Core-Periphery Model in Urban Economic Growth:

An Analysis Based on

Chinese City-Level Panel Data

1990-2006

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Abstract: This paper uses Chinese city-level panel data from 1990 to 2006 to estimate the impact of inter-city spatial agglomeration on urban economic growth. Our results show a ∽-shaped correlation between the distance to the nearest major ports in China and urban economic growth, which verifies the Core-Periphery Model in the new economic geography theory. We also find that a city which locates near the regional central city has a higher economic growth rate. Besides, our results suggest that due to the market segmentation between Chinese provinces, the "border effect" of Chinese provinces is equivalent to adding as much as 260 kilometers, which prevents cities from being absorbed by regional central cities in other provinces.

Key Words: Spatial agglomeration, market segmentation, urban economic growth, Core-Periphery Model

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I. Introduction

China has been experiencing rapid economic growth during the past thirty-years, while global capital and China's inland cheap labor keep combining in China's eastern coastal area. This spatial agglomeration of economic activities has brought tremendous changes in spatial distribution of China's economy, as well as the basis for empirical testing the "core-periphery" theory in the new economic geography. But no literature has used econometric modesl to describe the Chinese urban Systems. Given that the new economic geography theory has successfully interpreted spatial agglomeration and urban, regional economic development (Neary, 2001), this paper will use Chinese city-level panel data from 1990 to 2006, based on the new economic geography theory, research the effect of geography factors to China's urban economic growth, and show the process of spatial agglomeration in city level.

Our research will focus on the two following questions: First, how does the inter-city spatial agglomeration affect urban economic growth in China? Second, does Chinese inter-province market segmentation add actual distance between cities in different provinces, while limiting the inter-city agglomeration effect, as well as distorting the allocation of resources?

The new economic geography finds that the effects of spatial agglomeration on urban economy include both centripetal forces (Krugman, 1991) and centrifugal forces (Helpman, 1999; Tabuchi, 1998). Centripetal forces mean the power to promote economic concentration, while centrifugal forces refer to the contrary with such power. Centripetal forces derive primarily from related industries, knowledge spillovers and other external economies; centrifugal forces are due to poor mobility of production factors, transport costs, congestion and other external diseconomies.

Fujita et al. (1996, 1999a, 1999b) simulated a ∽-shaped curve between distance and urban market potential which reflects the economic scale of urban in a single-core urban system. This curve shows that with the distance to regional central cities increases, the market potential declines first, and later rises, then declines again, which reflects the interaction of spatial agglomeration between the centripetal force and centrifugal force. On one hand, the regions nearer to regional central cities are more attractive; on the other hand, the cities far away from central cities avoid from fierce competitions with central cities and surrounding regions, of which the impetus encourage manufacturers to stay away from central cities. Fujita et al. (1996a, 1999b) also draws a ∽-shaped market potential curve in a single-core urban system by numerical simulation, when describing the impact of the transport hubs, such as ports, on the city location.

But empirical studies of the new economic geography lag far behind the theory. "Buttressing the approach with empirical work" and "quantified models" are two important directions for the new economic geography future researches by Fujita and Krugman (2004). However, "Due to the highly nonlinear nature of geographical phenomena", it's not easy "to make the models consistent with the data". At the same time, economic geography, in particular the role of spatial agglomeration factors require a wide range of space, long time of accumulation and development, while national boundaries, geographical boundaries, war and other factors often limit the free flow of resources, it is difficult to use the empirical econometric model and real-world data to clearly portray the spatial agglomeration effects. Therefore, it's studies on stably-developing large countries that seem particularly important for the empirical researches of the new economic geography.

Hanson(2005), by constructing the market potential function, with the U.S. counties data, finds a significant negative non-line correlation between distance and market potential, and the impact decreases as distance increases, which almost disappears 200-300 km away. But Hanson doesn't find any evidence for "centrifugal forces".

Dobkins and Ioannides (2000, 2001), Ioannides and Overman (2004) and so on use the 1900-1990 U.S. metropolitan-area panel data to find no significant correlation between the distance to the nearest higher-level city and the population growth or wages, and there is no non-linear relationship, which may be because the links between wages or population and urban market potential are too complicated. None of the above researches have given convincing empirical evidences for the impact of spatial agglomeration on urban economy.

Researches using China data may contribute to the empirical studies of the new economic geography, mainly based on the following reasons: 1) China has a vast territory, as well as a large population. The vast territory provides not only space required by agglomeration effects, but also plenty of samples for empirical studies. Meanwhile, a large population provides sufficient market potentials. 2) Compared with the United States, China has a larger interregional geographical diversity and more obvious geographical heterogeneity, because of the concentration of the ports distribution, which leads to a bigger variance within cross-section samples. 3) China has a rapid economic development in the last thirty years with observably temporal changes of the spatial distribution of economic activities, which allow us to observe the impact of spatial agglomeration on urban economy in long term with the data of recent years.

