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Title: **The Spatial-Temporal Hierarchy of Regional Inequality of China**

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The Spatial-Temporal Hierarchy of Regional Inequality of China

Abstract

This paper advances the multi-scale and multi-mechanism framework of regional inequality in China by using the most recent statistical data. We analyze the multi-scalar patterns of China's regional inequality with GIS and statistical techniques, and demonstrate the significance of the municipality effect. The authors also apply multilevel modeling to identify the spatial structure and time dimension of the underlying forces driving regional development. This study illustrates that China's regional inequality is sensitive to the spatial-temporal hierarchy of multi-mechanisms, and reveals the relative influence of globalization, marketization, and decentralization.

Keywords: regional inequality, spatial hierarchy, multilevel modeling, GIS, China

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Introduction

China has been experiencing a gradual transition from a command economy to a market economy, and has achieved tremendous economic growth in the last three decades. At the same time, the uneven process of economic development among regions has also been intensified. Regional inequality has become a serious issue attracting considerable attention from both the government and researchers.

Regional inequality is an important issue of government policies (Wei, 2000). The Chinese government's regional policies and strategies have been changing in order to effect economic transition and social development. Since the government launched the open-door policy in 1978, China has maintained a comparative advantage and an open-door policy that focus on growth of the coastal regions to attract foreign investment and stimulate economic growth. To further the economic reform, in 1992 Deng Xiaoping, the leader of China, proposed "socialist marketization" and advocated establishing various types of enterprises besides state-owned enterprises. In the last decade, due to the increasing economic gap among regions, the Chinese government has paid more attention to solving economic polarization and endorsing programs to alleviate inequality. For example, in 1999, the "Western Development Program" (*xibu da kaifa*) was launched to boost the economic development of 12 provincial-level units (hereafter provinces) in the poorer western region. In 2003, Premier Wen Jiabao proposed "Reviving Northeastern Region" (*zhenxing dongbei*) as a national policy. The pattern of regional inequalities in China has been changing with these polices at different periods. Therefore, it is necessary to examine the time dimension for analyzing China's regional inequality.

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Regional inequality has always been a hot research area of geographers and economists. In recent years, the geographical aspect of development has become a mainstream concern, because differences in economic development are always associated with location (Krugman, 1999); the geographical scale is very important in regional inequality analysis (Wei, 2000; Wei and Fan, 2000; Wei and Ye, 2009). Some scholars have investigated the spatial patterns of China's economic development (e.g., Fan, 1995; Wei, 2000; Yu and Wei, 2003; Fan and Sun, 2008) and attempted to develop new explanations for regional inequality by studying spatial autocorrelation (e.g., Wei and Ye, 2004; Yu, 2006; Yu and Wei, 2008). However, the spatial-temporal hierarchy of regional inequality has been rarely studied, and the relevant importance of the factors underlying regional inequality is still unclear.

This paper analyzes the evolving patterns of regional inequality in China from 1978 to 2007, with an emphasis on the hierarchy of underlying factors and the time dimension with multilevel modeling. The next section outlines the literature and analytic framework of this research, followed by a discussion of data and methodology. Then we examine the pattern and the spatial hierarchy of China's regional inequality. Finally we conclude with major findings.

Literature Review and Analytic Framework

Theories of regional inequality are mainly dealing with three problems: namely, the question whether regional equality increases or decreases over time, the causes of inequality, and the development strategy for reducing regional inequality (Lipshitz, 1992). Since the 1950s, there has been a heated debate between the convergence and divergence

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schools. The neoclassical theory and inverted-U models are widely known representations of the convergence school of thought. The neoclassical growth theory emphasizes equilibrium conditions and the importance of the market in allocating resources, and considers regional inequality as a transitory phenomenon and an inevitable stage for the final equilibrium. Similarly, the inverted-U theory maintains that regional inequality increases during the early stages of development and decreases as the economy matures (Hirschman, 1958; Williamson, 1965; Friedmann, 1966; Alonso, 1980). Scholars such as Perroux and Hirschman advocate government intervention and promote the development of growth poles. This idea is also known as top-down development, or development from above (Wei and Ye, 2009). However, the persistence of poverty and regional inequality in the 1970s prompted the development of alternative schools emphasizing divergence and cumulative causation. The radical political economy perspective, for example, views regional inequality as inevitable under a capitalist system (Smith, 1984), which is pessimistic about the policy effects of regional inequality.

During the 1990s, Barro and Sala-I-Martin (1991; 1992) provided a new explanation on convergence which has renewed the discussion on regional inequality. The β-convergence indicates the trend that poorer regions grow more rapidly than wealthier regions, while the absolute difference may not necessarily decline over a period of time. Such a neoclassical approach emphasizing convergence has once again been criticized and challenged (e.g., Venables 2005; Silva 2007). Krugman's (1991) new economic geography, for example, emphasizes geographic (locational) factors and integrates traditional location theories and economic geography into this approach. However, these theories de-emphasize such important factors as institutional effect,

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spatial scale, spatial hierarchy, and the time dimension (Wei and Ye, 2009). These theories were also developed primarily to explain regional development in Western capitalist countries. Though these theories have influenced the policies and research on China's regional inequality, they have limited power in explaining regional inequality in China, which is under the transition to a socialist market economy.

Stemming from the above Western theories, the literature on China's regional inequality have displayed their own characteristics and proposed some new analytical frameworks (e.g., Yang and Liang, 1994; Wei, 2000; Wei and Ye, 2009). First, scholars have developed new explanations and proposed new processes that are responsible for regional inequality. Wei (1999; 2000) proposed the multi-scale and multi-mechanism frameworks and argued that China's economic reform can be better understood as a triple process of decentralization, marketization, and globalization; and regional inequality in China is sensitive to geographical scale and is influenced by multiple mechanisms. Researchers have investigated the effects of fiscal decentralization (e.g., Wei, 1996; Kanbur and Zhang, 2005; Tsui and Wang, 2008), foreign investment (e.g., Kanbur and Zhang, 2005; Fu, 2007), policy bias (e.g., Lu and Wang, 2002; Ho and Li, 2008), labor mobility (e.g., Ying, 2003), and globalization of science and technology (e.g., Sun and Wang, 2005; Lu and Wei, 2007; Segal, 2008). Second, some research has examined the efforts of the central government to develop interior China. For example, Fan and Sun (2008) presented an opposing argument that the Chinese government's programs and efforts since the late 1990s to reduce regional inequality have had some initial success; interregional and intraregional inequalities first became stable and then declined. Third, more vigorous methodological contributions have been produced in this field. Using

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visualization, spatial regression, and geographically weighted regression (GWR) geographers, Wei and his associates in particular, have demonstrated that regional inequality in China is sensitive to geographical clustering and agglomeration (e.g., Ying, 2003; Yu and Wei, 2003; Ye and Wei, 2005; Yu and Wei, 2008; Wei and Ye, 2009). Yu (2006), and Yu and Wei (2008) further presented spatial-temporal analysis based on spatial panel data, which better represented the dynamics of China's regional development.

The above theories and methodologies have been widely utilized in various study cases to highlight policy implications of regional development. For example, Jones and Wild (1997) examine the regional differentiation and spatial variability of Germany with GIS, and recognize the regional polarities between agglomeration cores and rural residuals after the unification of East Germany and West Germany in 1990. Their empirical results indicate the importance of reconstructing the economic culture of eastern Germany and incorporating sub-regional differentiation into a new framework of regional policy. Yao and Zhang (2001) propose a production model based on an augmented Solow growth model, and show that the regional economy in contemporary China has become more divergent in the reform period. They suggest that, the current policies focusing on the western region cannot effectively boost economic development in the remote western provinces due to the distance effects and adverse production environment. More recently, scholars have further explored the impacts of regional differentiation on sustainable development in England with GIS spatial analysis (Huby et al., 2007) and in Massachusetts, USA with GWR (Ogneva-Himmelberger et al., 2009). They argue that because of the interactive relationship between socio-economic

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inequality and environmental protection, the relevant policy intervention would be better developed by considering both socio-economic and environmental conditions.

