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Economic growth across space and time: Subprovincial evidence from mainland China

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Abstract

This paper considers the persistent differences in economic performance across Chinese regions. We introduce a new county- and city-level dataset that spans all of mainland China and provides a detailed view of Chinese regional growth over the period 1997-2005. Non-parametric kernel density estimation is employed to establish the cross-sectional GDP per capita distribution, and the distributional dynamics are investigated using the probability matrix technique and associated stochastic kernel estimator. A set of explanatory variables is then introduced, and several regressions are run to test for conditional β-convergence and to pinpoint influential factors for economic growth across counties and cities.

Keywords: Regional Economic Growth, China
JEL-Classification: O11, R11

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Department of Economics, Hamburg University, Von-Melle-Park 5, 20146 Hamburg, GERMANY
curran@econ.uni-hamburg.de, funke@econ.uni-hamburg.de, juewang123@gmail.com

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Tiivistelmä

Tässä tutkimuksessa tarkastellaan Kiinan alueiden talouskehityksen pitkäaikaisia eroja. Työssä otetaan käyttöön uusi piirikunta- ja kaupunkitason tilastoaineisto, joka kattaa koko Manner-Kiinan. Tämän yksityiskohtaisen aineiston avulla voidaan tarkastella Kiinan alueiden talouskasvua vuosien 1997 ja 2005 välillä. Ei-parametristen kernel-tiheysestimointien avulla voidaan selvittää henkeä kohden lasketun bruttokansantuotteen jakauma. Tämän jakauman dynamiikkaa tarkastellaan todennäköisyysmatriisien ja niihin liittyvän stokastisen kernel-estimaattorin avulla. Seuraavissa estimoinneissa talouskasvua selitetään useilla muilla muuttujilla ja pystytään näyttämään, että Kiinan alueiden välillä toteutuu ehdollinen β-konvergenssi.

Asiasanat: alueellinen talouskasvu, Kiina

1 Introduction

China's macroeconomic growth performance over the last decade has been nothing less than phenomenal. GDP has grown at the blistering pace of 8 per cent pa. The expansion of China's role in world trade has been no less remarkable, its overall share in world trade rising from less than 1% in 1979 to 6% in 2005. And, according to the World Bank, economic growth has contributed to rapidly falling poverty rates in China. From 1994 to 2004, the portion of population living below the poverty line declined from 35% to 17% in rural China, and from 0.90% to 0.30% in Chinese cities.[1] Despite these remarkable achievements, much debate and attention has focussed on China's uneven regional developments. Urban and rural standards of living continue to be poles apart. Rural prefectures and townships still struggle to come to grips with basic healthcare and education provision. Despite commitments from the central government to implement a new medical insurance scheme and free education, outlays on health care and education as a proportion of total spending remain lower than they were a decade ago.[2]

While high-speed economic growth and dramatic social changes continue to distinguish China across the globe, the country's leadership has recently been eyeing a smoother ride on its development path by issuing a guideline prioritising 'harmony'. The sustained reforms and opening-up over the past two and half decades have resulted in prosperity for many Chinese citizens, but the country's income gaps are among the top concerns of the Communist Party of China (CPC). Over the past three years rural income per capita has risen by more than 6% annually in real terms, but this has not halted the widening of the urban-rural income gap. The CPC's uneasiness stems from the fact that China's history is littered with rebellions, uprisings, and revolutions sparked by economic inequalities. Against this historical experience, Chinese leaders have placed the concept of a 'harmonious socialist society' for renewed political legitimacy and political cohesion of the country at the top of their agenda. It is envisaged that this harmonious society should feature democracy and the rule of law, and enable all the people to share the social wealth brought by reform and development.

[1] See http://iresearch.worldbank.org/PovcalNet/jsp/index.jsp. Some optimistic observers have argued that China's GDP is likely to grow at rates of at least 8% per year for at least a generation, ie to 2030, and perhaps beyond that date [see Fogel (2006)].
[2] 'Rural China: Missing the Barefoot Doctors', *The Economist*, 11 October 2007, pp. 27-29.