Bao et al. (2002) find the economies in coastal areas developed faster by absorbing more FDI and labor, using Chinese province-level data. Chen et al. (2008) find that the coastal areas have the geographical advantages in industrial concentration. Other studies also find "spatial-concentration" or "spatial-dependence" in China's regional economic development, that is, coastal provinces and cities develop faster (Ho and Li, 2008). Nevertheless, such studies only use coastal- inland dummy or east-middle-west dummy to measure the factors of geographical location, so there are at least two deficiencies: First, they can't explain whether the observed "spatial-concentration" or "spatial-dependence" stems from the policy or geographic location; Second, it's unable to clearly characterize the non-linear effect of spatial agglomeration or verify centripetal forces and centrifugal forces.

Based on the above problems, we use Chinese city-level panel data from 1990 to 2006 to estimate the impact of spatial agglomeration of the regional central cities as well as the major ports on urban economic growth. In this paper, there are two main indicators measuring geographical factors: the distance to the nearest regional central city, and the distance to the nearest major port. Because we use the continuous distance indicators, we can simulate the effect of agglomeration as distance changes, and identify centrifugal forces and centripetal forces.

Policy is an important variable which impacts spatial agglomeration in the new economic geography. But when it comes to studies on Chinese urban system, an important policy variable which affects regional economic development often be overlooked, which is market segmentation. Studies have suggested that among Chinese provinces there is serious market segmentation (Young, 2000; Ponect, 2005). This division is likely to add the actual distance between cities in different provinces, and limit the inter-city agglomeration effects, thus, lead to distortions in resource allocation. This article will examine the effects of China's inter-province market segmentation on spatial agglomeration, and compare the agglomeration effects between capitals and regional central cities, thus, explore the effects of market segmentation and "border effect" on Chinese urban economic growth.

In addition, we will compare the effects of the geographic factors with other traditional factors, such as investment, labor, FDI, government expenditure in short- and long-term, respectively. Thus, we might find long-term economic growth factors and explore a sustainable developing way for urban economy.

Section II of this paper will introduce the research method and data used in this paper. Section III presents the the empirical results. Section IV would try to expand the primary model to find long-term economic growth factors. And the last section offers conclusions of this paper.

II、Method and Data

Although we use Chinese city-level panel data, we focus on the effects of inter-city spatial agglomeration in long-term. So we use the cross-section OLS regression as our basic method, which is based on the economic growth model of Barro (2000). The model specification is as follows:

$$Dgdp_{it} = f(\ln gdp_{i0}, \operatorname{int} e_{i0}, lab_{i0}, edu_{i0}, gov_{i0}, fdi_{i0}; con_{i0}; geo_{i0} ...)$$

In this paper, we used Chinese city-level panel data (1990-2006) based on *Chinese cities Statistical Yearbook*, including 286 cities from 30 provinces of mainland China.

The dependent variable $Dgdp_{it}$ is the the annual growth rate of real per capita GDP deflated by provincial urban CPIs, respectively, for the city i year t. The theoretical assumptions of the new economic geography emphasize the agglomeration effect of industrial and service, so we removed the first industrial output out of the GDP indicators and the agricultural population out of the population indicators. For details on data sources and data construction, see Appendix (To be filled).

In the right of equation, following the traditional economic growth literatures (Barro, 2000), we add the initial level of per capita GDP $\ln gdp_{i0}$ to observe whether Chinese economy conditional converges at city level; we control the ratios of investment to GDP ($\text{int}\, e_{i0}$), of employee population to total population (lab_{i0}), and of teachers to students (edu_{i0}) to observe the effects of investment, labor and education. And the government expenditure proportion and foreign direct investment proportion of GDP, are also usually controlled by economic growth literatures, which are gov_{i0} and fdi_{i0} in this paper.

con_{i0} represents some other control variables related to Chinese urban economic growth, including: the ratio of the non-agricultural population to the total population (*urb*) accounting for the level of urbanization; the population density (*density*) and its square (*den_2*) accounting for internal population agglomeration in urban. In order to alleviate the endogeneity bias of this model, we use the initial situation of all explanatory variables in 1990, so that the estimated results would represent the long-term impact of the explanatory variables above on urban economic growth.

Based on this long-term economic growth model, we add the geographical variables of our concern, including: 1) the shorter straight-line distance to Shanghai and Hong Kong *disport*, which are two major ports of China, its square *disport_2* and cubic *disport_3*, which in order to observe the impact of distance to major port on urban economic growth; 2) the shortest straight-line distance to the regional central cities *distbig*, its square *distbig_2* and cubic *distbig_3*, which in order to observe the impact of distance to the regional central city on urban economic growth; 3) the GDP level of the nearest regional central city in the initial year *gdpofbig0*; 4) dummy *samepro*, represents whether the city is in the same province with the the nearest regional central city; 5) dummy *seaport* and *riverport*, to show whether a city has a seaport or river port; 6) following the studies on Chinese economic growth, we also put the capital- or municipality- dummy (*capital*), as well as central-(*mid*) and western- (*west*) dummy. Statistical distribution of distance variables is in Table 1.