Based on the above review, three areas deserve more research efforts. First, the scale nature of regional inequality should be further studied (Wei, 2007; Wei and Ye, 2009). Although there has been extensive research on the causes and mechanisms of the rising inequality in China, little is known about the relative importance of these contributing factors. Second, the spatial hierarchy of regional inequality has not been thoroughly examined, and a single-level investigation might hide some important characteristics of regional inequality. The application of the multilevel modeling in regional inequality is very limited. Third, government policies keep changing in the reform era, and consequently the influence of the time dimension on regional inequality should be examined. The objectives of this research are to map the shifts in patterns of regional inequality at different geographic scales in China since 1978, to explore the spatial hierarchy of the mechanisms, and to examine the influence of underlining factors.

This paper maintains that regional inequality in China is sensitive to spatial scale, and that multi-mechanisms of regional inequality have a spatial-temporal hierarchical structure, which influences the patterns of regional inequality. This research is conducted under the framework of multi-scale, multilevel, and multi-mechanisms.

Multi-Scale

There are 31 provincial administrative units (hereafter provinces) in China. These provinces are traditionally grouped into three regions: eastern, central, and western (Figure 1). The "three economic belts" scheme is based on the Seventh Five-Year Plan (1986–1990) and is commonly used to analyze regional inequality in China (e.g., Fan,

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1995; Lee, 2000; Wei, 2000; Yu and Wei, 2003; Fan and Sun, 2008). The eastern coastal region has benefitted from the preferential policies of the Chinese government and from its greater accessibility to foreign trading partners. The central interior region is the origin of China's culture, politics, and agricultural economy, and therefore is highly populated. The less-developed western mountain region is sparsely populated but has rich natural resources. This research examines the patterns of regional inequality at three different geographic scales: inter-province, between all provinces; inter-region, between the three regions; and intra-region, between the provinces of each region.

(Figure 1 about here)

Multi-Mechanism

China's economic growth can be described by the triple transitions of decentralization, marketization, and globalization, which have introduced a new set of institutional and market forces (Wei, 2000; Wei and Fan, 2000) (Fig. 2). He et al. (2008) have further defined these transitions and analyzed their effects on geographical concentration. Regional decentralization from the central to local governments reflects the institutional change, not only triggering interregional competition for business, but also pushing local governments to implement successful development policies (Montinola et al., 1995). Conversely, marketization and globalization create the conditions of comparative advantage and agglomeration economies. The economic reform has stimulated foreign investment and exports; however, the preferential policies are unevenly practiced in some selected areas, especially the coastal region. Therefore, the market force has changed the dominant role of state-owned enterprises, and advocated the competition between firms with various ownership forms, for example

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private and joint-venture enterprises. The globalization process has further enhanced the comparative advantage due to geographical concentration. This research chooses specific indicators for each transition, which will be discussed in detail later.

(Figure 2 about here)

Multilevel

Each of the three economic belts in China has unique geographical, historical, economic, and cultural characteristics. China's administrative divisions and policy-making have a spatial hierarchical structure. The economic policies have been conveyed through multiple levels of government, including province, prefecture-level city, county, township and village. The current literature has not effectively identified the spatial hierarchy of both economic growth and the underlying mechanisms, and therefore is unable to capture the relative importance of these mechanisms, including the characteristics of regional inequality. This research explains the process of economic growth at three levels (Figure 3). Due to the change of China's economic policies after reform, and the important role of regional inequality, the time level is selected as the first level. There is no regional government established for the coastal, central and western regions, but different economic policies have been carried out in these regions due to their variety in policy, geography, and history. Therefore, the regional level is the second level. Province level, the third level, is identified to examine the uniqueness of each province.

(Figure 3 about here)

Data and Methodology

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Study Area

The study area includes the 27 provinces and 4 municipalities of mainland China. In order to keep the consistency of the study area, Chongqing is taken as a provincial-level municipality, although this city has been separated from Sichuan Province since 1997. Hainan, separated from Guangdong Province after 1988, is also considered as a province in this study. The municipalities are special province-level subdivisions, which are not restricted to the multilevel administration system (Song, 1999) and benefit from similar or even more preferential policies than other coastal provinces (Wu, 2005). Therefore, they can obtain more funding and projects from the central government and have more opportunities to attract foreign investment. The eastern region has three municipalities: Beijing, Shanghai, and Tianjin; the western region has one municipality, Chongqing.

Data

Data for this study includes constant GDP per capita (GDPPC), per capita foreign direct investment (FDIPC), the share of state-owned enterprises (SOE), education (EDU), population growth rate (POPGR), and GIS shapefile. These social and economic data are obtained primarily from China data online (http://chinadataonline.org). The commonly used constant GDP per capita are chosen as the indicator of the overall level of economic development (Fan and Sun, 2008). We apply the provincial indices to convert GDP per capita in current prices into 1978 constant prices. GIS shapefiles are downloaded from China Data Center (http://chinadatacenter.org)

Methods

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This research explores the interregional, interprovincial, and intraregional inequality of China with three statistical indices commonly employed in measuring regional inequality, the coefficient of variation (CV), Gini coefficient, and Theil index. The CV is a popular measure of statistical dispersion, defined as the ratio of the standard deviation to the mean. The Gini coefficient is based on the Lorenz curve, graphically representing the cumulative distribution function of a probability distribution. The Theil index is a measure of information entropy. However, the CV is sensitive to outliers; the Gini coefficient is strongly affected by high values; and the Theil index is sensitive to low incomes (Shorrocks, 2006; Fan and Sun, 2008). Thus we use all three measures and compare the results in order to minimize potential misinterpretation and provide a credible explanation.

To further understand China's regional inequality, multilevel regression modeling is applied to examine the underlining mechanisms. The existing literature commonly uses the single-level regression technique, which treats the units of analysis as independent observations, and fails to recognize hierarchical structures. The consequence is that standard errors of regression coefficients are underestimated, leading to an overstatement of statistical significance. Multilevel modeling overcomes that limitation and recognizes the existence of data hierarchies by allowing for residual components at each level in the hierarchy. The spatial application of multilevel modeling attempts to separate the effects of personal characteristics and place characteristics (contextual effects) on behavior (Goldstein, 1987; Duncan and Jones, 2000; Fotheringham et al., 2002). The multilevel regression analysis is conducted in MLwiN 2.02 (Rasbash et al. 2005) to fit these three models.

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$$y_{ijt} = \beta_0 + \beta_1 x_{ijt} + u_t + r_{jt} + e_{ijt}$$

where, y_{ijt} is the dependent variable in region j at year t; x_{ijt} the independent variables in region j at year t; u_t is the standard error at year t; r_{jt} is the standard error of region j at year t; e_{ijt} is the standard error of i in region j at year t.

This research runs single-level (province), two-level (region and province) and three-level (time, region, and province) regression models to identify personal effect, contextual effect, as well as time effect. Five time points, 1990, 1995, 2000, 2005, and 2007 are included. The dependent variable is the constant GDP per capita (GDPPC). Following the rationale in Yu and Wei's paper (2003), this research chooses the following seven independent variables:

(1) The foreign direct investment per capita (FDIPC) reflects the effect of globalization. The more globalized the region is, the more FDI the region has obtained. We expect a positive relationship between FDIPC and economic growth.

(2) The share of state-owned enterprises in a province's fixed asset investment (SOE) is an indicator of marketization. A higher SOE reflects lower level of marketization. The SOE is expected to negatively affect economic growth.

(3) The education level (EDU) is the number of institutions of higher education per 10,000 persons, which represents labor quality, and is also an indicator of marketization. We expect a positive relationship with economic growth.

(4) The population growth rate (POPGR) is a control variable. Population growth rate of the previous five years is calculated for the 1990, 1995, 2000, and 2005 POPGR.

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For 2007 POPGR, the population growth rate from 2005 to 2007 is computed. A negative relationship with economic growth is expected.

(5) The coastal dummy (CDummy) is a locational factor that mainly shows the level of decentralization, since the central government has opened coastal provinces first and allowed them more decision-making power. The coastal province is 1, and non-coastal province is 0. We expect the positive relationship between the CDummy and economic growth.

