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Economic Growth and Growth Linkages in China 1994 - 2003

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Abstract: This paper investigates to what extent income growth in the Chinese provinces is linked to growth and income levels in neighboring provinces. We find that the rate of income growth in a province is positively related to income and growth in neighboring provinces. However, we find no evidence of such positive interdependence between growth in rich coastal provinces and their immediate inland neighbors. This suggests that there has been little synchronization in economic growth rates between these regions, and/or that the immediate hinterland of the coastal growth centers might have been bypassed as China's manufacturing sector has migrated westward.

***JELCODE*:** F14; F15; O53
***Keywords*:** Domestic integration, economic growth, spatial interdependence, China's economy

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1. Introduction

The introduction of economic reforms in the late 1970s marked a new era in terms of China's openness to the global economy, with comprehensive policies to improve the country's global competitiveness and trade performance. Since then, the Chinese economy has grown steadily and structural changes have transformed the country from being basically an agricultural economy toward a manufacturing based economy. In tandem with economic reform, factors such as an abundant supply of low cost of labor, massive inflows of foreign direct investment, an export oriented policy environment, and technological progress have been instrumental in the transformation of the Chinese economy: these are all issues that have been discussed in detail in the literature on Chinese economic growth and development. Less understood, however, is to what extent economic reform has led to increased domestic integration and how economic growth is transmitted across geographical space. These are relevant questions given the current concern for the substantial income gap between the more developed coastal provinces and China's interior regions: the regionally unbalanced development strategy initiated in the early 1980s was based on the assumption that growth would rapidly be diffused westwards from the coastal provinces that were the first ones to take advantage of the new opportunities.

Two opposite views regarding the degree of Chinese market integration are provided by Naughton (1999) and Young (2002). The former argues that inter-provincial trade and especially intra-industry trade in manufactured products is large, and thus consistent with national economic integration. In contrast, the latter argues that after two decades of economic reform, China's internal market is still fragmented. Other studies focusing on regional income differences, e.g. Fujita and Hu (2001), suggest that the income differences between the coastal area and the interior are increasing, that there is a strong agglomeration of industrial production to the coastal area, and that a convergence trend can be detected among coastal provinces. They also conclude that biased regional policies have some positive effects but that their role is limited. Brun *et al.* (2002) claim that growth in China's coastal provinces does not have a uniform effect on the country, and that the effect on the central region is statistically significant and positive while the impact on the western region is not. Hence, Brun *et al.* (2002) suggest that economic growth may bypass some regions. Breslin (2000) argues that decentralization has strengthened provincial boundaries as determinants of economic activity in China, and that the country's transition from relative isolationism to relative openness has reduced the importance of external relationships in parts of the country. These results are partly supported by Xu (2002), who suggests that economic integration between provinces has progressed under reform, but that the process is by no means complete.

Adding a geographical dimension to the analysis, Ying (2002) applies spatial econometrics and finds that per capita income growth in Chinese provinces is spatially interdependent with growth in neighboring provinces and that this interdependence declines with the distance between them. In an attempt to distinguish the importance of local and regional factors for growth, Xu (2002) finds that local factors account for roughly 30 percent of regional per capita income and that local policy therefore plays an important role for local development. Poncet (2003) concludes that international opening has occurred in conjunction with internal market fragmentation. Madariaga and Poncet (2007) underline that over the 1990s, not only was China's domestic market fragmentation along provincial borders great, but it also became more severe, at least between 1992 and 1997. By combining Local Moran statistics and information on the flow of foreign direct investment (FDI), they also detect spatial clustering and spatial interdependence in both FDI flows and per capita income growth.

As pointed out by Xu (2002), local factors are crucial for any province's own development. However, local factors may be spatially correlated. For example, growth in two geographical units may co-vary because they draw on common sources. An example could be access to a common resource, like iron ore or oil. If two provinces are both able to draw on the same resource endowment, they may exhibit seemingly interdependent growth patterns even though no spillovers are present. Hence, logic suggests that analyses of spillovers and growth interdependence must also take into account industry structure and endowments.

There is no doubt that existing work in this field has improved our understanding about the nature of domestic integration and diffusion of economic growth in China. Yet, the geographical pattern of economic development is complex, and more detailed analyses are crucial for better understanding of the potential ramifications of economic reform and growth on regional development.

This paper contributes to the literature on growth and growth patterns in China by (i) analyzing inter-provincial growth interdependence using a framework that allows us to take into account local factors that are important for growth and (ii) by taking a closer look at the pattern of growth interdependence between the coastal provinces and their neighbors.

Our main conclusion from the first part of the analysis where all provinces are included suggests that provinces are clustered such that rich (poor) as well as rapidly (slowly) growing provinces are clustered close to each other to a greater extent than would be expected if the distribution had been random. In addition we find that provinces benefit from having both rich and rapidly growing neighbors. A noteworthy finding is that we see no signs of increasing growth interdependence during the period of study. Rather, the evidence point at decreasing growth interdependence across provinces

In the second part of the analysis, we follow Demurger *et al*. (2003) by grouping developed coastal and metropolitan provinces into a “growth pole” region, and categorize the poorer provinces directly adjacent to the growth pole as “hinterland” regions. Using these groups of provinces, we apply spatial econometrics tools to explicitly analyze the growth interdependence between the growth pole and the hinterland provinces.

Results indicate that although China as a whole exhibits a pattern of positive and mutual growth interdependence, there is no evidence for positive growth spillovers between provinces belonging to the growth pole and their immediate inland neighbors. Contrary to the overall pattern, members of the growth pole and the hinterland tend to be relatively independent from each other, or even to exhibit a negative relationship with respect to economic growth. A possible explanation for this puzzling finding could be that expansion in the growth pole may attract human capital and investments from the hinterland to the growth pole and that the subsequent westward expansion of production to some extent bypassed these relatively “depleted” provinces.

The paper is structured as follows: The next section presents a brief background to China’s reform ideology and some theoretical guidance for the analytical work at hand. The data and an exploratory spatial data analysis are presented in section 3. Results are presented in section 4 and section 5 concludes.