In particular, we use straight-line distance instead of road or railway distance as our measure of distance, because it's not only available, but also exogenous, which avoids some potential estimated bias brought by the endogeneity of traffic distance.

III、Results

Estimated results of the model are in Table II. In addition to the traditional economic growth factors, we add the geographical variables we are concerned in the equation (1), including the first item of the distance to the central city and the major port, both of which are insignificant. It may be because, as Fujita et al. (1996, 1999a, 1999b), that there is a "∽"shaped relationship between the distances to the central city or major port and economic activities. So we add the square and cube of distances to the equation (2).

Equation (2) shows that distance to major ports and its square and cube are all significant, while neither of the distance to central cities or its square or cube is significant. This is most likely due to the effects of three items need a broader scope, but the reality of distance to regional central city is not large enough. So we removed the cube of the distance to central city from the equation (3). Obviously, all distance variables are significant: the distance to central cities is negative, its second item is positive; the distance to major ports is negative, while the second item is positive and the third item negative. Based on estimated results, we draw the relationships between distance to the major port or central city and urban economic growth rate, respectively, in Figure I and II in appendix, of which the horizontal axis means the distance, and the longitudinal axis means the impact on economic growth.

Figure I suggests that the impact of the distance to the major port on urban economic growth has basically the same shape with the market potential curve in new economic geography (Fujita et al., 1996, 1999b). While a city located closer to ports, it's closer to foreign markets, thus has a larger market potential and a higher economic growth rate. While the distance is longer than a certain extent, foreign markets are no longer that important. Therefore, a location far away from ports might promote the accumulation of regional and domestic market potentials, as well as the the development of local economy. While the distance is long enough, the city far way from both domestic and foreign markets would suffer from both low market potential and economic growth rate.

In Figure 1, we marked major cities in China in accordance with the distance to the major port as followed. We can see that it's Chongqing, Chengdu, Xi'an that locate at the distance from 1200 to 1600 km – which is the protruding part of the "∽" shaped curve. And the above three cities are nearly most developed in the western and central China. At the same time, the absolute value of the slope of decreasing-parts in this curve is much larger than that of the increasing-part, which means if the spatial distance can be shortened, it would improve the growth of the whole economy. Of course, physically, the distance can't be shortened, but the transport costs represented by distance could be reduced by improving transport conditions, loosening restrictions on interregional migration and reducing the provincial market segmentation in China.

As shown in figure II, when it's close to the regional central cities, scale effect and other external economies brought by spatial agglomeration promote the central city to absorb economic resources from surroundings, which is the significant centripetal force. So the closer to the central cities, the faster it grows. But when it's far away from the regional central city, instead of the centripetal force, the centrifugal force plays a major role. So the farther the distance, the faster it grows. Our estimated result shows the turning point is about 300 kilometers, which means in less than 300 kilometers, inter-city spatial agglomeration shows a strong role of the centripetal force, which is similar with Hanson (2005). The difference is that we also find that when the distance is greater than 300 kilometers around, because of transportation cost and other other external diseconomies, the inter-city spatial agglomeration performs as the centrifugal force.

What needs to be emphasized is that, in Figure 2, the curve is U-shaped rather than "∽"-shaped, which is not surprising. By comparing Figure I and II, we might find that to see the complete "∽"-shaped curve, it required at least 1,400-km distance, while the real distance to the regional central city is not long enough. Therefore, it's definitely possible that Figure 2 shows the left part of the whole "∽"-shaped curve.

We also notice that in the equation (1) - (3), the central-western dummy is almost always no significant, which is because the spatial distance variables have captured the weakness of the central and western area in geographical location. The same-province dummy is always significantly negative, which seems the spatial agglomeration of the regional central cities differs whether or not small cities are in the same province with the central cites. If a city is in the same province with the nearest regional central city, the absorption effect from the central cities will be larger, therefore, the city will grow slower. On the contrary, this means that the "border effect" similar to Parsley and Wei (2001) exists in Chinese provincial borders, which increases the actual distances between cities in different provinces. Preliminary estimating, China's inter-province "border effect" is equivalent to adding as much as 260 km[1].

The "border effect" in this paper presents as the distortion of the spatial concentration. We think it's relevant with Chinese province-level market segmentation. Young (2000), Ponect (2005) prove that China has serious province-level market segmentation. This inter-province market segmentation may be not conducive to agglomeration effects of the regional central cities, but to economic growth of small and medium cities in the different province.

To observe the relationship between the inter-province market segmentation and the spatial agglomeration more clearly, we add in the equation (4) the interaction of

[1] We estimate the average "border effect" by dividing the coefficient of the same-province dummy by that of the distance to the nearest regional central city in the equation (3).

the same-province dummy with the distance to the central cities, and in the equation (5) the interactions of the same-province dummy with both the distance to the central city and its square item. Results are in table III.

In the equation (4), both the distance to central city and the same-province dummy are not significant, but the interaction is significantly negative. This means at the same distance, the absorption effects are stronger to the small cities within the same province. In the equation (5), neither of the distance, the same-province dummy nor the interaction is significant, perhaps because the distance to the regional central city and the same-province dummy have a strong colinearity while there's not enough samples.