(6) The new policy dummy (NPDummy). This is a newly proposed variable, used to examine whether the new policies have stimulated development in the western region as well as the northeastern region, and have effectively reduced the regional inequality. The province under "Western Development Program" and "Reviving Northeastern Region" are defined as 1, other provinces 0. The first five independent variables follow the research of Yu and Wei (2003). A positive relationship is expected.

(7) The per capita fixed asset investment (FAIPC) is also selected as a control variable since it has been a major factor of economic growth in China (Wei and Kim, 2002; Yu and Wei, 2008). We expect a positive relationship between FAIPC and GDPPC.

Migration is not taken as an independent variable in this paper, although it has been an important issue of China's regional development. Migration in China has been considered largely a consequence rather than a driving force of regional inequality, in response especially to regional disparity in job growth. Wei (1997) has found that state policy, global forces and regional disparities have all determined the migration pattern of China. Fan (2005) has also emphasized the increasing influence of regional inequality on the migration trend in China.

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Findings and Interpretation

Regional inequality trends and the role of municipalities

The CV, Gini, and Theil all reveal similar results of the regional inequality of China in the period from 1978 to 2007 (Figures 4 and 5). The interprovincial inequality basically showed a U-shaped pattern before 1999, which has been proven by several previous researches (e.g., Lu and Wang, 2002; Yu and Wei, 2003). Since 2000, the interprovincial inequality fluctuated significantly: a sharp decline in 1999 and 2000, an increase from 2001 to 2004, and a three-year consecutive decline from 2005 to 2007. However, the interregional inequality had a different trajectory. It showed a ladder-like, upward trend and increased gradually. Based on the coefficient of variation, the Gini coefficient, and the Theil index, the interprovincial inequality in 2007 was 20%, 1%, and 5% lower than the 1978 level, respectively; while the interregional inequality in 2007 was 71%, 27%, and 175% higher than the 1978 inequality (Table 1). Therefore, China's regional inequality did not follow either convergence or divergence schools of thought, but appeared to have more complex patterns than what these western theories interpret.

(Table 1 about here)

Though interprovincial and interregional inequalities have different trends, both are responding to the changes of economic policies. The economic reform launched in 1978 stimulated the development of some coastal provinces, which lagged behind previously. Therefore, the interprovincial inequality in the 1980's decreased. However, these policies did not close the gap between the three regions, and thus the regional inequality in this period still increased. Deng Xiaoping's Southern Tour in 1992 pushed the open-door policy forward and further accelerated the growth of the coastal region and

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made it much richer than interior regions, causing both interprovincial and interregional inequality to increase in the 1990's. Since the late 1990's, China has carried on a series of polices and strategies for alleviating regional inequality. For example, the Ninth Five-Year Plan (1996–2000) and the Tenth Five-Year Plan (2001-2005) proposed to promote the balanced development between regions. Both interprovincial and interregional inequalities had noticeable drops at the end of the 1990s, but they had up-down fluctuations after 2000. Because the short-term decrease might only be a period of fluctuation, a longer period is needed to examine whether these new policies and strategies have a long-lasting effect on reducing regional inequality. Ho and Li (2008) did not find any evidence for the effectiveness of these new policies based on the analysis of 1952 to 2000. However, Fan and Sun (2008) highlighted the initial success for reducing regional inequality according to the declined inequality from 2004 to 2006. This research holds that China's severe unequal economic development is caused by the policies as well as the initial conditions. However, the empirical analyses demonstrate that the efforts made by the Chinese government only have certain influence on regional development, but haven't fundamentally solved the inequality issue.

(Figures 4 and 5 about here)

It is worthwhile to point out that the municipalities have fundamental influences on the overall regional inequality of China. We have calculated the CVs of the constant GDP per capita of inter-province, inter-region, and intra-region with and without the four municipalities (Figures 6 and 7). The CVs of interprovincial inequality vary from 0.76 to 0.96, while those of interregional inequality range from 0.24 to 0.44 and show quite different patterns (Figure 6). After removing the four municipalities of Beijing, Shanghai,

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Tianjin, and Chongqing, both interprovincial and interregional inequalities dropped down significantly. The former changed from 0.27 to 0.46, and the latter from 0.07 to 0.33. The lines of interregional, interprovincial and interregional inequality without municipalities had very similar trends. Apparently, the advanced municipalities are a notable component causing the substantial inequality among regions. In addition, the municipalities also have an effect on uneven development within regions. Figure 7 highlights the changes of the intraregional inequality of the constant GDP per capita from 1978 to 2007. The eastern region experienced much more uneven development than the central and western regions, but showed a clear downward pattern. The CVs decreased from 0.93 in 1978 to 0.61 in 2007. The central and western regions remained relatively stable among provinces, and neither of them had significant up or down changes. Without Beijing, Tianjin, and Shanghai, the CVs of the eastern region decreased sharply and changed from 0.26 to 0.36, because other coastal provinces were in similar levels of economic development (Table 2). These three municipalities caused the serious inequality within the eastern region. In contrast, Chongqing's role in the western region was still limited because it has been upgraded to a municipality for only one decade. Its economic development lagged far behind the other three municipalities and was not significantly different from other western provinces (Table 2). However, the promotion as a municipality in 1997 has dramatically accelerated Chongqing's economy. The growth rate of the GDP per capita from 1978 to 2007 reached 49%, higher than that of the western region, 31.6%.

(Figures 6 and 7 about here)

(Table 2 about here)

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The preceding analysis points to the two findings of China's regional inequality in the reform era. China's regional inequality is sensitive to the geographical scale, and the question as to whether the regional inequality increases or decreases cannot be answered based solely on the single-scale investigation. Although the interprovincial gap has declined in most years, the disparity between the three regions has kept rising. Figure 8 reflects the ascending spatial concentration of economic growth and the widening gap between coastal and interior regions. In 1978, only three municipalities, Shanghai, Beijing, and Tianjin, had their GDP per capita falling within the two highest groups. All other provinces were poor; some coastal provinces (e.g., Shandong, Zhejiang, Fujian, and Hainan) were even among the poorest ones. In 2007, the provincial GDP per capita increased about 10 times compared to those in 1978. But all western and central provinces, except Neimenggu, Jilin and Hubei, dropped to the poorest group. Therefore, regional inequality has not been controlled even though the central government has made some effort.

Moreover, the municipalities have played an important role in the changing patterns of regional inequality. The four municipalities count for more than one-eighth of the total GDP, but the percentage decreased from 15.31% in 1978 to 12.8% in 2007 (Table 2). Since the economic reform, the gap between the coastal provinces and municipalities has narrowed; for example, Zhejiang and Jiangsu joined the two richest groups with Beijing, Tianjin, and Shanghai (Figure 8). The coastal provinces catching up with the municipalities is one of the major reasons for the declining interprovincial inequality. At the same time, the gap has further widened between the eastern region, and the central and western regions due to the three municipalities, as well as other affluent

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coastal provinces. The eastern region contributed to more than half of the total GDP; the percentage continued increasing from 52.4% in 1978 to 62.5% in 2007 (Table 2). The eastern region determined the overall trend of regional inequality. The strategy of upgrading Chongqing as a centrally administered municipality is aimed to stimulate western development and balance the development of interior and coaster regions, but it takes a long period of time to develop Chongqing as well as its surrounding provinces. Some previous researchers have also explored the relationship among the individual provinces or grouped provinces, and the whole country (e.g., Lu and Wang, 2002; Yu and Wei, 2003; Ho and Li, 2008). However, this research emphasizes analyzing the municipalities and demonstrates the interaction between them and the overall regional inequality.

(Figure 8 about here)

The spatial hierarchy of underlying mechanisms of regional inequality

We found a strong multicollinearity between FAIPC and FDIPC ($\rho = 0.8$), since FAI includes the fixed asset investment part of FDI. The potentially confounding effects of multicollinearity might cause misinterpretation of regression coefficients and standard errors of individual variables, although the overall regression model is not affected (Mason and Perreault, 1991). Also following our conceptual framework, we decide to drop the control variable FAIPC.