2. Background and theoretical guidance

China’s market-oriented reforms introduced in the late 1970s aimed at modernizing the economy and at catching up to the other Asian economies. This marked an essential departure from the political isolation and strategy of regional self-sufficiency that had been applied during the preceding decades. During this period, production decisions had completely neglected principles of comparative advantage, economies of scale, and specialization, with the result that inter-provincial trade was essentially a residual. A major element in the reform process was the gradual withdrawal of government from the allocation, distribution, and pricing of goods and services. Parallel to the diminishing role of planning, the Chinese economy was opened up for international trade and investment. These policies were motivated by the search for dynamic and static gains resulting from increased competition, specialization, and diffusion of new technology. A major element in this process was an uneven geographical prioritization. Some regions were allowed to become rich ahead of others, and development efforts aimed at the most promising regions were considered appropriate (Lin and Liu, 2002). The rationale for this unbalanced development strategy was to channel scarce investment resources into a few key sectors. However, there was a clear expectation that there should be strong connections to adjacent sectors and regions, which would enhance a process of economic development through supply and demand linkages. That is, there was a strong belief in the so called “trickle down” effect in which development in the costal take-off areas would spread outside the region. Hence, in addition to classical motivations for analyzing economic growth and spillovers, the Chinese policy priorities have provided further arguments for exploring these questions.

2.1 Theoretical guidance

As noted by Litwick and Qian (1998), the question of balanced versus unbalanced growth has been a long-standing item in the theoretical debate on development, and several mechanisms for economic spillovers between countries or regions have been discussed. The research in this area has evolved significantly since Hirschman (1958) first presented his core-periphery model, which stated that the concentration of manufacturing production to a rich (core) region would first generate polarization as the poorer (peripheral) region fell behind, and thus increase regional economic disparity, and then later, as economic growth proceeded in the core region, cause benefits to trickle down to the peripheral region. The logic behind an unbalanced development strategy that initially focused on developing the industry in a core region was the existence of various interactions between domestic industries (Kelegama and Foley, 1999). Porter’s (1990) theory of the competitive advantage of countries also suggested that there is a mutually beneficial and symbiotic relationship between firms making final outputs and firms supplying inputs for that output.

In an early contribution to the literature, Thoburn (1973) argued that for backward linkages to function properly and be profitable they must be of a certain minimum size, and because export growth is not constrained by the domestic market size, exports are more likely to provide this minimum demand. More recently, the analysis of industrial location and backward linkages has been challenged and further developed by authors such as Krugman (1991 a, b), Krugman (1993) Krugman and Venables (1996), and Venables (1996). Krugman (1993) and Venables (1996) argue that increasing returns, economies of scale, and imperfect competition are far more important than constant returns, perfect competition and comparative advantage as drivers of trade and specialization; and that the externalities (market, technological, etc.) underpinning these increasing returns are neither international nor national in scope, but arise through regional or local agglomeration. Hence, they assume that industrial location and agglomeration are partly random, so that the initial pattern may be a pure coincidence.

Thus, agglomeration forces are basically localization externalities, which tend to lead to local clustering of economic activity. Pecuniary externalities, on the other hand, are more important to large-scale core-periphery patters of economic development within nations, leading to greater divergence between rich and poorer regions. Fujita *et al*. (1999) also point to the importance of competition and argue that linkage theories only work when returns to production at the level of the individual firm are increasing: otherwise, the firm would not concentrate production to the largest market, but rather establish a separate facility to serve each market. Athukorala and Santosa (1997) point to the importance of backward linkages for export-led growth, since the greater the linkages between the export sector and the rest of the economy, the greater the benefits to the economy from export expansion.[1]

2.2 Spillover effects

The spillover effects from a growing sector in one location to other locations can be readily described in terms of demand and supply linkages (externalities). These linkages can appear in a number of forms. Demand linkages from a growing core may, for example, boost growth in the periphery if firms in the periphery can expand their output by selling goods and services to the growing core. Similarly, increasing economic activity in the core region may reduce transaction costs, leading to increased trade across the regional border and higher economic growth.

Supply linkages, which are probably the most common mechanisms for spillover effects in China, can be generated by the transfer of technology via foreign investment, imports, imitation of market institutions, the employment of new managerial skills, and so forth. Supply side linkages may also appear via the use of public capital goods provided by the core region. For example, rapidly increasing exports in the core region may trigger

[1] In his path-breaking work *Principles of Economics*, Marshall (1920) argued that the decision of where to locate economic activities is affected by three categories of technology spillovers: (i) knowledge spillovers that are "in the air", (ii) forward and backward linkages and, (iii) labor market pooling. The first two concepts implicitly comprise distance, whereas the size of cities is central to the latter. Reasons to believe that knowledge is locally bounded are conveyed as five 'stylized facts' by Dosi (1988), and are further developed by Feldman (1994), and Baptista and Swann (1998).

construction of new ports, airports, railways, and roads, which facilitate the growth of both domestic and international trade from the peripheral region.

3. Data and exploratory spatial data analysis

The data used in this paper cover the variables traditionally used to analyze the determinants of economic growth and spatial interdependence. The sample consists of 29 provinces in mainland China for the period 1994 to 2003[2]. The data are compiled from various issues of the *China Statistical Yearbook*, and the *Comprehensive Statistical Data and Materials on 50 Years of New China*. All monetary variables are converted to 1990 constant prices.

3.1 The evolution of spatial similarity over space and time

We start with an exploratory analysis in which we investigate whether China's provinces are linked together such that neighboring provinces have similar growth and income levels. Given that economic units are interdependent it is reasonable to expect a certain clustering of hi-hi (low-low) values. We explore this issue by means of Morans' I. When analyzing spatial clustering the spatial weight matrix **W** plays a central role, as it defines how close geographical units are to each other. The elements of the weight matrix are assumed *a priori* and tested using statistical methods. Closeness is typically defined either in terms of the geographical distance between two units, or by defining units that share borders as being neighbors (first order contiguity). In the exploratory data analysis we apply a first order contiguity matrix **W** such that $w_{ij} = 1$ if unit i and j share borders and zero otherwise[3]. Using the first order contiguity matrix allows us to extend the analysis by looking at higher order neighboring matrices located two or more provinces away.

