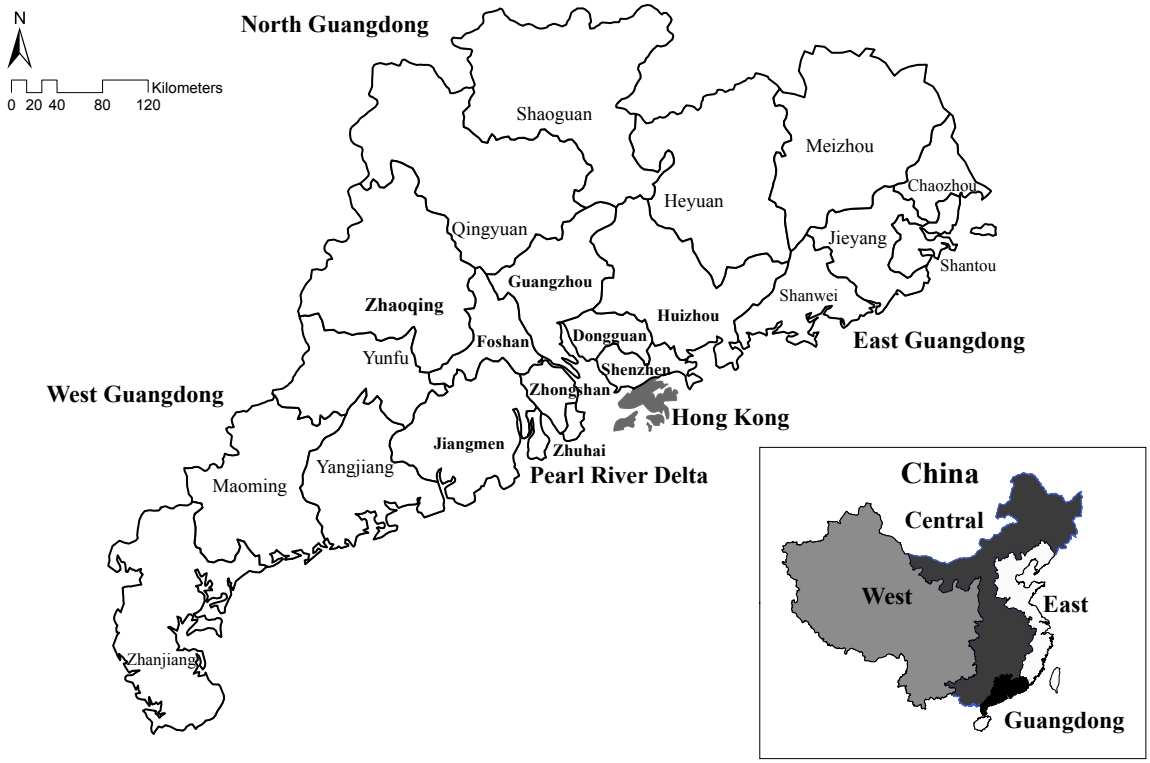

Fig. 2 Location of Guangdong and regional divisions

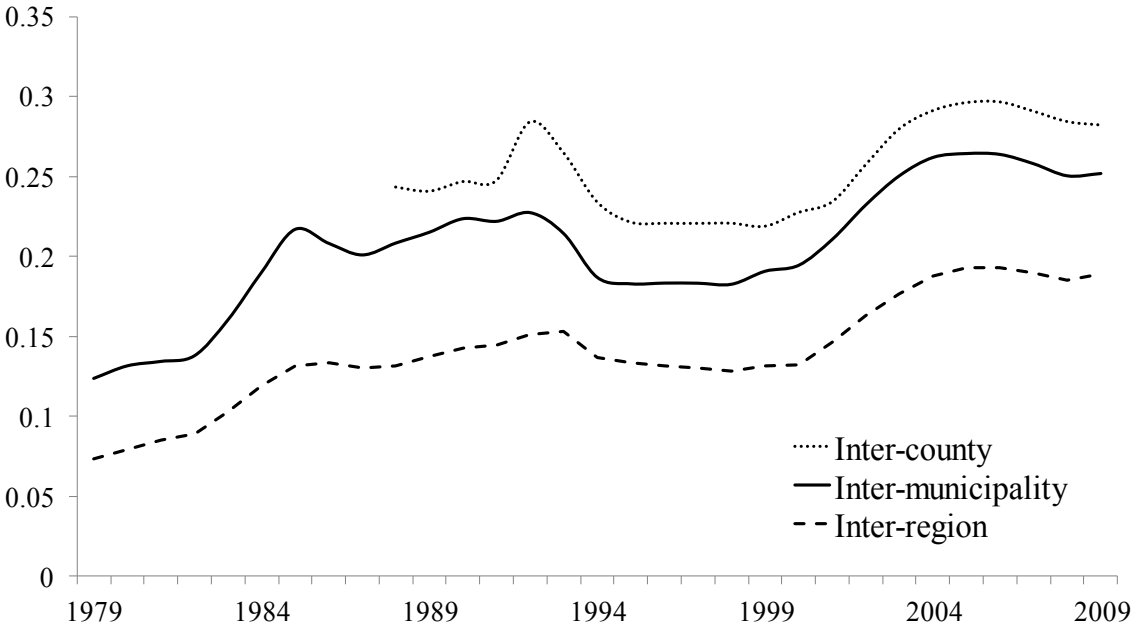

Fig. 3 Regional inequalities at different scales