Thus there are six independent variables in our regression models. The single-level regular regression model is used to compare and test whether the model is improved when the contextual and time levels are added. The two-level model separates the regional and provincial levels to examine the spatial-hierarchy of the mechanisms of

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China's regional inequality. The three-level model further adds the time scale, since the data set is composed of simple repeated data of 31 provinces at five time points. The time level explains the variation of growth for each individual province in a certain region with time.

(Table 3 about here)

The results of single-level, two-level, and three-level regression modeling are reported in Table 3 and reveal the following findings: first, spatial hierarchy does exist, and regional inequality is sensitive to the time dimension. In the single-level regression model ($R^2 = 0.84$), the six independent variables can explain 84% of variance of the GDPPC. There is a significant reduction in deviances from the single-level model to the two-level model ($p < 0.0001$), and from the two-level model to the three-level model ($p < 0.05$). The likelihood tests suggest that the adding of regional and time levels has statistically improved the regression models between economic growth and multi-mechanisms. This result also illustrates that the multi-mechanism framework becomes more valuable to analyze the regional inequality of China with the spatial-temporal hierarchy.

Second, multilevel modeling has offered a new method to improve the effectiveness of the single-level regression model to examine the mechanisms underlying regional development. The six independent variables represent the three mechanisms, globalization, marketization, and decentralization, respectively. Three variables, FDIPC ($p = 0$), EDU ($p = 0.04$) and SOE ($p = 0.1$, marginally) reflecting globalization and marketization, are significant in explaining regional growth. When we further develop this model to two-level and three-level regression models, neither the EDU ($p = 0.11$,

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0.19) nor the SOE (p = 0.15, 0.89) are significant. The FDIPC (p = 0.0001) becomes the only significant independent variable. Apparently, the multilevel model avoids exaggerating the influence of marketization and decentralization. Some recent research (Yu, 2006; Yu and Wei, 2008; Wei and Ye, 2009) has also integrated spatial factors into the regression model by applying geographically weighted regression (GWR). The GWR model focuses on the spatial autocorrelation caused by the closeness of space, but is unable to reflect the influences of the spatial hierarchy as well as the time dimension on the regional development.

Third, the spatial-temporal hierarchy determines the relative importance of the mechanisms of China's regional inequality (Figures 9, 10, and 11). FDIPC has caused significant variance of the GDPPC between provinces and regions, as well at different time points (Figure 9). The variances become larger as FDIPC increases. As an indicator of globalization, foreign investment has become the key component of accelerating economic growth (Wei and Fan, 2000). With policy and geographical preferences, the eastern region accounts for more than three quarters of the total foreign investment since 1978 (Table 4). Its FDIPC was 3.5 and 10 times of that in central and western regions, respectively. The uneven distribution of foreign investment is the most important factor causing regional inequality in China. This result is different from Yu and Wei's work (2003) which identifies the SOE as the number one factor of China's regional inequality based on the data from 1990 to 2000. The difference reflects the transition China has experienced in last two decades. Deng Xiaoping's southern tour highlighted market-oriented reform and determined the prominent position of marketization in economic development in the 1990s. However, in the 21st Century, China's economy has become

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more globalized through the accession to the World Trade Organization (WTO) in 2000, successfully hosting the 2008 Olympic Games, and being selected to run the 2012 World Expo in Shanghai. These events have strengthened the link between China and the world, and therefore globalization has gradually dominated the triple transitions. In contrast, marketization only has auxiliary effects on regional development. Two marketization indicators, the SOE and EDU, only lead to the variance of the GDPPC between provinces (Figures 10 and 11). With the emergence of various types of enterprises, the share of state-owned enterprises has kept dropping, and the influence on economic growth has been gradually fading. Education level is a driving force for economic development, but the role is very limited. Two decentralization indicators, the coastal dummy and the new policy dummy, are not significant to regional growth at all. This indicates that the interregional competition stimulated by decentralization is not sufficient enough to alleviate the regional imbalance caused by globalization and marketization. It also demonstrates that the new strategies to reduce regional inequality haven't obtained the expected results, which is consistent with the results of the CV, Gini, and Theil index.

(Figures 9, 10, and 11 about here)

(Table 4 about here)

Discussion and Conclusion

This paper investigates regional development in China in the reform era. We found that regional inequality at different geographical scales has shown various patterns, which is influenced greatly by the four municipalities. The interprovincial inequality has declined due to reducing disparities between the coastal provinces and the municipalities,

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while the interregional inequality has been rising due to the fact that the eastern region is still far ahead of the central and western regions. Without the municipality effect, both interprovincial and interregional inequalities decline significantly. The spatial concentration of regional development has increased, and the eastern region has accounted for the higher percentage of the total GDP than the early stage of the economic reform. Therefore, the new development strategies for reducing regional inequality haven't achieved the expected results. This research also contributes to the literature by applying multilevel modeling to recognize the spatial-temporal hierarchy of the mechanisms and to identify the relevant importance of the triple transitions. We found that globalization is the dominant mechanism causing regional inequality, since the important driving force of economic growth, the FDI, is extremely unevenly distributed among the three regions. The influence of marketization has decreased gradually with the decline of the state-owned enterprises. And decentralization of the central authority is still limited in the ability to solve the inequality problem.

Our study recognizes that the multi-mechanisms framework is capable of explaining China's regional development. Unlike the convergence or divergence theories which only emphasize free mobility of capital or government intervention, the multi-mechanisms include the state, local agent and global forces (Wei, 2000). They represent "from above", "from below", and "from outside" forces of development (Wei and Fan 2000, p.466), which have been usually interwoven. The municipality effect is an example of how these forces have driven regional growth; because the municipalities have more preferential policies from the central government, higher local autonomy, and can attract more foreign investment. The spatial distribution of the municipalities is one reason for

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serious regional inequality, since three richest municipalities (Beijing, Shanghai, and Tianjin) are located in the eastern region. In addition, the impact of each mechanism has been shifting with time due to the changing policy orientation. In the first phase of economic reform, the key strategy was decentralizing power from the central government to the local government, mainly in the eastern region. Marketization became the dominant direction of the reform in the 1990s, and globalization was the most important mechanism after 2000. Therefore, the spatial and time structures of the multi-mechanisms have a direct effect on regional development. Our analysis on the spatial-temporal hierarchy makes the multi-mechanisms framework more effective to explain regional inequality in China.

The above findings have at least three theoretical and policy implications. First, neither neoclassical theories nor "new convergence" is capable of explaining regional development in China, due to the fact that they all de-emphasize the transitional nature of the Chinese economy and the role of the state and polices. Second, given the multi-scalar nature of regional inequality, it might be more effective to further improve policies at varied scales and integrate policies from above and below, paying special attention to key metropolitan areas. In the past 10 years, the central government proposed the "Western Development Program" (12 provinces); "Reviving Northeastern Region" (3 provinces), and "The Rising of Central China" (9 provinces), which contrasts the policies of the 1980s and 1990s when China only selected some coastal cities and special economic zones as growth poles. As the municipalities have played leading roles in regional development, further reform of key interior cities might drive the development of these cities and their surrounding areas. Since the current interior development strategies cover

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many provinces, it might be useful to select some provinces and regions for their best practices. Third, further institutional reform is essential to attract external investment and talents. The central and local governments need to further improve the investment environment to attract foreign investment, since FDI has been the most important factor causing the regional gap, as shown in this research. The combination of the rich resources in the western region, adequate labor in the central region, and the potential capital would boost economic growth in interior regions.

In conclusion, this paper has documented the patterns of China's regional inequality, identified the significant effects of the municipalities, and implemented multilevel modeling to reveal the spatial-temporal hierarchy and the importance of multi-mechanisms. This research could be improved by considering the spatial autocorrelation among provinces and regions. Some researchers have demonstrated the strengthening positive spatial autocorrelation of China's development (Yu, 2006; Yu and Wei, 2008). The integration of the GWR and multilevel modeling might present new findings of China's regional inequality.

We'd like to acknowledge the funding of the Ford Foundation (10851022) and the NSF of China (70621001).

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Table 1. Coefficient of variation (CV), Gini coefficient, and Theil index of the constant GDP per capita of China.