Chen et al. (2007) believe that government intervention has a strong role in promoting market segmentation in the Chinese province level. Obviously, the provincial governments segregate the market to restrict the agglomeration effects from big cities in other provinces, so as to protect their own economic development. Although for the cities of the province, such market segmentation can prevent them from the absorption effect of other provinces large cities, but for the regional economy or even the national economy, it brings a loss of resource allocation efficiency, thus a lower growth rate of the whole economy, resulting in smaller Chinese cities (Au and Henderson, 2006), and smeller variance among Chinese cities (Fujita et al., 2004).

When the inter-province market segmentation exists, the provincial governments have incentives to limit the agglomeration effects of the regional central cities in other provinces, strengthen the economic concentration of the province capital by administrative orders, in order to promote the province economic development. To understand this effect better, we replace "the distance to the nearest regional central city"(*distbig*) in the original model with " the distance to the provincial capital" (*distcap*) to compare the agglomeration effects between regional central cities and provincial capitals, and observe the restriction of inter-province market segmentation to the agglomeration effects of regional central cities, as well as the resultant distortion of resources. See Table IV.

As can be seen from Table IV, in Equation (6) we only add the distance to the provincial capital, which is significantly negative, showing the provincial capitals have strong absorption effects on the the surrounding cities. In the equation (7), we add both the distance to the provincial capital and its square, both of which are not significant. So provincial capitals have only significant centripetal forces, which is not conducive to the economic growth of the remote cities. Considering that the distance to the capital and the capital dummy may have a strong correlation, we remove the capital dummy in the equation (8). The results have no significant changes.

We draw Figure III simulating the relationship between urban economic growth and the distance to the central city or the provincial capital. As can be seen from Figure III, at distance less than 90 kilometers, the concentrated effects of regional central cities are stronger than those of the provincial capitals; while at distances more than 90 kilometers or so, provincial capitals have stronger centripetal forces. So even in the presence of the inter-province market segmentation, the agglomeration effects of the regional central cities in other provinces still have important impacts on the provincial small cities. Market segmentation, not only in theory is not conducive to the promotion of inter-regional division, but also difficult to truly reverse the inter-regional agglomeration.

IV、Model Development: Do geographical factors affect urban economic growth in long or short term?

As asserted by Forbes (2000), the relationship between economic growth and growth factors maybe change by the difference in the time horizon considered, which has been proved by Wan et al.(2006) with Chinese data. We have confirmed the impact of geography on urban economic growth with the time horizon of sixteen years, but we do not know whether this effect also exists in a shorter term. To this end, we use panel data to estimate the equation (9), (10), and compare with the equation (3). The explanatory variables of the equation (9), (10) are the same with the equation (3). Because the geographical variables do not changed across time, we use the Generalized Least Squares (GLS) to estimate the random effects model instead of the fixed effects model. The results are in Table 5.

Forbes (2000) uses data averaged over a 5-year interval in a growth regression and claims that this is a medium- or short-run relationship. Meanwhile, Barro (2000) relies on averages over a 10-year interval to estimate long-run relationships. Though no consensus exists regarding what time horizon constitutes or defines the short-, medium-, or long-run concepts (Wan et al., 2006), we may use the same regression model with different time horizons to compare the coefficients of the explanatory variables in short-, medium-, or long-run in one model.

In equation (9), we lag the explanatory variables by 1 year using the Chinese city 1990-2006 annual panel data, in fact, to find the short-term urban economic growth factors. Regression results show that the distance to the central cities and to the major ports and their respective square or three items are significant. In the equation (10), we use the Chinese city 1990,1995,2000,2005 panel data, with the five-year average per capita real GDP growth rate as the dependent variable, the initial situation of all explanatory variables in each five-year period as their values. Regression results also show a significant relationship between geographical distance and economic growth. Compare equation (9), (10) with (3), the geographical distance variables and the seaport dummy are almost all more significant with bigger absolute values of coefficients in the long-term. Thus, the impact of geographical factor on economic growth is more significant in a longer term.

We also compared the impact of other factors influencing urban economic growth in different time horizons. Regression results imply that, the impact of investment on economic growth is significant positive in short term while not so significant negative in long term This may be due to the level of investment is a short-term factors of economic growth, which means, regions with a high investment level maybe have no obvious economic advantages, on the contrary, may suffer from low efficiency spawned by over-investment.(Zhang, 2003). Labor force has a negative impact on economic growth, which may be related to China's overall labor surplus (Wan et al., 2006). However, the impact of labor force isn’t significant in long term. Education is a positive factor of economic growth and even more significant in long term. On one hand, this can be explained by long-term economic growth factor, on the other hand, it can be related with the measurement of education variable. Considering the availability of data, this paper chose the ratio of teachers and students in primary and junior schools as a city-level education measure, which is actually a proxy variable of educational resources. Human capital, as well as economic growth lags behind education resource investment, which can partly explain why education is so significant in long term. Government expenditure impacts on economic growth positively in short term whereas not significant in long term, which may be because the current governmental expenditure would instantly improve local investment and consume in short term, however, in the long term, high government expenditure will distort the resource collocation of market with the low efficiency of its own.（Barro，2000; Clarke, 1995; Partridge, 1997). FDI has no significant relationship with urban economic growth in either short-or long- term which explained by Luo (2006) is that FDI as a kind of investment does not have significant impact on economic growth directly, but it can play a positive role in economic growth indirectly by productivity improvement and squeezing into domestic investment.