As a point of departure, Figure 1 and Figure 2 depict Moran's I for per capita income and per capita income growth, pooled over the full sample period. A positive value of Morans' I indicates that high (low) values are close to other high (low) values to a greater extent than what would be expected from a random distribution, whereas a negative value indicates a chess-board type of pattern.

[Figure 1 and 2 about here]

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2 China is administratively decomposed into 31 provincial units which fall into three categories: provinces (a total of 22), autonomous regions (a total of 5), and municipal cities (a total of 4). Tibet is excluded from our sample due to data constraints and the province of Chongqing is kept within Sichuzan.

3 For a detailed description on methodology, see Anselin (1988) , Anselin and Florax (1995) and Anselin (1995).

Figure 1 and Figure 2 show how the degree of similarity between provinces' income levels and growth evolve as the distance between them increases (with distance measured as the number of provincial borders one has to cross to reach from one province to the other). To be precise, the first order neighbor is the one with which you share a common border, while you have to pass through one (two) provinces to reach the second (third) order neighbor. In Figure 1, where we analyze the similarity in income levels, the Morans' I records a value of 0.57 for the first order contiguity, a value that decreases to 0.22 when we reach the second order neighbor and is insignificant and close to zero (0.02) for the third order contiguity. Hence, per capita income in a province is related to per capita incomes in nearby provinces, but this relationship diminishes with distance. It is noteworthy that the value of Morans' I is negative for the fourth order contiguity, indicating a negative relation between the levels of per capita income at this stage. We interpret the spatial autocorrelations as follows: When we move across space, starting from a relatively rich province, we move into provinces with gradually lower and lower per capita income. Entering the fourth province we are expected to land in a belt of relatively poor provinces. Hence, results suggest an (on average) relatively smooth diffusion process, where the spillovers related to per capita income levels do not exhibit any clear spatial disruption.

Interestingly, the spatial autocorrelations for per capita income growth, illustrated in Figure 2, are somewhat different from the results for per capita income levels, as growth rates are positively and significantly related between provinces regardless of the order of contiguity (although the point estimates generally have lower values). As expected, the closest co-variation is with the first order neighbors[4].

Economic reform brought significant changes to the economic landscape inherited from the central planning era. The gradual abolishment of central planning and the parallel introduction of markets have allowed provinces and regions to make better use of their comparative advantages and to increase both domestic and international trade. Significant investments in energy and transportation were done parallel to this development. While most authors agree on the positive impacts of reform, it is debated whether or not it has led to greater domestic integration.

If economic integration makes provinces near each other more similar over time, or if integration makes the linkages between provinces stronger, we would expect an upward trend in Morans' I over time. Figure 3 displays Morans' I for both the level of per capita

[4] Estimates are performed in *SpaceStat* based on non-parametric estimation using 10 000 permutations.

income and its growth rates year-by-year for the period 1994-2003. The estimates for per capita income levels show a slight increase in income similarity among provinces and are consistent with the interpretation that income levels have converged over time[5]. Surprisingly, we observe that income growth has tended to become less correlated with that in the neighboring provinces over time. We will discuss some possible reasons for this puzzling finding in section 4.

[Figure 3 about here]

4. Empirical determinants of economic growth

4.1 Method and local drivers of growth

This section reports results from growth regressions. The initial estimations are based on the neo-classical framework, and control for both physical capital and human capital accumulation. However, contrary to traditional growth models we leave the initial per capita income variable out of the model.

Our reasons for estimating spatial growth regression without convergence are the following. First, for consistency, the inclusion of lagged dependent variables require us to estimate dynamic panel data models using estimators such as GMM or sys-GMM that extract time series variation only. These estimators require relatively large samples for efficiency.[6] If the data exhibit relatively low time series variation and if variables change over time, but only slowly, then it is unlikely that using only the time series variation in the data will generate statistically significant variable estimates – results are also likely to be fragile. This problem is concisely described by Beck (2001).

Secondly, as discussed by Magrini (2004), analysis of differenced data means giving up any attempt to uncover what happens to the cross-sectional distribution, including explanations of who is rich and who is poor: instead, the analysis will be focused on convergence to each unit's own steady state income level, which is a less clear concept.

Third, we are focusing on the spatial pattern of growth in which spatial dynamic GMM models sometimes are seen as a solution. However, as pointed out by Kukenova and Monteiro (2008), the distribution of spatial GMM models is yet unknown and there is so far no

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[5] Since we In Table 3 not are analyzing higher order contiguity we here and in subsequent analysis apply the inverse distance as preferred distance measure.

[6] See e.g. Hsaoi (2003) and Baltagi (2008).

estimator that allows estimation of dynamic panel models that include a spatial lag as well as other potentially endogenous variables. One should therefore be careful when estimating such models, in particular when the sample size not is large. Given that we are looking at data for Chinese provinces, where N is 29, it seems clear that this route is less attractive.

Fourth, there is a large set of spatial growth regression models at hand that has been used in the analysis of growth and spatial interdependence. This body of work suggests taking a route with well defined models with known properties. For a discussion of models and a survey see e.g. Anselin and Florax. (2005) and LeSage and Fisher (2008).[7]

Finally, the evidence on whether there is an ongoing convergence process in China is contradictory.[8] Taken together, the spatial growth model therefore appears to be methodically well defined and relevant both from an empirical as well as a policy making point of view, while the weak evidence for a convergence process suggests that this variable is of second order. We therefore estimate the following base case equation, to which we subsequently add additional variables, including spatial interdependence:

$$\hat{y}_{i,t} = \alpha + \beta_1(\hat{k}_{i,t}) + \beta_2(\hat{L}_{i,t}) + \beta_3(\hat{h}_{i,t}) + \varepsilon_{i,t} \qquad \text{(Eq. 1)}$$

where, $\hat{y}_{i,t}$ is growth in per capita income in province *i*, and time *t*. $\hat{k}_{i,t}$ is growth in fixed capital, $\hat{L}_{i,t}$ is population growth, $\hat{h}_{i,t}$ is growth in graduates (institutions of higher education) as share of population, $\varepsilon_{i,t}$ is the error term, α is the intercept, the β_i 's are the coefficients to be estimated, and time (t) runs from 1994 through 2003

The population growth rate variable is the gross population growth rate including net migration flows. The neo-classical model (see e.g. Mankiw, Romer, and Weil, 1992) predicts a negative effect from population growth on per capita income growth. In other words, growing populations *ceteris paribus* leave less capital per worker and reduce labor productivity and per capita GDP[9]. In the neo-classical growth model, accumulation of capital

[7] Examples of empirical spatial growth studies include Basile (2008), Garret *et al.*, (2007) and Moreno and Trehan (1997), where the latter include spatial growth regressions with and without initial income on the right hand side.