Measure	Interprovince				Interregion			
	1978	1990	2000	2007	1978	1990	2000	2007
CV	0.96	0.84	0.81	0.76	0.24	0.29	0.41	0.42
Gini	0.36	0.33	0.35	0.35	0.29	0.30	0.37	0.37
Theil	0.16	0.13	0.15	0.15	0.03	0.04	0.07	0.08

Source: China data online.

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Table 2. Growth rates of the provinces and regions of China, 1978-2007.

Province	GDP Per Capita (1978 Constant Yuan)				Growth Rate (%)		
	1978	1990	2000	2007	1978-1990	1990-2000	2000-2007
Eastern Region							
Beijing	1249	2801	6284	11880	10.36	12.43	12.72
Tianjin	1141	2326	5988	13637	8.65	15.75	18.25
Hebei	362	789	2404	5090	9.83	20.48	15.95
Liaoning	675	1495	3394	7399	10.12	12.70	16.85
Shanghai	2484	5035	12175	24391	8.56	14.18	14.33
Jiangsu	427	1293	4377	10352	16.89	23.85	19.50
Zhejiang	330	1102	4022	8945	19.50	26.50	17.48
Fujian	271	817	2978	6356	16.83	26.45	16.20
Shandong	315	837	2832	6672	13.81	23.85	19.37
Guangdong	367	1256	3574	7990	20.19	18.46	17.65
Guangxi	223	408	1152	2365	6.93	18.21	15.04
Hainan	310	798	2141	4144	13.09	16.84	13.36
Central Region							
Shanxi	363	784	1418	3881	9.66	8.08	24.82
Neimenggu	318	822	1900	5843	13.18	13.12	29.65
Jilin	381	938	2252	4984	12.15	14.02	17.33
Heilongjiang	559	1086	2337	4688	7.87	11.52	14.37
Anhui	242	585	1752	3636	11.84	19.93	15.36
Jiangxi	273	642	1793	3740	11.24	17.92	15.52
Henan	231	592	1643	3649	13.07	17.75	17.43
Hubei	330	819	2265	5050	12.34	17.66	17.56
Hunan	285	587	1506	3192	8.87	15.65	15.99
Western Region							
Chongqing	257	610	1667	3976	11.43	17.35	19.78
Sichuan	261	615	1498	3374	11.29	14.38	17.88
Guizhou	174	411	874	1689	11.40	11.27	13.31
Yunnan	223	565	1194	2191	12.75	11.14	11.92
Xizang	367	724	1618	3453	8.11	12.35	16.20
Shaanxi	292	732	1630	3509	12.57	12.29	16.46
Gansu	346	740	1608	3276	9.49	11.71	14.82
Qinghai	426	737	1395	2918	6.08	8.94	15.59
Ningxia	366	804	1621	3190	10.00	10.15	13.83
Xinjiang	317	878	1767	3265	14.76	10.12	12.10
Municipalities and Regions							
% of GDP Municipalities	15.31	13.24	12.83	12.74	----	----	----
% of GDP Eastern Region	52.30	54.90	60.90	62.50	----	----	----
Average GDPPC of Municipalities (Yuan)	1283	2693	6529	13471	9.16	14.24	15.19
Average GDPPC of Eastern Region (Yuan)	680	1580	4277	9102	11.03	17.07	16.12
Average GDPPC Central Region (Yuan)	331	762	1874	4296	10.85	14.59	18.46
Average GDPPC Western Region (Yuan)	303	682	1487	3084	10.42	11.80	15.34

Source: China data online.

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Table 3. Results of the single-level and multilevel regressions, 1990-2007.

Single-Level			Two-Level			Three-Level		
Independent variable	Coefficient	P-value	Independent variable	Coefficient	P-value	Independent variable	Coefficient	P-value
FDIPC	34.769	0	FDIPC	36.118	0.0001	FDIPC	35.705	0.0001
EDU	10.945	0.04	EDU	8.459	0.11	EDU	6.533	0.19
SOE	-14.651	0.1	SOE	-13.038	0.15	SOE	-1.299	0.89
POPGR	-3.143	0.98	POPGR	-105.9	0.38	POPGR	-197.619	0.12
CDummy	-447.454	0.13	CDummy	-487.146	0.23	CDummy	-252.686	0.37
NPDummy	196.269	0.44	NPDummy	176.733	0.47	NPDummy	72.161	0.76
R-Square	0.84		Likelihood ratio test	<0.0001		Likelihood ratio test	<0.05	

Note: FDIPC-foreign direct investment; EDU-education level; SOE-the share of state-own enterprises; POPGR-population growth rate; CDummy-coastal dummy; NPDummy-new policy dummy.
Source: China data online.

Table 4. FDI and FDI per capita of three regions.

Region	FDI ($ Million) / Percentage				FDIPC ($)			
	1990	1995	2000	2007	1990	1995	2000	2007
Eastern Region	3046 / 94%	32947 / 87%	35411 / 88%	96036 / 78%	6.5	67.0	66.0	169.8
Central Region	112 / 3.5%	3378 / 9%	3700 / 9%	21663 / 18%	0.3	7.9	8.3	49.0
Western Region	76 / 2.5%	1441 /4%	1332 / 3%	4922 / 4%	0.3	5.2	4.6	16.9

FDI: foreign direct investment.
Source: China data online.

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Figure Captions

Figure 1. Three regions and provincial-level units in China.

Figure 2. Triple transitions of China's regional development.

Figure 3. Multilevel framework of China's regional development.

Figure 4. Interprovincial inequality of GDP per capita, 1978-2007.

Figure 5. Interregional inequality of GDP per capita, 1978-2007.

Figure 6. Inequalities of Inter region and inter province (CV).

Figure 7. Inequalities of intra region (CV).

Figure 8: Spatial pattern of regional development in China.

Figure 9. Variance for FDI per capita at time, region, and province levels.

Figure 10. Variances for share of state-own enterprises at province level.

Figure 11. Variances for education level at province level.

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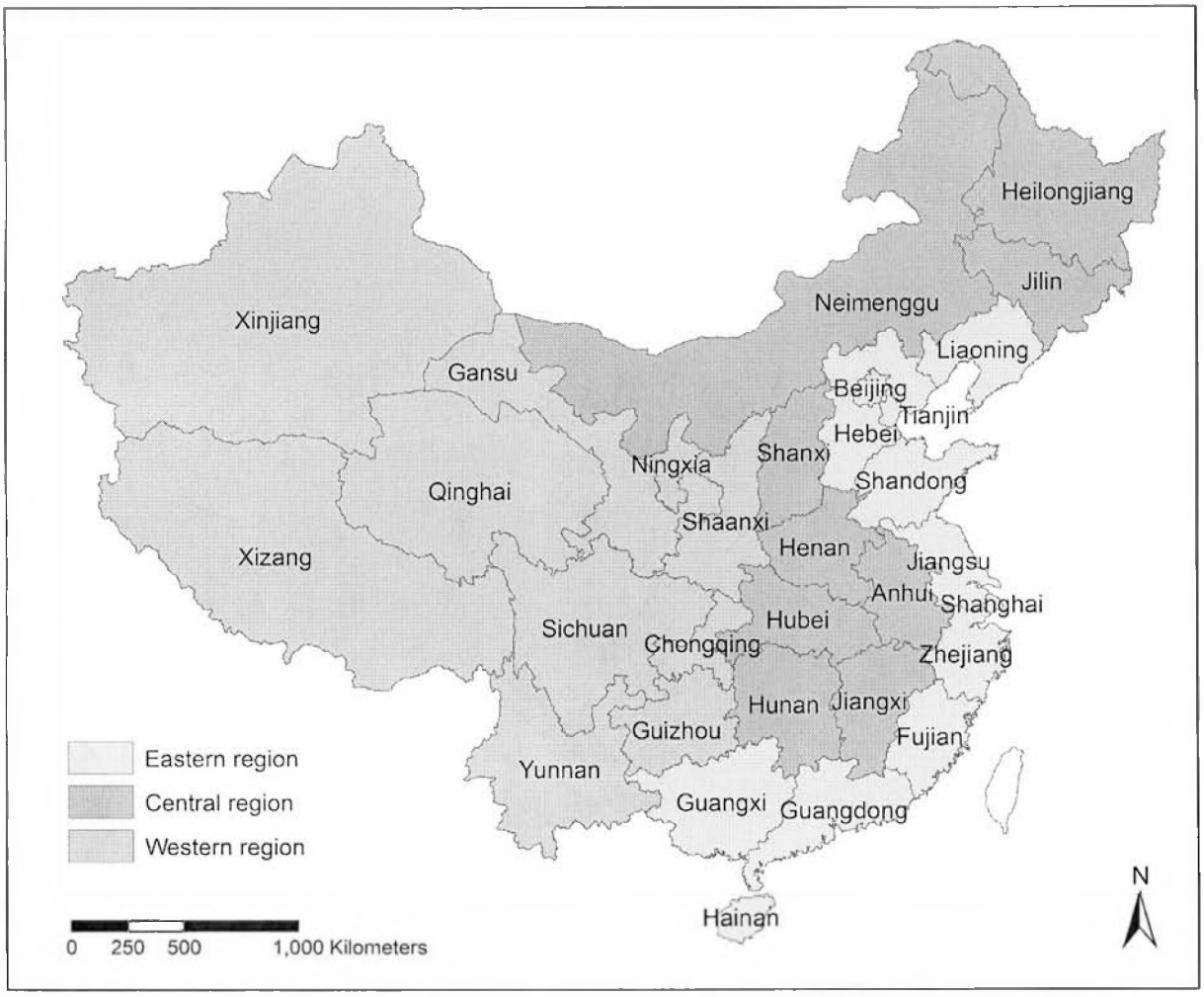