As to the structural variables related with Chinese economic characteristics, the relationship between population density and economic growth implies U-shaped in short term, which is opposite to Au and Henderson (2006). Meanwhile, in long term, this relationship seems to have an inconspicuous coherency with inversed-U Shaped of Au and Henderson. It can be explained by that population density is an endogenetic variable of geographic location and some other urban characteristics which, if be controlled by the model, the impact of population density on economic growth is not conspicuous. The positive impact of urbanization only happens in short term. The capital dummy and the west-central dummy are not positively, which obviously differ with former researches, such as Bao et al. (2002), Chen et al.（2008）, Ho and Li（2008), which is because with the inter-city distances controlled in the paper no obvious growth disadvantages exist in western or central regions ,and no advantages in provincial capitals. In other words, spatial agglomeration factors contribute most in the interregional economic disparities in China. Finally, the initial level of per capita

GDP has a significant negative impact on Chinese urban economic growth, which performs as the China economy conditional converges at the city level, but this kind of "convergence" is not significant in long term.

We simplify the model further by making the independent variables only include exogenous geographical distances and initial economic level while the dependent variables remain the lagged one-year GDP per capita growth rate, the average GDP per capita growth rate of five years and the sixteen years. Regression results are in Table VI, which suggest all geographical distances are significant, and with time passing by, almost all coefficients and significances of the geographic factors increase as well as the R-square of the regression models, indicating that the impact of geographical factors on the urban economic growth are more significant in long term.

Regression results also suggest that conditional convergence exists at the city-level of Chinese economy when only geographical distances controlled, and the speed of which increases in longer term.

V. Conclusions

The most important finding of this paper is to verify the “∽”-shaped non-linear relationship between the geographical distance and urban economic growth, based on the spatial agglomeration effects and the Core-Periphery model in the new economic geography theory. We find that the Core-Periphery model is well proved in the Chinese urban economic growth model: 1) There is a significant “∽”-shaped relationship between the distance to major port and Chinese urban economic growth, which is negative first, then positive, negative at last. 2) There is a significant U-shaped relationship between the distance to regional central city and Chinese urban economic growth, based on which the inter-city spatial agglomeration effects present the trend of centripetal forces within the distance of 300 kilometers, while the trend of centrifugal forces out of the distance of 300 kilometers. 3) The "border effect" caused by Chinese inter-province market segmentation is equivalent to an increase of about 260 kilometers of the actual distance. While this market segmentation limits the spatial agglomeration of the regional central cities in other provinces, it protects the economic growth of small cities in the province. Nevertheless, this protection for small cities in the province suggests the efficiency losses of the interregional resource allocation.

This article also studies other urban economic growth factors. Our main findings include the following: (1) Education promotes long-term urban economic growth. (2) Investment, government spending, FDI though may promote economic growth in short term, but there's no significant impact in long term. (3) There is "conditional convergence" in Chinese urban economic growth.

Our research suggests that the inter-city agglomeration effect must be made full use of to achieve the goal of sustainable growth of urban economy, which is also the primary impetus behind Chinese sustainable economic growth. However, the inter-province market segmentation limit the agglomeration effects, thus is not conducive to interregional allocation of resources. Therefore, we should reduce the restrictions on the inter-province transportation of production factors (especially labor) and goods, promote market integration and rational distribution of resources.

As to economic policy-making, the urban economic long-term sustainable growth depends on making full use of the spatial agglomeration effects and the improvement of education. In contrast, investment, government expenditure, FDI may contribute to short-term growth of the local economy, but it will not promote the economic growth in long term. As to western and central areas in China, the key to urban and regional economic growth is the improvement of transportation and the development of the domestic market. To improve the transportation, it will shorten the transport distance and cost among central, western and coastal areas, as well as the small cities and regional central cities, which is conducive to the effects of spatial agglomeration and regional economic development. The development of the domestic market suggests that compared with the eastern coast facing a broader international market, the western areas should make full use of regional and domestic markets with the effects of regional agglomeration, and promote regional economic growth with the development of regional central cities.