in Guangdong, 1979-2009: Theil Index

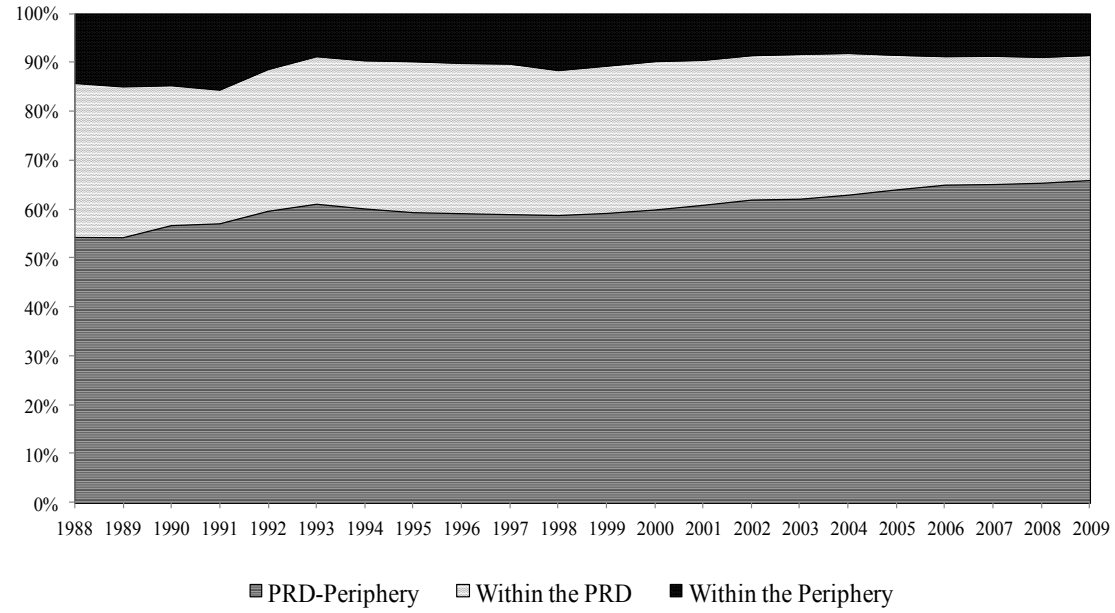

Fig. 4 Theil decomposition of overall inter-county inequality in Guangdong (core-periphery), 1988-2009