Figure 1. Three regions and provincial-level units in China.

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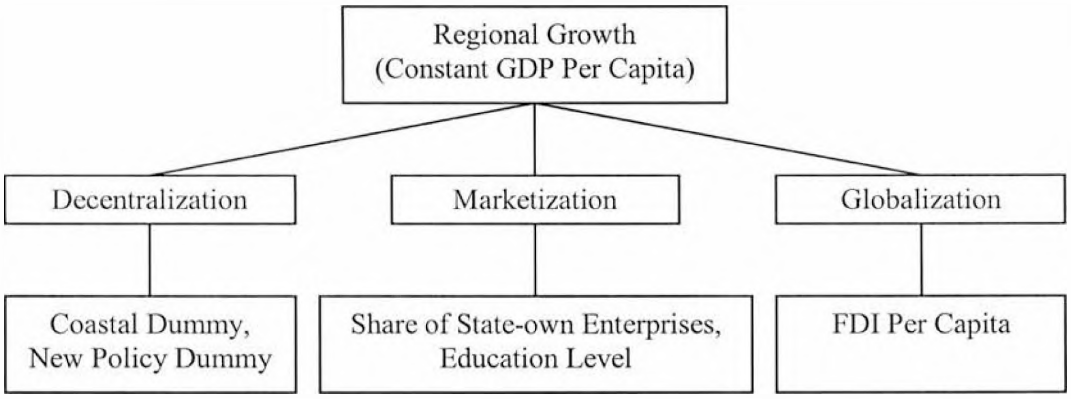

Figure 2. Multimechanisms of China's regional development.

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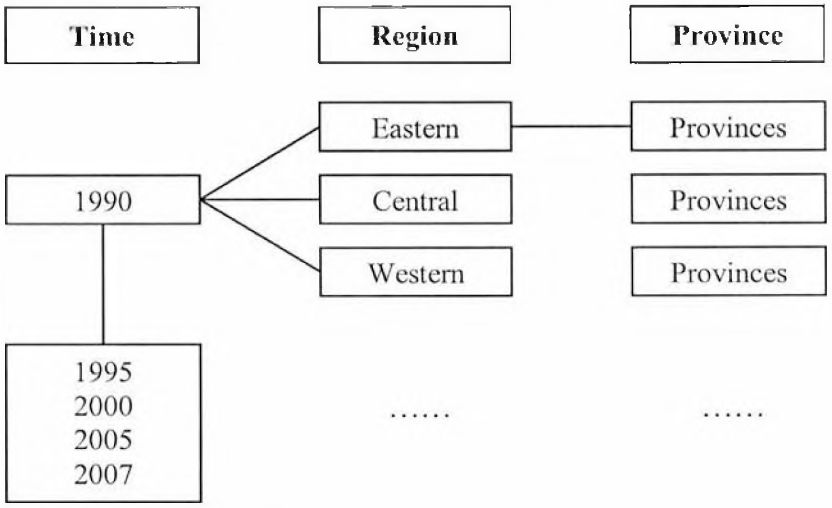

Figure 3. Multilevel framework of China's regional development.

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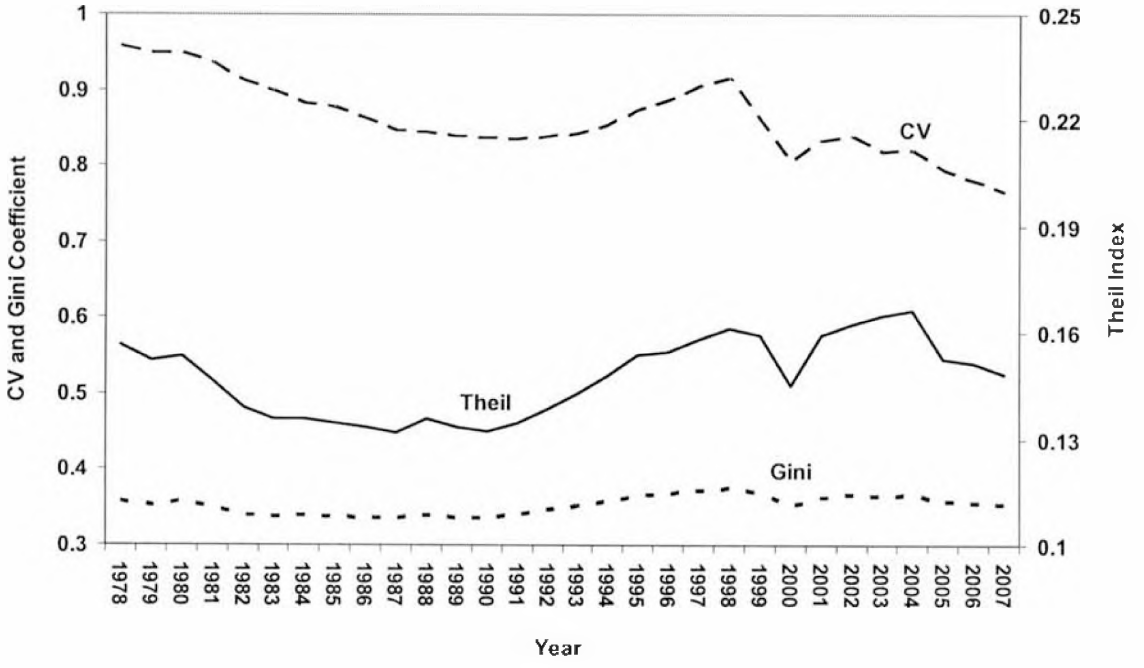

Figure 4. Interprovincial inequality of GDP per capita in China, 1978-2007.