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Figure I: Distance to the major ports and urban economic growth

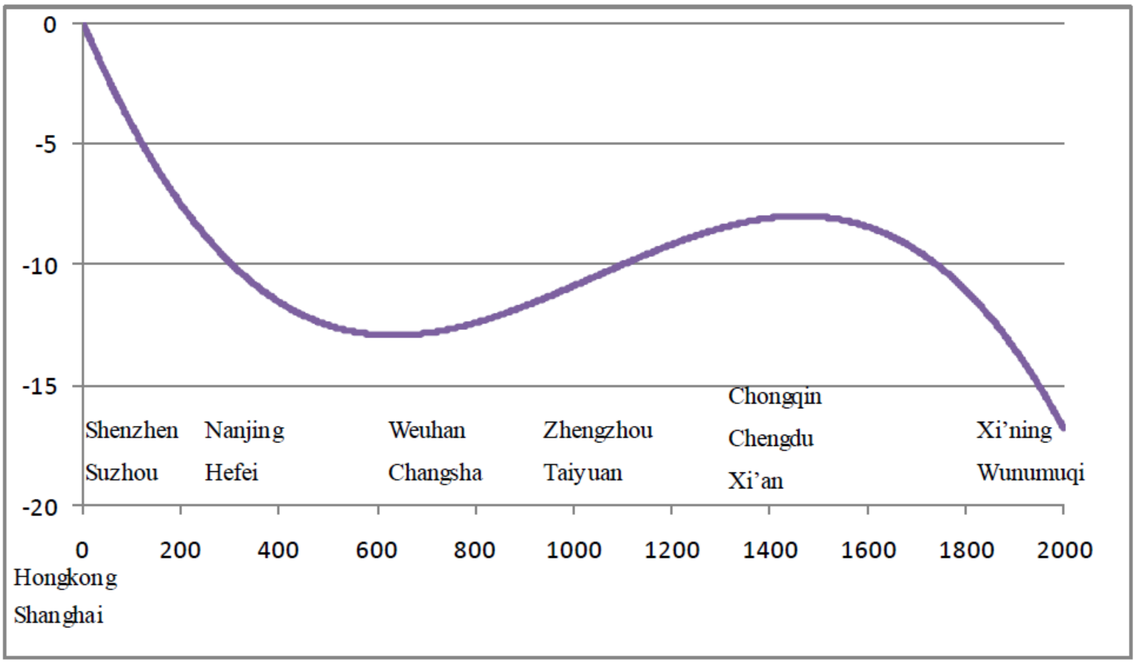

Figure II: Distance to the regional central cities and urban economic growth

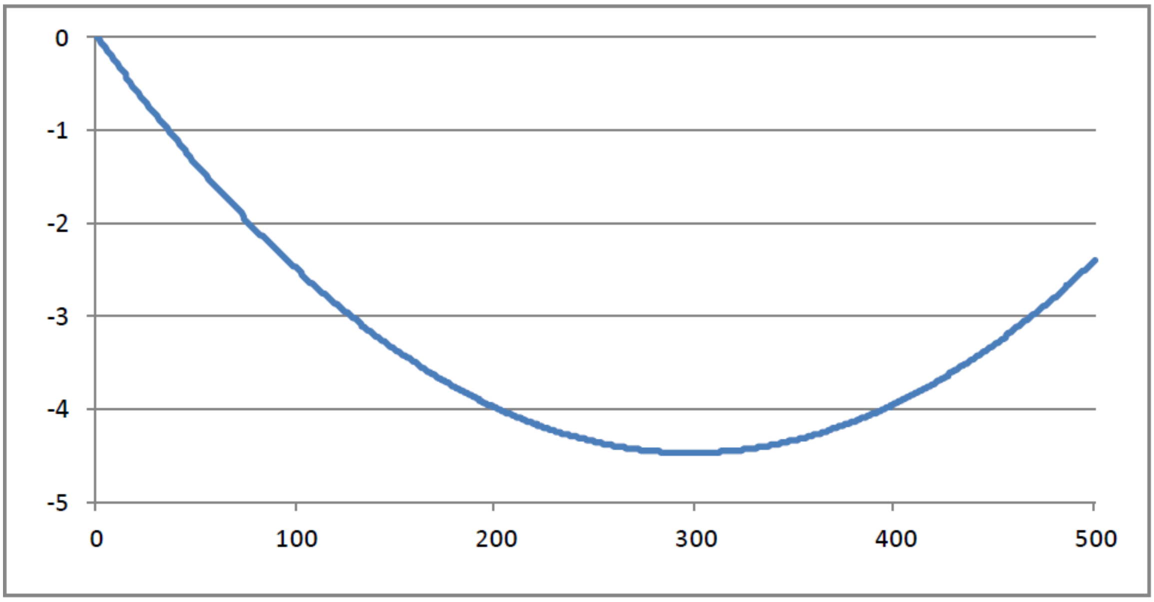

Figure III: Distance to the regional central cities or provincial capitals and urban economic growth