In this paper we consider regional economic growth across China over the period 1997-2005. We introduce a county- and city-level dataset of real GDP per capita that spans the whole of mainland China.[3] The main motivation for this paper is to contribute to a fuller understanding of the persistent differences in economic performance across China. The paper is structured as follows. Section 2 provides a concise literature review, which comprises the key findings to date concerning Chinese regional growth. Section 3 introduces the county- and city-level dataset utilised in this paper and illustrates with colour-coded maps the insights gained from moving from provincial-level to county- and city-level disaggregation. In Section 4 we establish the evolution of the entire cross-sectional distribution of real GDP per capita over time using non-parametric kernel density estimation and track the dynamics of individual county- and city-level districts over time using the transition probability matrix technique and associated stochastic kernel estimator. Section 5 expands our dataset to include a set of explanatory variables and utilizes OLS, LTS, and BIF regressions to test for conditional β-convergence across these county- and city-level districts. Section 6 sets out conclusions and some implications for policy-makers.

2 Literature review

The previous literature has analysed the uneven pace of reform and growth across Chinese regions from various angles. The insights and results of existing studies can be summarised as follows:

(a) The assessment of regional inequality is not independent of the degree of disaggregation. In most papers the measurement of inequality is still based on provincial-level data. On the contrary, Herrmann-Pillath et al (2002) used prefecture-level data on a total of 312 prefectures in 1993 and 1998, and concluded that regional development should be analysed on a high level of disaggregation. Jones et al (2003) and Song et al (2000) used data for about 200 cities and concluded that differences in growth rates are far more severe than indicated in studies using data at higher levels of aggregation.

[3] The quantity of real GDP generated in each district, scaled by district population, is a standard proxy for productivity in the face of data constraints at high levels of disaggregation. It is not intended to represent income per capita.

(b) Unel and Zebregs (2006) demonstrated that capital deepening has been by far the most important source of GDP per capita growth across Chinese provinces in the 1980s and 1990s.
(c) Differences in natural endowments have contributed to the divergence in economic activity and income across space [Bao et al (2002), Demurger et al (2002)].
(d) Uneven preferential open-door policies in the post-reform period may have led to different policy-determined clubs of provinces. For example, Démurger et al (2002) constructed an index ranging from 0 to 3 for each province during the reform years, depending on the type and extent of favoured free trade zones.
(e) Dayal-Gulati and Husain (2002) showed that the prevalence of state-owned enterprises and a high ratio of bank loans to deposits – an indication of large directed lending – were associated with lower growth and centripetal forces.
(f) One reason given for diverse regional growth patterns is an uneven influx of FDI with a high concentration in coastal areas [see Wei et al (1999), Wen (2007)].
(g) Démurger (2001) demonstrated that transport facilities are a key differentiating factor in explaining regional growth differentials.
(h) The coastal areas have taken advantage of their long commercial and industrial traditions and geographic and ethnic links with Hong Kong, Macao and Taiwan. They have as a result attracted a dominant proportion of FDI before FDI started to penetrate into interior regions.