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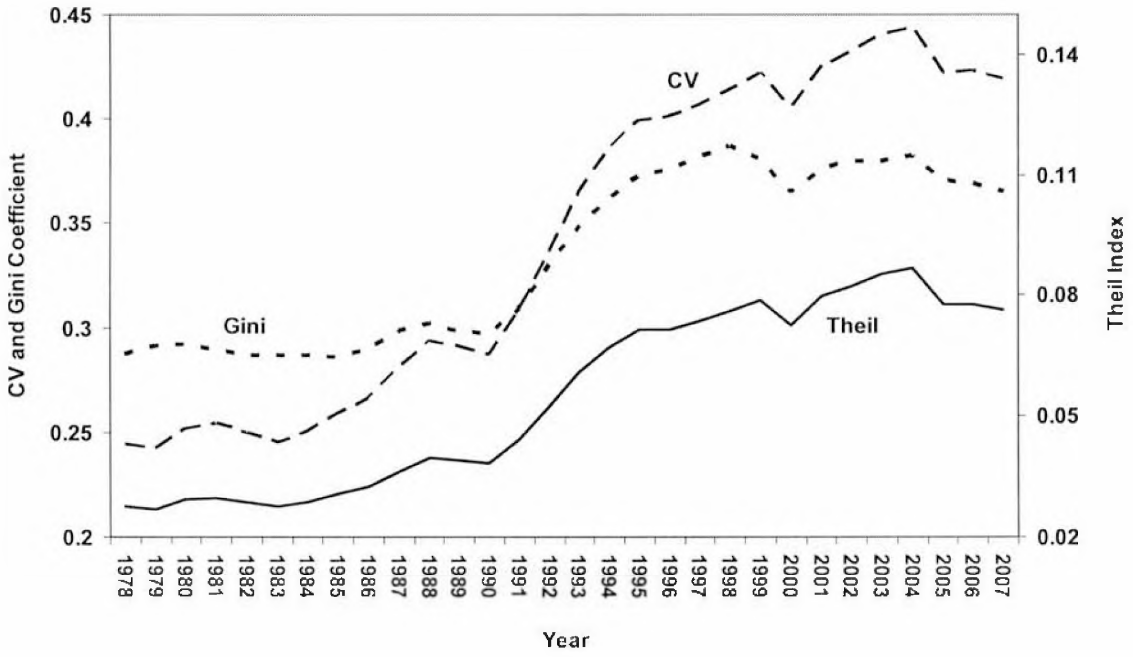

Figure 5. Interregional inequality of GDP per capita in China, 1978-2007.

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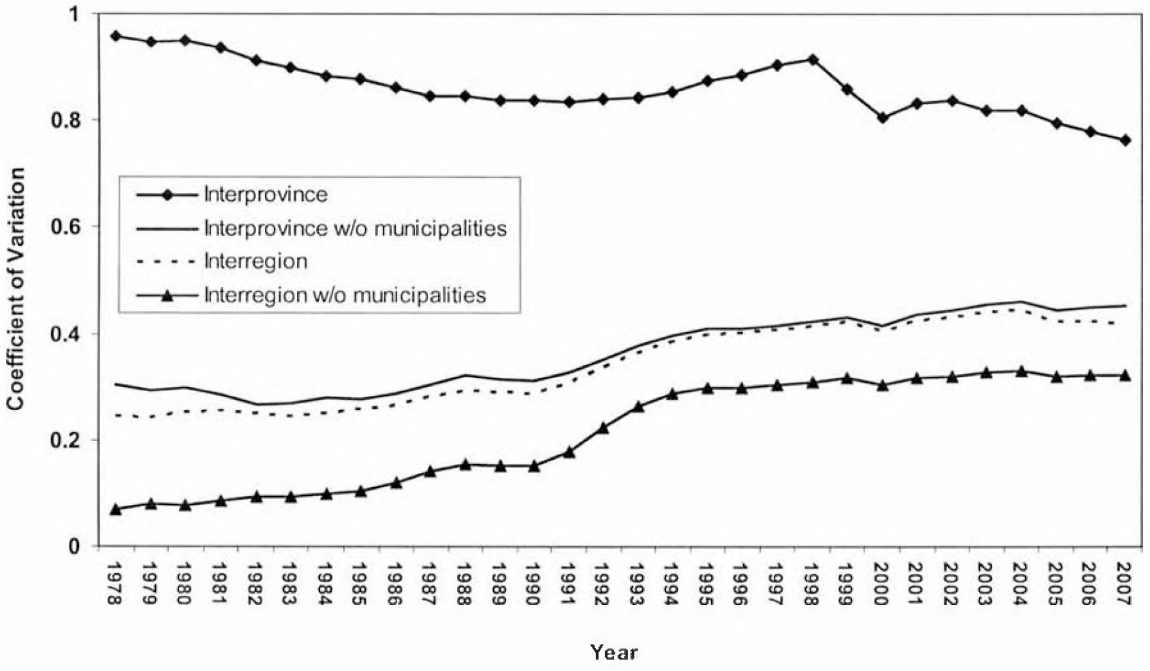

Figure 6. Inequalities of interregion and interprovince in China, 1978-2007.

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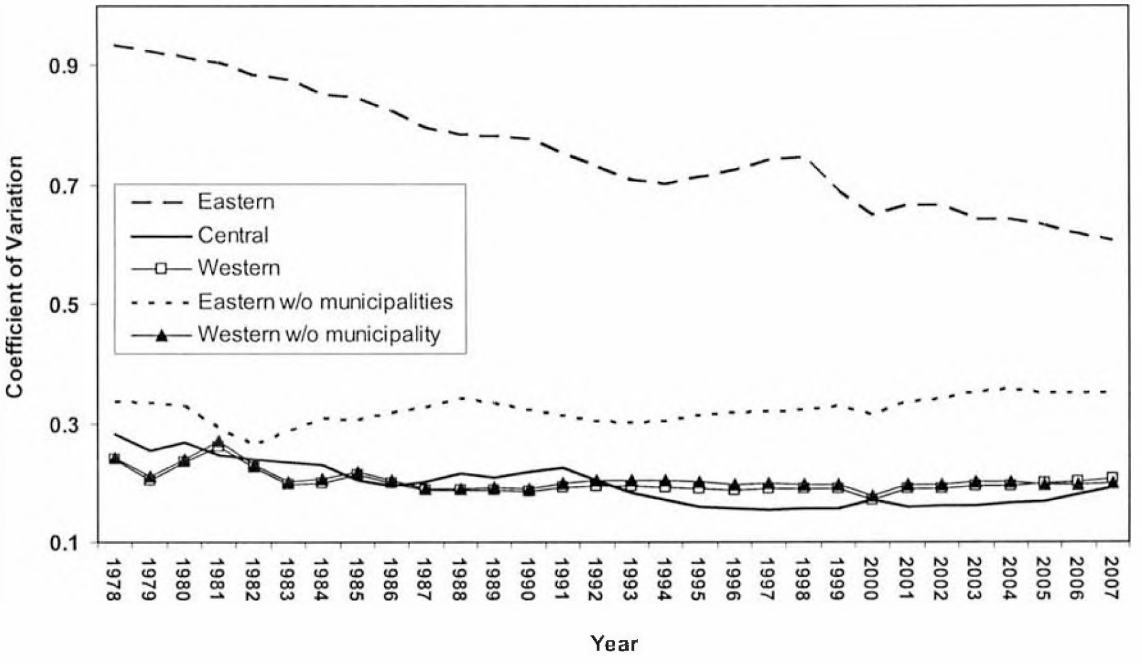

Figure 7. Inequalities of intraregion in China, 1978-2007.