[8] For example, Weeks and Yao (2002) apply a system GMM estimator and find evidence of a nation-wide divergence process in China. Similarly, Pedroni and Yao (2006) find evidence of divergence on both a national basis as well as in various regional and political subgroups. Lei and Yao (2008) take a long time perspective and find no convergence in the pre-reform period, but a slow (1-2 percent per year) convergence in the post-reform period. Having a regional perspective on China, Maasoumi and Wang (2007), Anderson and Ge (2009), and Takashi and Ryoichi (2007) find convergence in some regions of China, but no convergence or even divergence in other areas. Finally, Zhang et al. (2001) find evidence for provincial convergence toward their own steady state, as well as evidence of big shocks affecting the regional income distribution.

[9] Notably, some studies such as Fagerberg (1994) and Durlauf and Quah (1999) report inconclusive country

raises labor productivity, wages, and GDP per capita. Hence, the expected value of the growth rate of fixed capital is positive[10]. Another important issue is that labor is not homogenous. Instead, workers have different skills, education, and experience, all of which have an impact on productivity. For any given supply of labor, the average productivity of workers is expected to increase with educational attainment. To account for differences in skills, we use the ratio of the provincial flow of graduates (institution of higher education) to total population[11].

[Table 1 about here]

As noted in estimation 1 in Table 1, both physical capital and human capital accumulation have a positive effect on per capita income growth, while increasing population (as expected) reduces economic growth in per capita terms. Hence, these results support the predictions of the neo-classical model. In the second estimation, as suggested by Barro and Sala-i-Martin (1995), we add a number of variables conducive to growth. Notably, the results suggest a positive and significant impact of FDI on economic growth, although the estimated coefficient is small. The result is not uncommon for the Chinese case (see e.g. Wen 2007 and references therein). There are several reasons why FDI is expected to have a positive effect on economic growth. Arguments include the observation that foreign owned multinational companies (MNCs) are more efficient than local firms, which has both a direct impact on output and growth as well as an indirect impact that operates via local industry. The entry of foreign MNCs has a positive impact on competition, and they bring in new technology and knowledge that may subsequently diffuse to local firms: both of these processes are likely to raise the efficiency of local firms.

Results in Table 1 also suggest a negative relationship between the dependence on state-owned enterprises (SOEs) and economic growth. This is also a common result for the Chinese case, although the issue of SOEs and their role in the economy is a complex one. Traditionally, China's economy has been heavily dependent on SOEs, and although the situation is changing rapidly, many of the remaining SOEs operate with soft budget constraints and objective functions given by the state. As a result, these firms may have a

evidence regarding the impact of population growth on per capita income. The possible endogeniety of population growth has been further discussed in Barro and Sala-i-Martin (1995). At present, however, there does not appear to be any consensus regarding the issue.

[10] An alternative measure of capital growth is defined as investments net of capital depreciation.

[11] As there are possible endogeniety problems as well as an obvious time lag between finishing education and making an impact on the labor market, we use one year lagged values.

negative effect on the allocation of resources in the economy. The estimation also controls for the urban-rural divide by adding the weight of manufacturing industry to regional GDP, with the results indicating that economic growth has been most rapid in the more industrialized provinces.

4.2 Introducing geography

In estimation 3 through 6 in Table 1 we introduce geography to the model and analyze how economic growth in a province is related to growth in surrounding provinces. The inter-provincial growth interdependence is taken into account by the estimation of spatial lag models (see e.g. Anselin 1988). The spatial lag is formulated as follows:

$$\hat{\boldsymbol{y}}_{i,t} = \boldsymbol{\alpha} + \boldsymbol{\rho} \boldsymbol{W} \hat{\boldsymbol{y}}_{i,t} + \boldsymbol{\beta}_1 (\hat{\boldsymbol{k}}_{i,t}) + \boldsymbol{\beta}_2 (\hat{\boldsymbol{L}}_{i,t}) + \boldsymbol{\beta}_3 (\hat{\boldsymbol{h}}_{i,t}) + \boldsymbol{\varepsilon}_{i,t} \qquad \text{(Eq. 2)}$$

where $\hat{y}_{i,t}$ is growth in per capita income in province *i'*, at time *t*. W^r is a block diagonal NT x NT row-standardized inverse distance matrix. Row standardizing means that each row sums to one and makes the spatial lag coefficient bounded from above to unity.[12] This standardization makes the estimated ρ equivalent to an elasticity measure. Introducing the spatial lag implies an endogeniety problem which can be handled using an IV approach[13]. The validity of the instruments is confirmed by the Sargan test-statistic.

As we can see from estimation 3, Table 1, the results give support to the hypothesis of interdependent growth rates. Using inverse distance weights, the estimated coefficient of the lagged spatial growth rate is roughly 0.75. That is, a one percentage point increase in the growth rate of per capita income in neighboring provinces raises the growth rate of per capita income by 0.75 percentage points. In estimation 4, the model is expanded by adding the degree of SOE and manufacturing dependence (to extract information about the industrial structure) and FDI and openness (to capture business climate and degree of connectivity). The inclusion of these variables lowers the coefficient of the spatial lag from 0.75 to 0.28. This suggest that in sparsely formulated regression models, the spatial lag (ρ) may pick up the lack of control of quantifiable growth linkages.[14]

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[12] In Instrumental Variable (IV)-models the coefficient on the spatial lag may exceed unity. For details, see e.g., Anselin (1988).