3 Regional economic growth across China: Descriptive evidence

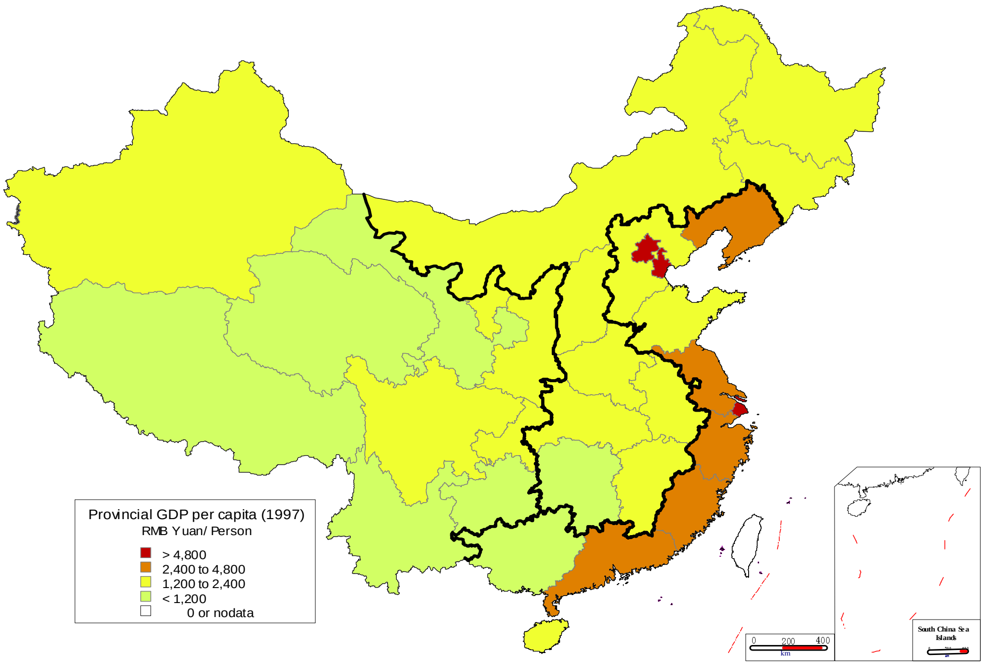
Many regional growth studies of the Chinese economy have been based on data relating to Chinese province-level (shěngjí) divisions. However, these Chinese provinces represent very large geographic units, especially in the western and central regions – in many cases comparable in size to large European countries. A lower level of aggregation can therefore be regarded as a natural choice for an analysis of regional growth patterns. In this paper we utilize a dataset disaggregated to county- and city-level. As of December 31, 2005, the People's Republic of China administers 33 province-level regions, which comprise 333 prefecture-level regions that are further divided into 2,862 county-level regions (xiànjí), 41,636 township-level regions, and several village-level regions. The thirty-three province-level (shěngjí) divisions are comprised of twenty-two provinces, five autonomous regions, four municipalities, and two special administrative regions. The dataset utilized here reports on 2,283 county- and city-level districts; which we refer to as 'districts' in the remainder of the paper. When missing values are excluded, the dataset yields 2,199 observations for county- and city-level GDP per capita over the period 1997-2005. The GDP per capita data has been deflated using provincial-level GDP deflators obtained from nominal and real GDP indices available from the *CEIC* Database. Unless otherwise indicated, all other data has been derived from the China Data Centre at the University of Michigan (see http://www.umich.edu/~iinet/chinadata/). Every effort has been made to take into account changes in administrative boundaries over time, with case-by-case estimates where counties and/or cities had to be reshuffled and fitted into newly formed larger aggregates.[4]

In order to get a more intuitive feel for the different levels of aggregation of Chinese data (provinces, county- and city-level, and the Western-Central-Coastal distinction that has emerged in the literature), it is useful to begin with the most aggregated view and then zoom in. The obvious starting point in such a 'top-down' approach is the empirically observed belt of the three regions (western, central, and coastal) that have become the standard point of departure in the literature. Even a casual glance at Chinese national accounts data reveals the great disparity between these regions: in 1997, for example, real GDP per capita of the western and central regions were 71% and 82% respectively of the national figure, while the coastal (eastern) region's real GDP per capita was 159% of the national figure. In 2005, a similar situation was evident, with the western, central, and coastal regions now clocking in at 78%, 94%, and 185% of the national figure. This reflects an annual growth rate of 8.1% in the west, 8.6% in the centre, and 8.7% on the coast over the 1997-2005 period. Taken as a whole, a comparison of the three belts indicates strong growth across the board, but also a coastal region continuing to forge ahead, with the central region unable to close the gap, and the western region falling further behind. Figures 1 and 2 provide a colour-coded illustration of the Chinese West-Central-Coastal disparities in real GDP per capita as they were in 1997 and 2005, with the three belts divided into their constituent provinces. The West-Central-Coastal distinction is clear to see from Figures 1 and 2. What is more, coastal real GDP per capita appears to perform strongly over the 1997-2005 period, in contrast to the performance of the western and cen-