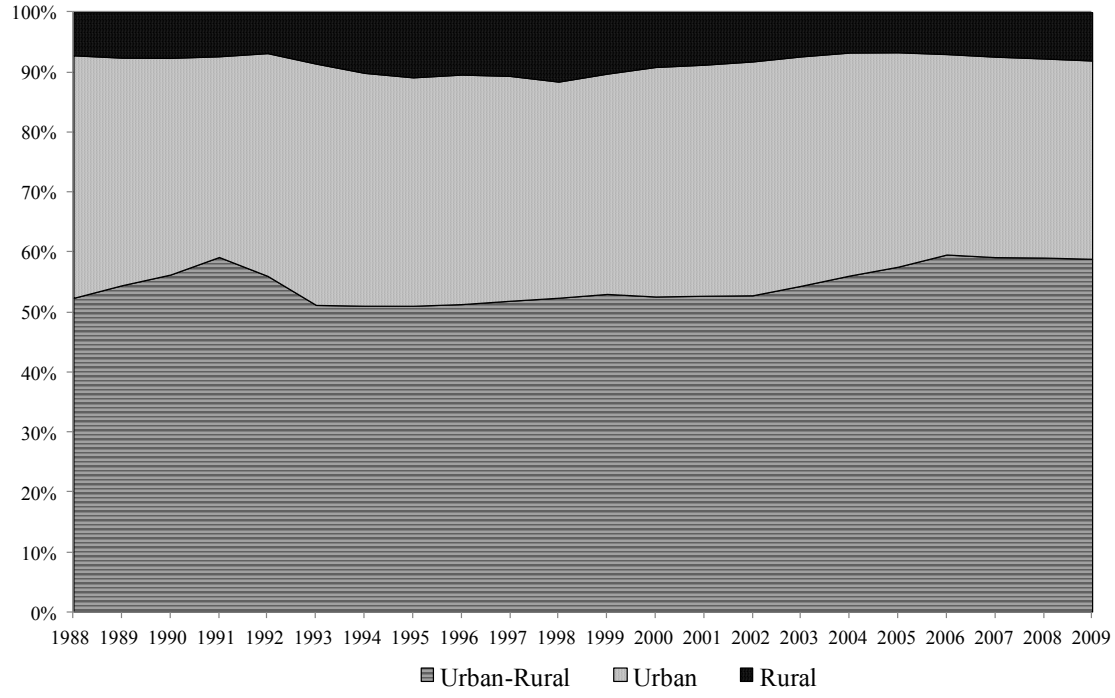

Fig. 5 Theil decomposition of overall inter-county inequality in Guangdong (urban-rural), 1988-2009

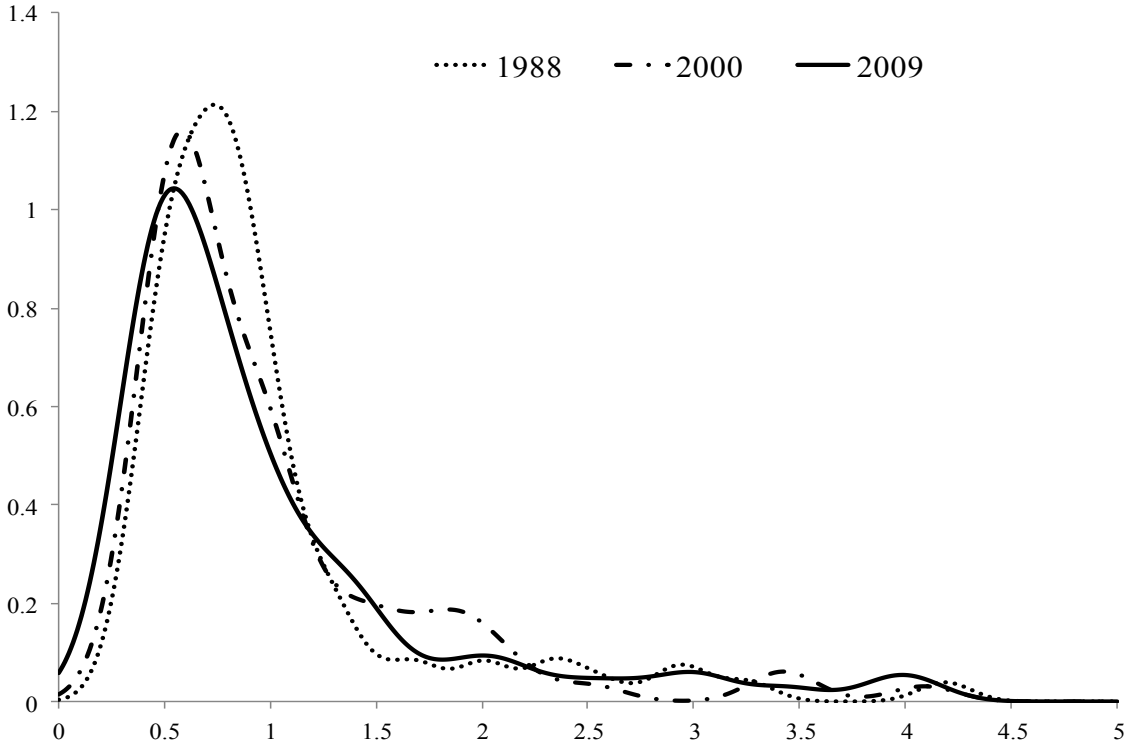

Fig. 6 Kernel densities of relative per capita GDP at the county level, 1988, 2000, 2009