[13] Following Anselin (1988), we apply spatial lags of the exogenous variables as instruments.

[14] Substituting the inverse distance matrix for a row standardized first order contiguity matrix lowers the coefficient of the spatial lag, but does not upset the significance of the results, indicating that the findings are robust with respect to choice of distance weight procedures.

In estimations 5 and 6 we replace neighbors' income growth with the income level and investigate whether positive growth spillovers are induced by the neighbors' per capita income levels. The growth enhancing income effect is captured by the variable (W^r) *ln(y)* and the results suggest that a ten percent higher per capita income in neighboring provinces raises growth by 0.3 – 0.6 percentage points.[15] These results are in line with results reported for other countries by e.g. Barro and Sala-i-Martin (1995, Table 12.3), while Moreno and Trehan (1997, Table 6) report a statistically insignificant growth effect of GDP per worker in neighboring countries.

In Estimation 7 we make a first attempt to analyze whether the diffusion effects of neighbors' growth rates are evenly distributed across space. The costal provinces (including Beijing) are arguably the engine of China's industrial take-off, and we label these provinces "the growth pole". According to the trickle-down theory, growth in the growth pole is supposed to spread inland. We therefore identify the immediate inland neighbors to the growth pole, label these provinces "the hinterland", and analyze whether the growth interdependence for the "hinterland" deviates from the overall pattern. Results suggest that the interdependence for the hinterland provinces deviate negatively from the overall pattern. Since much of the Chinese growth is expected to stem from the growth pole, and subsequently move inland, we focus in the next section on growth interdependence between the growth pole and the hinterland provinces.

4.3 Linkages between rich provinces and poor neighbors

The above finding of interdependent growth rates across all provinces is consistent with the Chinese reform strategy that assumes that the country's economic development is driven by coastal provinces from where it gradually spreads inland.[16] However, a brief look at the map suggests that the geographic pattern of income and growth has not been evenly distributed. While the coastal provinces have the highest incomes, the provinces immediately to the west and northwest of the coast actually register lower incomes than provinces further inland. This is not fully consistent with a pattern of development where wealth trickles down in a step-wise fashion from the coast to the nearest inland provinces, and then further west.

There are several possible reasons why the diffusion of growth must not necessarily be continuous across space. The most obvious may be geography itself – topography, soil characteristics, climate, and patterns of rainfall are only a few examples of

[15] Note that the inclusion of the spatial variable makes the significance of FDI and openness disappear.
[16] See Ljungwall (2004) and references therein.

factors that determine how well a province or region is able to take advantage of growth spillovers. The fact that the provinces neighboring the coast are more mountainous than provinces further inland may therefore provide part of the explanation for the heterogeneous growth pattern. In addition, it is possible that effects akin to Christaller's c*entral place theory* or Von Thünen's localization patterns also influence the diffusion of economic growth (Christaller 1966; Von Thünen 1966). In essence, these theories say that when resources are concentrated to growth poles (or central places), they are largely drawn from the hinterland. That is, the growth relation between these regions may even be negative. The depletion of resources in the hinterland means that it is unlikely that a new growth pole can emerge in the immediate vicinity of an existing growth pole: it is instead likely to be located some distance away, where it can draw resources from its own hinterland.

Looking specifically at the coastal provinces and their immediate inland neighbors, it can be noted that the differences between the growth pole and the hinterland are significant. For instance, per capita income is 156 percent higher in the growth pole, while both FDI and capital intensity are more than 200 percent higher. That proximity to the coast is an important factor for foreign trade becomes clear when it is noted that the ratio of export plus imports to GDP is more than 800 percent higher in the growth pole (noting, however, that many firms in the neighboring provinces are indirectly involved in exports through their role as suppliers and subcontractors to coastal exporters).

Given this background, we continue by specifically examining the interdependence between the growth pole and their inland neighbors. As a first step, we modify the concept of neighbor. To be precise, provinces in the growth pole are treated as neighbors to the inland provinces (the hinterland) only and vice versa. That is, provinces in the growth pole are not considered as neighbors to each other, nor are provinces within the hinterland treated as neighbors to each other. As distance weights, we continue to apply the inverse distance.

Given the recorded income difference between the growth pole and the hinterland it might not come as a surprise that the Moran statistics indicate a negative and significant relation between these two regions.[17] However, Moran's I not only indicate a negative relation for income levels but also for growth rates, although the negative co-variation in growth rates turns out to be non-significant.[18]

In Figure 4-5, we continue to explore interdependence between the growth pole

[17] Morans' I is -0.39 and significant at the 1 percent level. Estimations based on a robust permutation approach using 10 000 bootstrap permutations.
[18] Morans' I is -0.01, p-value 0.49. Estimations based on a robust permutation approach using 10 000 bootstrap permutations.

and the hinterland using the local Moran. Results largely confirm the overall pattern, with more negative and significant values for income levels compared to growth rates. It is interesting to note that for both income levels and growth rates, it appears that the negative relation between the growth pole and the hinterland is strongest in the southern parts of China. Using Morans' I is a valuable tool for getting an overview of the relation between growth and geography. However, one obvious disadvantage of the exploratory data analysis is that it does not take into account other factors that might impact the results. We therefore proceed by repeating the regression analysis performed earlier for the full sample of Chinese provinces, now restricting the analysis to the growth pole and the hinterland regions. As in the above analysis of the hinterland-growth pole relation, we continue to define hinterland provinces as neighbors to growth pole provinces and vice versa, ignoring interdependency within the hinterland and growth pole respectively. The results from regression analysis on this restricted part of China are presented in Table 3.