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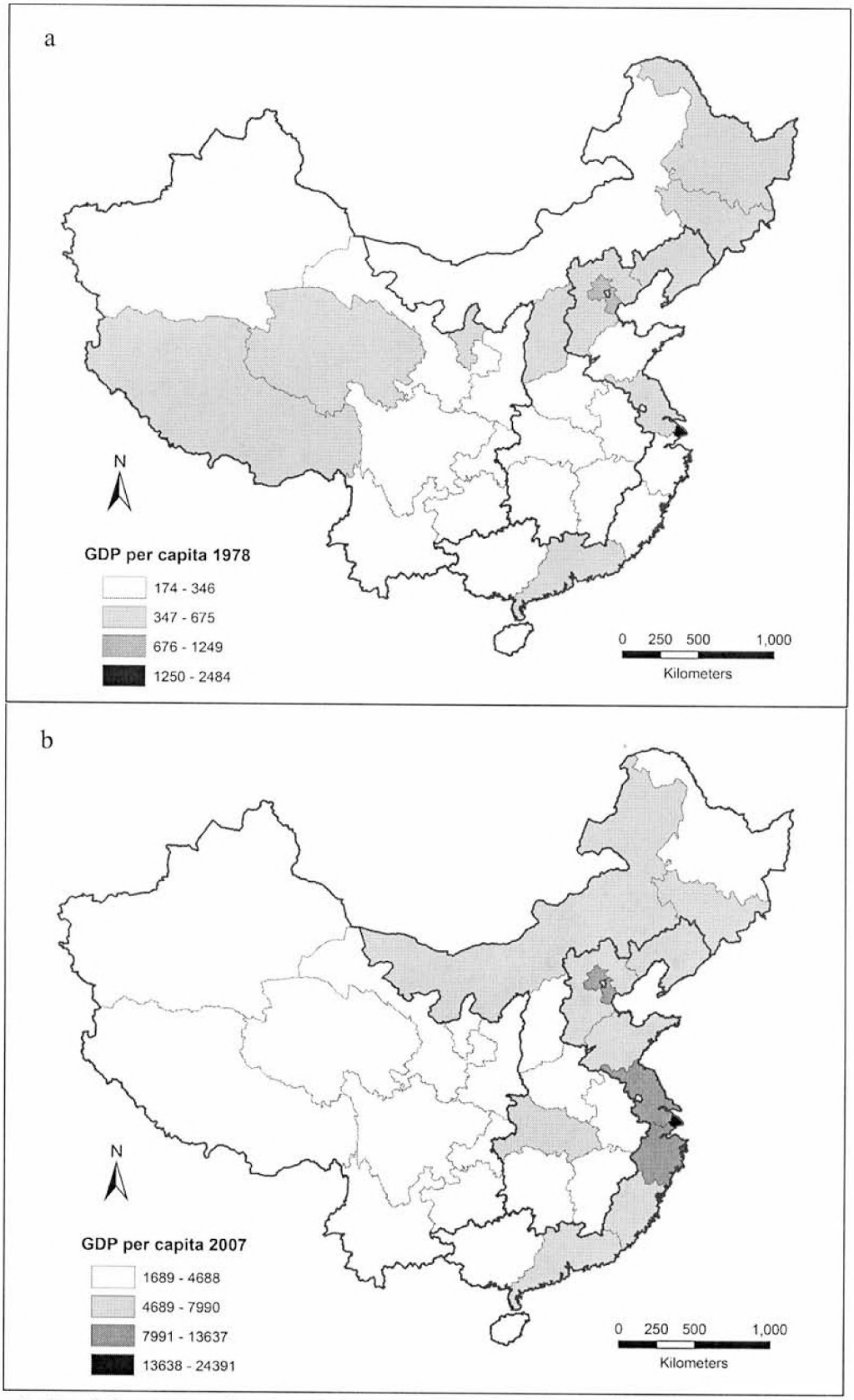

Figure 8: Spatial pattern of regional development in China in 1978 (a) and 2007 (b).

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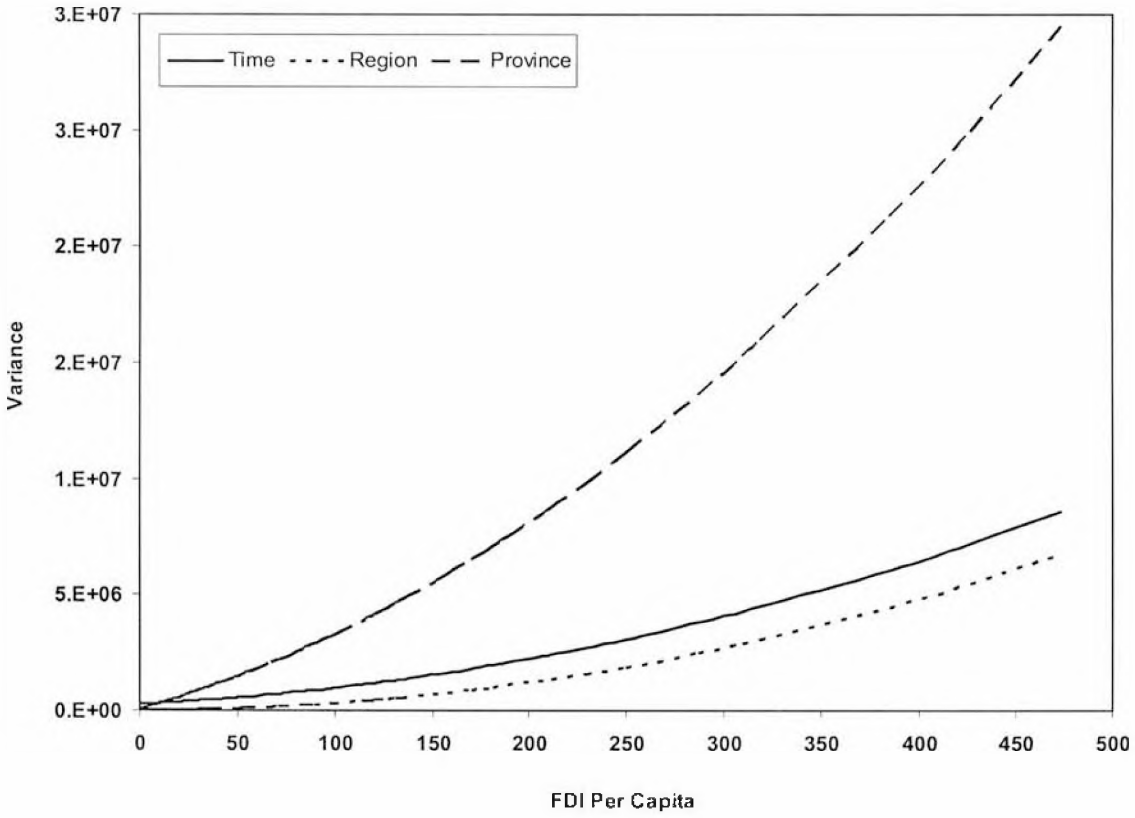

Figure 9. Variance for FDI per capita at time, region, and province levels.

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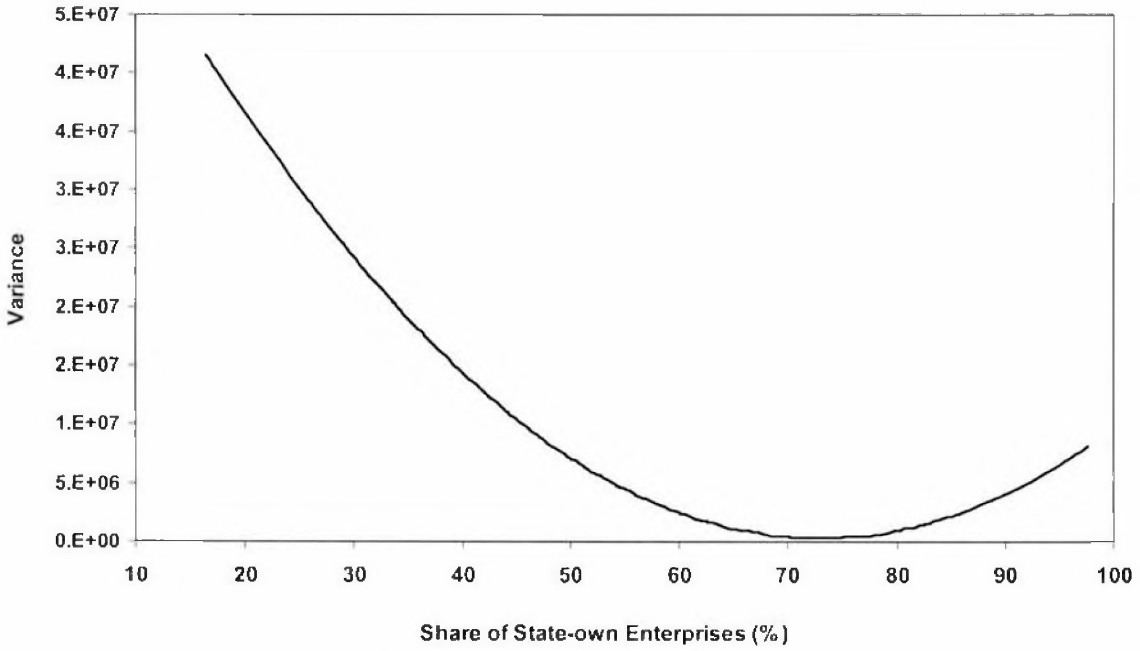

Figure 10. Variances for share of state-own enterprises at province level.

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