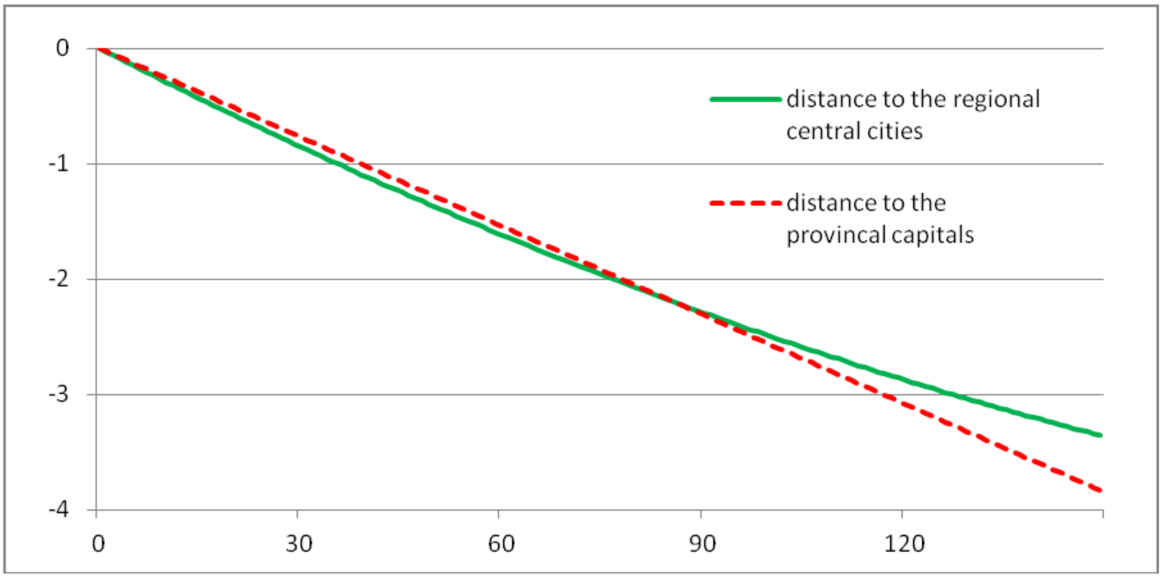

Table I：

	distbig	disport	distcap
min	0.00	0.00	0.00
mean	260.70	830.70	162.20
max	2351.80	3526.40	1121.20
average	291.33	896.75	180.03

Table II：

	(1) dgdp16	(2) dgdp16	(3) dgdp16
lngdp	-2.047	-4.143	-3.902
	(2.762)	(2.838)	(2.809)
inve	-0.158**	-0.138*	-0.135*
	(0.0758)	(0.0755)	(0.0752)
labor	0.116	0.105	0.109
	(0.0938)	(0.0946)	(0.0942)
edu	3.169***	3.352***	3.308***
	(0.680)	(0.674)	(0.670)
fdi	0.0746	0.0190	0.0130
	(0.0947)	(0.0958)	(0.0951)
gov	0.202	0.102	0.119
	(0.291)	(0.295)	(0.293)
density	0.00108	0.00142*	0.00145*
	(0.000802)	(0.000813)	(0.000809)
den_2	-2.39e-08	-3.75e-08	-3.82e-08
	(2.34e-08)	(2.37e-08)	(2.36e-08)
urb	0.0274	0.0114	0.0154
	(0.0518)	(0.0515)	(0.0510)
capital	3.876	2.944	2.307
	(2.448)	(2.690)	(2.516)
mid	-5.515*	-3.856	-4.101
	(3.169)	(3.234)	(3.206)
west	-5.023	-6.498*	-6.276*
	(3.341)	(3.333)	(3.309)
distbig	-0.00851	-0.0145	-0.0300**
	(0.00539)	(0.0265)	(0.0134)
distbig_2		0.0000156	0.0000504**
		(0.0000554)	(0.0000215)
distbig_3		1.97e-08	
		(2.89e-08)	
disport	-0.0000480	-0.0565***	-0.0478***

	(0.00274)	(0.0213)	(0.0170)
disport_2		0.0000664**	0.0000541***
		(0.0000263)	(0.0000191)
disport _3		-2.17e-08**	-1.72e-08***
		(9.18e-09)	(6.32e-09)
gdpofbig0	-1.823	-2.429	-2.654
	(2.463)	(2.513)	(2.485)
samepro	-6.865***	-7.530***	-7.809***
	(2.598)	(2.765)	(2.728)
seaport	5.046**	5.734**	5.374**
	(2.488)	(2.508)	(2.446)
riverport	3.136	3.359	2.680
	(2.598)	(2.774)	(2.583)
Constant	19.28	49.69	48.61
	(28.15)	(30.96)	(30.85)
Observations	133	133	133
R^2	0.367	0.414	0.412

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

附表三：

	(3) dgdp16	(4) dgdp16	(5) dgdp16
distbig	-0.0300**	0.0112	-0.00794
	(0.0134)	(0.0105)	(0.0207)
distbig_2	0.0000504**		0.0000240
	(0.0000215)		(0.0000271)
distbig *samepro		-0.0433***	0.0166
		(0.0160)	(0.0471)
distbig *samepro			-0.000128
			(0.000124)
samepro	-7.809***	1.534	-4.097
	(2.728)	(4.303)	(5.388)
disport	-0.0478***	-0.0320**	-0.0359**
	(0.0170)	(0.0126)	(0.0170)
disport_2	0.0000541***	0.0000291**	0.0000382*
	(0.0000191)	(0.0000112)	(0.0000199)
disport_3	-1.72e-08***	-7.08e-09**	-1.13e-08
	(6.32e-09)	(2.78e-09)	(6.90e-09)
Constant	48.61	37.73	59.12**
	(30.85)	(29.91)	(29.65)