[Table 3 about here]

For the basic control variables that capture local factors such as investment, FDI, manufacturing dependency, population growth and SOE dependence, the estimated impact is as expected, and the results do not differ much from those reported earlier for the whole of China

However, when we compare the spatial interdependence between the growth pole and the hinterland, we find some striking differences from what we found for the whole country. First, results from estimations 3 and 4 in Table 3 point at a significant negative income relation between provinces in the growth pole and their inland neighbors. Hence, proximity to a richer province in the growth pole does not seem to yield any particular benefits in terms of per capita income growth for the first-tier inland provinces. This result should be interpreted with some caution, since there is a risk that the sampling procedure has a bias: we have selected provinces that were *a priori* known to differ from each other in terms of income and development levels.

In addition to a negative relation in terms of per capita income levels, estimations 1 and 2 suggest that there does not seem to be any particular benefit for the hinterland of income growth in the growth pole – the estimated coefficient is negative and significant, indicating a negative relation in terms of growth rates. This result should be less sensitive to any *ex ante* sampling bias than the results based on analysis of income levels.

Thus, although China as a whole exhibits a pattern of positive mutual growth interdependence, the results in Table 3 suggest that this pattern is significantly weaker (or perhaps even negative) when we look at the growth pole and its immediate inland neighbors. In other words, there does not seem to be any smooth transition of positive spillovers from the coastal provinces to their poorer westward neighbors.

We may speculate about the reasons for the negative relation between the growth pole and hinterland provinces. There are two immediate candidates for explaining the negative interdependence. First, as pointed out above and discussed already by Christaller (1966) and Von Thünen (1966), growth in the growth pole may drain resources from the hinterland.[19] For example, skilled labor may have been tempted to move from inland provinces toward the costal belt, and investment resources from the hinterland may have been attracted by the growth opportunities in the coastal provinces rather than remaining in the hinterland. As a consequence of the resulting depletion of resources in the hinterland, it is unlikely that a new growth pole can emerge in the immediate vicinity of an existing growth pole: it is instead likely to be located some distance away, where it can draw resources from its own hinterland. In the case of China we might think of the central part of China as the alternative second growth pole.[20]

A complementary argument is that the central parts of China supply the coastal provinces with raw material and intermediate goods. In this process, the hinterland may have been disconnected and mainlyt considered as a transit area on the way to the coast. If this scenario is accurate, one would expect a weak or insignificant relation between the hinterland and the growth pole, if the scenario based on resource depletion is more correct, it may even result in negative growth interdependence, at least for some time periods.

5. Summary

In recent years, a debate has evolved in China on whether economic reform has led to increased domestic integration and how economic growth is transmitted across geographical space. This is an inherently important question, given that evidence suggests that China has

[19] The original version of Christaller's central place theory was published in German in 1933, while Von Thünen's localization theories were first published (also in German) already in 1826. The references in the text are to the first English translations of the works.

[20] One may note that the negative coefficient is a partial correlation. That is, both the hinterland and the growth pole may co-vary due to nation-wide and period specific nation-wide trends. In addition, both regions have their own local growth factors.

not excelled in terms of the diffusion of economic growth from the more developed coastal regions to China's interior areas, as was the intended rationale for the regionally unbalanced development strategy initiated in the early 1980s.

This paper has explored to what degree China's provinces are linked together such that neighboring provinces show a similar pattern with respect to economic growth and income levels. As a point of departure, we calculated Morans' I statistics and performed spatial growth regressions for the whole of China and found support for both spatially autocorrelated income levels and economic growth rates. Perhaps a bit surprisingly, we found that the degree of economic growth synchronization has tended to decrease over time during our period of study, 1994-2003. In other words, the relationship between the rate of economic growth in a province and economic growth in its surrounding provinces has weakened.

To be precise, results from spatial growth regressions suggested that income growth in China's provinces is significantly correlated with growth in neighboring provinces; a one percentage point increase in per capita income growth in neighboring provinces is expected to increase economic growth by 0.28-0.75 percentage points. We further investigated whether having a rich neighbor promotes economic growth. Results indicate that a high per capita income level in a neighboring province has a positive effect on per capita income growth, although the coefficient estimate suggests that the impact is only moderate.

A number of observers of China's recent economic development have argued that the country's economic growth is driven by coastal provinces and that growth has subsequently spread inland, an idea consistent with China's initial development strategy. We investigated this issue by extracting 16 provinces consisting of relatively wealthy coastal and metropolitan provinces that we define as the "growth pole", and provinces located one step west-wards from the coastal areas, which we refer to as the "hinterland" region . Replicating our spatial growth regressions on this subsample, we found no positive impact of growth in the growth pole on the hinterland provinces. On the contrary, we found a negative relationship.

Our main conclusion from the first part of the analysis is that rich (poor) provinces tend to be clustered more than would be expected from a random pattern, and that provinces benefit from having both rich and rapidly growing neighbors.

The direct conclusion from the second part is that while China as a whole exhibits a pattern of positive mutual growth interdependence, there is no evidence to support this kind of relation between provinces in the growth pole and their immediate inland neighbors. In other words, there does not appear to be any smooth diffusion of positive spillovers from coastal and metropolitan provinces to their poorer neighbors further west. Instead, results suggest that the geographical development pattern is more complex. While there are spatial growth patterns, these do not suggest that growth is diffused smoothly from growth centers to increasingly distant locations. Instead, the growth effects may sometimes bypass neighboring provinces, leading to wave-like diffusion patterns. This pattern could be generated by several different factors. Obvious differences in topography, land productivity, climate, and other geographical factors may help explain the results, but it is also possible that there are more systematic determinants.

We have suggested that the insights of early economic geography models, like Christaller's central place theory and Von Thunen's industry location theory, may be relevant also for the diffusion of growth in the modern Chinese context.

More specifically, it is possible that market opportunities associated with growth in the rich growth pole have attracted investments and human capital from the hinterland to the growth pole, resulting in some degree of depletion of the hinterland provinces. In addition, the hinterland might serve as a transport zone between central China and the coastal and metropolitan areas, resulting in weak supply and demand linkages between the growth pole and the hinterland. Comparing economic indicators between the growth pole and its hinterland, the number are fairly clear. After three decades of growth and labor migration to the coast, the first-tier inland provinces are still well behind the growth pole provinces (although it should be noted that there has been substantial progress in absolute terms also in the hinterland provinces). Over time, it is possible that the growth dynamics will change, perhaps as a result of the increasing scarcity of land in the growth pole, so that the positive growth linkages are strengthened and the hinterland can draw stronger benefits from growth and development in the coastal areas. In the meantime, however, there may be reason for the government to design policies to support growth in the hinterland, to avoid the emergence of even larger gaps in income and development between neighboring provinces.