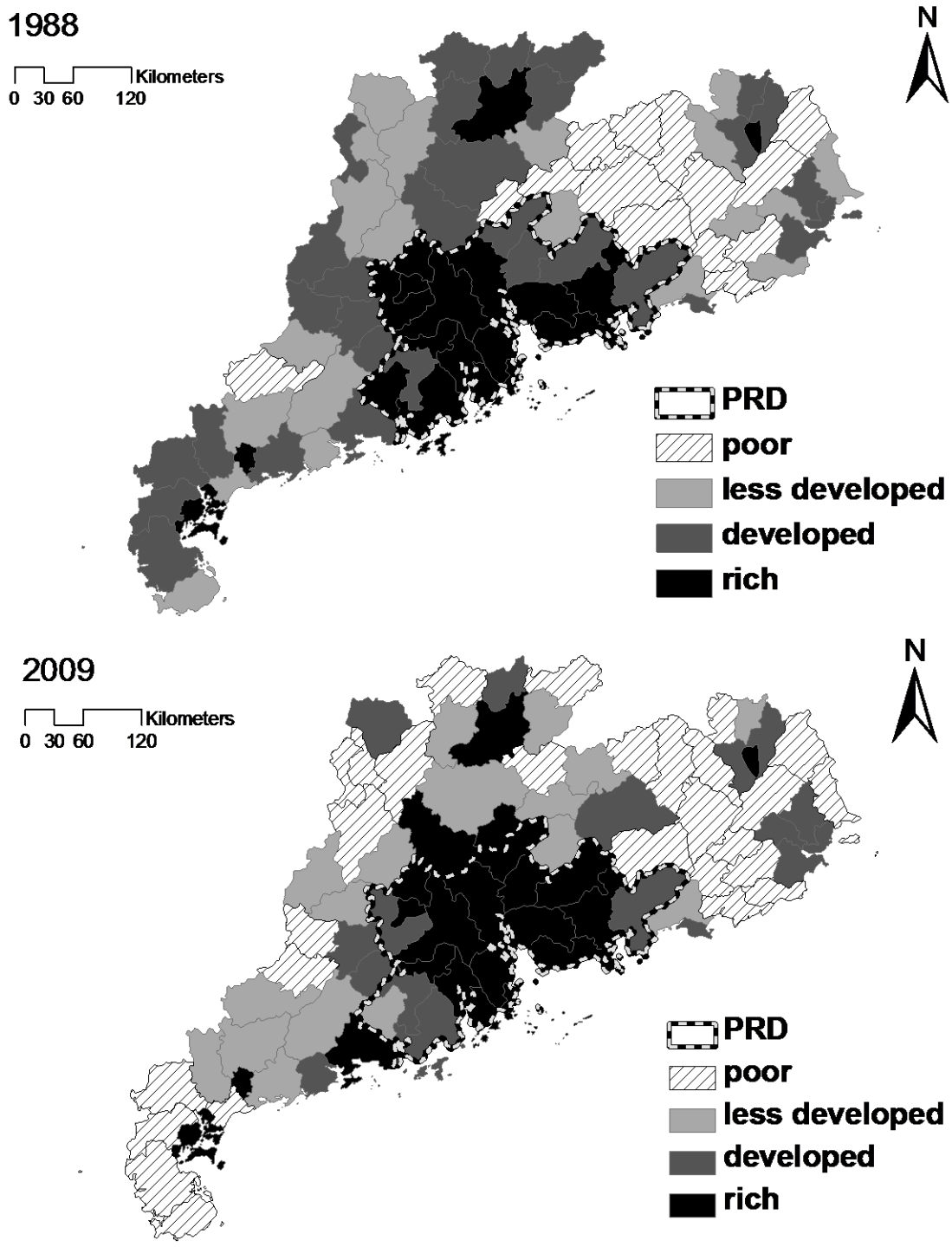

Fig. 7 Spatial patterns of regional development in Guangdong, 1988, 2009

Fig. 8 Global Moran's *I* of county level GDP per capita in Guangdong, 1988-2009

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