Observations	133	133	133
R^2	0.412	0.421	0.413

Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

附表四：

	(3) dgdp16	(6) dgdp16	(7) dgdp16	(8) dgdp16
distbig	-0.0300**			
	(0.0134)			
distbig_2	0.0000504**			
	(0.0000215)			
distcap		-0.0257**	-0.0402	-0.0277***
		(0.0104)	(0.0362)	(0.00817)
distcap_2			0.0000350	
			(0.0000841)	
samepro	-7.809***			
	(2.728)			
capital	2.307	0.877	-0.180	
	(2.516)	(2.930)	(3.887)	
disport	-0.0478***	-0.0192*	-0.0197*	-0.0189*
	(0.0170)	(0.0106)	(0.0107)	(0.0105)
disport_2	0.0000541***	0.0000163*	0.0000168*	0.0000162*
	(0.0000191)	(0.00000877)	(0.00000887)	(0.00000872)
disport_3	-1.72e-08***	-3.78e-09*	-3.87e-09**	-3.75e-09*
	(6.32e-09)	(1.92e-09)	(1.94e-09)	(1.91e-09)
Constant	48.61	11.91	14.09	11.60
	(30.85)	(26.00)	(26.62)	(25.88)
Observations	133	133	133	133
R^2	0.412	0.425	0.426	0.425

Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

附表五：

	(9) dgdp1	(10) dgdp5	(3) dgdp16
lngdp	-2.393***	-3.051***	-3.902
	(0.774)	(1.069)	(2.809)

inve	0.0874***	0.0522**	-0.135*
	(0.0197)	(0.0261)	(0.0752)
labor	-0.0911***	-0.120***	0.109
	(0.0172)	(0.0202)	(0.0942)
edu	0.284	1.862***	3.308***
	(0.374)	(0.398)	(0.670)
fdi	-0.0130	0.0197	0.0130
	(0.0181)	(0.0253)	(0.0951)
gov	0.283***	0.345***	0.119
	(0.0860)	(0.113)	(0.293)
density	-0.00175***	-0.000136	0.00145*
	(0.000149)	(0.000446)	(0.000809)
den_2	6.83e-08***	8.43e-09	-3.82e-08
	(2.26e-09)	(1.57e-08)	(2.36e-08)
urb	0.0651***	0.0100	0.0154
	(0.0187)	(0.0252)	(0.0510)
capital	0.711	0.335	2.307
	(1.231)	(1.513)	(2.516)
mid	-0.425	-1.572	-4.101
	(1.330)	(1.709)	(3.206)
west	-0.840	-0.801	-6.276*
	(1.475)	(1.918)	(3.309)
distbig	-0.0194***	-0.0146**	-0.0300**
	(0.00528)	(0.00687)	(0.0134)
distbig_2	0.0000232***	0.0000230**	0.0000504**
	(0.00000799)	(0.0000111)	(0.0000215)
disport	-0.0145**	-0.0243***	-0.0478***
	(0.00661)	(0.00898)	(0.0170)
disport_2	0.0000174**	0.0000263***	0.0000541***
	(0.00000726)	(0.0000101)	(0.0000191)
disport_3	-5.95e-09**	-8.18e-09**	-1.72e-08***
	(2.35e-09)	(3.30e-09)	(6.32e-09)
gdpofbig0	-1.466	-1.010	-2.654
	(1.073)	(1.395)	(2.485)
samepro	-5.527***	-5.621***	-7.809***
	(1.111)	(1.437)	(2.728)
seaport	1.992	2.650*	5.374**
	(1.213)	(1.501)	(2.446)
riverport	0.131	0.625	2.680
	(1.297)	(1.601)	(2.583)
Constant	47.56***	46.24***	48.61
	(10.77)	(14.40)	(30.85)
Observations	2817	569	133
R^2	0.341	0.187	0.412

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

附表六：

	(11) dgdp1	(12) dgdp5	(13) dgdp16
lngdp	-2.664***	-5.056***	-7.407***
	(0.755)	(0.875)	(-3.99)
distbig	-0.0106**	-0.0113**	-0.0254***
	(0.00494)	(0.00539)	(-2.88)
distbig_2	0.0000191***	0.0000271***	0.0000552***
	(0.00000737)	(0.00000839)	(3.90)
disport	-0.0168***	-0.0175***	-0.0398***
	(0.00590)	(0.00658)	(-3.62)
disport _2	0.0000175***	0.0000198***	0.0000429***
	(0.00000614)	(0.00000701)	(3.59)
disport _3	-5.51e-09***	-7.02e-09***	-1.46e-08***
	(1.99e-09)	(2.30e-09)	(-3.70)
Constant	38.09***	58.79***	90.47***
	(7.420)	(8.320)	(5.49)
Observations	3224	718	208
R^2	0.0054	0.0518	0.129

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01