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Appendix

Figure 1. Morans' I, p.c.i., 1994-2003.

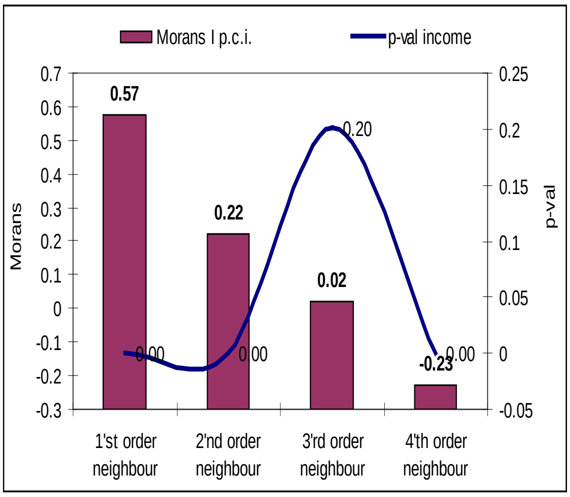

Figure 2. Morans' I, p.c.i growth, 1994 - 2003.

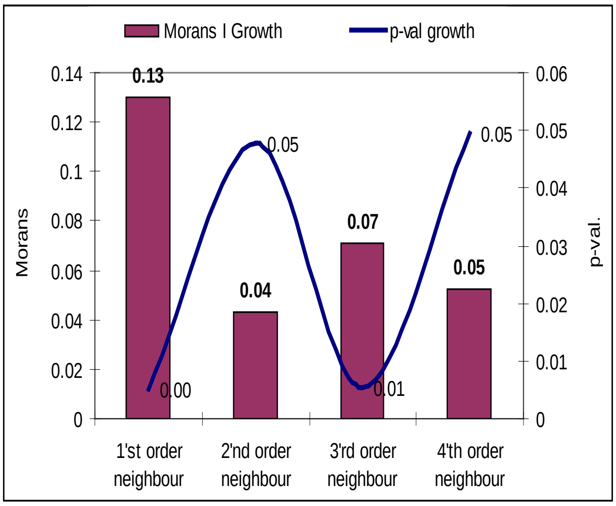

Figure 3. Morans' I for per capita income and income growth, 1994 - 2003.

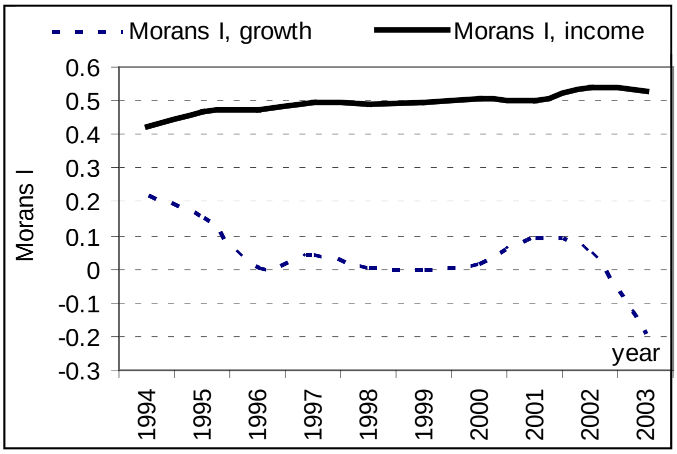

Table 1. Determinants of per capita income growth, 1994-2003.

Variable	Est. 1	Est. 2	Est. 3	Est. 4	Est. 5	Est. 6	Est. 7
Estimator	OLS	OLS	IVFGLS	IVFGLS	IVFGLS	IVFGLS	IVFGLS
1. Population growth (t)	-0.8258 (0.000)	-0.8368 (0.000)	-0.8645 (0.000)	-0.8697 (0.000)	-0.8260 (0.000)	-0.8499 (0.000)	-0.8682 (0.000)
2. Capital accumulation (t)	0.1121 (0.000)	0.1085 (0.000)	0.1112 (0.000)	0.1090 (0.000)	0.1136 (0.000)	0.1107 (0.000)	0.1115 (0.000)
3. Human capital accumulation (t-1)	0.0350 (0.011)	0.0184 (0.142)	0.0350 (0.010)	0.020 (0.113)	0.0274 (0.037)	0.0205 (0.108)	0.0372 (0.006)
4. FDI (t-1)	-	6.1e-08 (0.000)		3.4e-08 (0.181)		2.7e-08 (0.269)	
5. SOE share ind output (t)	-	-0.0163 (0.073)		-0.0183 (0.046)		-0.0176 (0.047)	
6. Manu share of GDP (t)	-	0.0947 (0.000)		0.0892 (0.000)		0.0694 (0.007)	
7. Openness (t)	-	-		0.0368 (0.149)		0.0392 (0.116)	
8. Neighbors' p.c.i growth (t) (inverse dist. matrix)	-	-	0.7474 (0.046)	0.2773 (0.406)			0.7690 (0.039)
9. Neighbors' p.c.i (t) (inverse dist. matrix)	-	-			0.0594 (0.000)	0.0270 (0.030)	
10. Neighbors' p.c.i growth (t) * hinterland dum. (A)							-0.0821 (0.180)
Period dum.	yes	yes	yes	yes	Yes	yes	
Sargan, p-value	-	-	0.911	0.965	0.918	0.957	
p-val: var8-var10 = 0							0.03
Obs	261	261	261	261	261	261	

Notes: p-values within parenthesis (.). Replacing the inverse distance matrix for the first order contiguity matrix decreases the coefficient for the spatial variable according to: Mod 1. from 0.75 to 0.07; Mod 2. from 0.29 to 0.09; Mod 3. from 0.06 to 0.03; Mod 4. from 0.03 to 0.02; Mod 5. from 0.96 to 0.25; Mod 6. from 1.06 to 0.39.
(A) Interaction variable between a dummy for provinces immediately to the west of the costal belt provinces, here labeled "the hinterland to the growth pole".

Figure 4. p-value, local Moran, pci,
16 provinces, 1999.

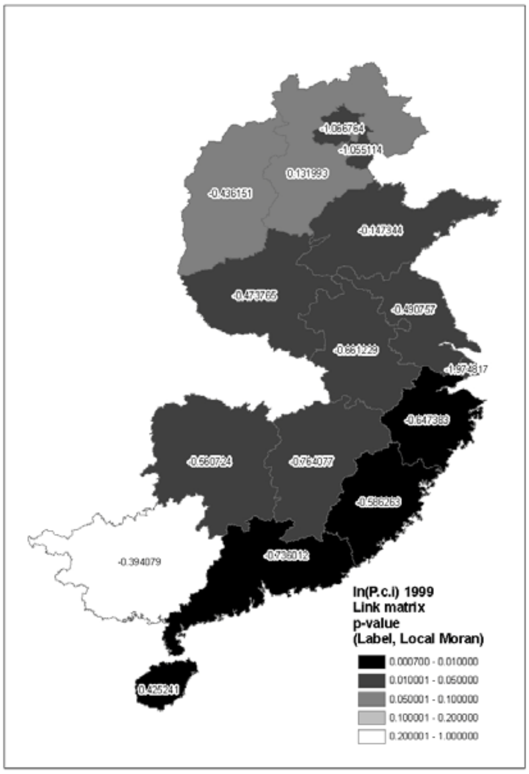

Figure 5. p-value, local Moran, pci growth,
16 provinces, 1999.

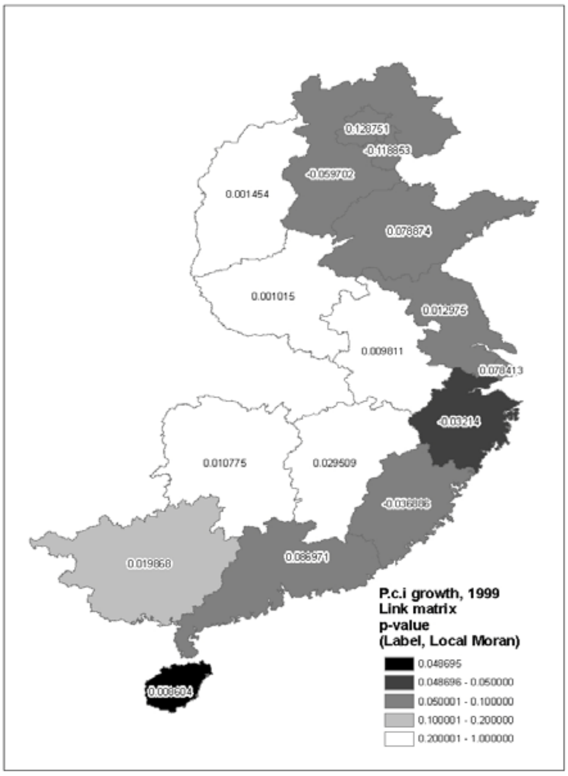

Table 3. Determinants of growth:
Growth pole and hinterland provinces, 1994-2003.

Variable	Est.1	Est. 2	Est. 3	Est. 4
Estimator	IV-FGLS	IV-FGLS	IV-FGLS	IV-FGLS
Population growth (t)	-0.8374 (0.000)	-0.8503 (0.000)	-0.8202 (0.000)	-0.8297 (0.000)
Capital accumulation (t)	0.0684 (0.061)	0.0981 (0.002)	0.0606 (0.078)	0.1045 (0.001)
Human capital accumulation (t-1)	0.0182 (0.428)	0.0208 (0.356)	0.0267 (0.271)	0.0246 (0.290)
FDI (t-1)		3.3e-08 (0.342)		1.7e-08 (0.608)
SOE share of ind output (t)		-0.0155 (0.355)		-0.0189 (0.268)
Manu share of GDP (t)		0.0646 (0.076)		0.0656 (0.105)
Openness (t)		0.0321 (0.354)		0.0417 (0.239)
Growth pole - hinterland growth (t) interdependence	-1.1242 (0.009)	-0.9629 (0.021)		
Growth pole - hinterland p.c.i (t) interdependence			-0.0945 (0.009)	-0.0393 (0.338)
Period dummies	yes	yes	yes	yes
Sargan, p-value	0.911	0.760	0.528	0.344
Obs	144	144	144	144

Notes: p-value within parenthesis. Growth interdependence between growth receivers and growth pole provinces using the spatial link matrix containing inverse distance weights connecting growth pole provinces only to growth receivers and vice versa (i.e. in this set-up interdependence between growth pole provinces are ignored). Replacing the link matrix for the standard inverse distance matrix decreases the coefficient for the spatial variables according to: Mod 1. from -1.124 to -0.602; Mod 2. from -0.923 to -0.598; Mod 3. from -0.094 to -0.018; Mod 4. from -0.094 to -0.013; Mod 5. from -3.487 to -1.764; Mod 6. from -2.062 to -0.695.
For province grouping, see Table A1.

Table A1. Province grouping

Growth pole provinces	"Hinterland provinces" immediately to the west of the growth pole	Other provinces
Beijing	Shanxi	Neimenggu
Tianjin	Anhui	Liaoning
Hebei	Jiangxi	Jilin
Shanghai	Henan	Heilongjiang
Jiangsu	Hunan	Hubei
Zhejiang	Guangxi	Hunan
Fujian		Sichuan
Shandong		Guizhou
Guangdong		Yunnan
Hainan		Shaanxi
		Gansu
		Qinghai
		Ningxia
		Xinjiang

Note: Chongqing is merged into Sichuan throughout the period of analysis.
Due to missing data Tibet is dropped from the analysis.