[4] While GDP is the more common measure of national income, for countries benefiting from substantial foreign direct investment inflows, GNP is regarded as the more appropriate measure, as it excludes profits and

tral regions. This impression is broadly in line with that of Yao and Zhang (2001), who have suggested that the three belts can be divided into three distinct diverging clubs. In this way, China could be characterised by a three-tiered cluster growth pattern.

Figure 1 West-central-coastal disparities in real GDP per capita 1997



<u>Note:</u> The three belts consist of the following provinces: (i) *Coast*: Beijing, Tianjin, Liaoning, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan, and Guangxi; (ii) *Central*: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Inner Mongolia, and Hunan; (iii) *West*: Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. The relevant data source is China Data Online: http://chinadataonline.org/. Nominal GDP per capita data is deflated using provincial-level GDP deflators (base year 2000 = 100) obtained from nominal and real GDP indices available from the *CEIC* Database. To ensure compatibility and integrity of data for different levels of aggregation, belt-level data were obtained by aggregating the appropriate provincial data. The national total is calculated directly from national data from China Data Online.

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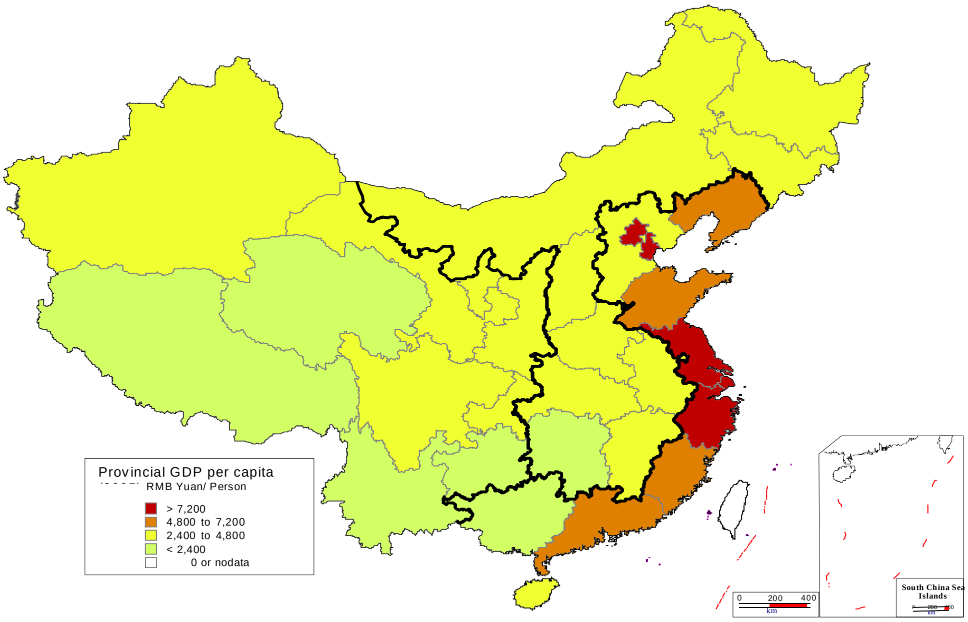
remittances repatriated by foreign multinationals to their home country. Unfortunately, in the Chinese case, data constraints dictate that we use GDP as our measure of national income.

Figure 2 West-central-coastal disparities in real GDP per capita 2005

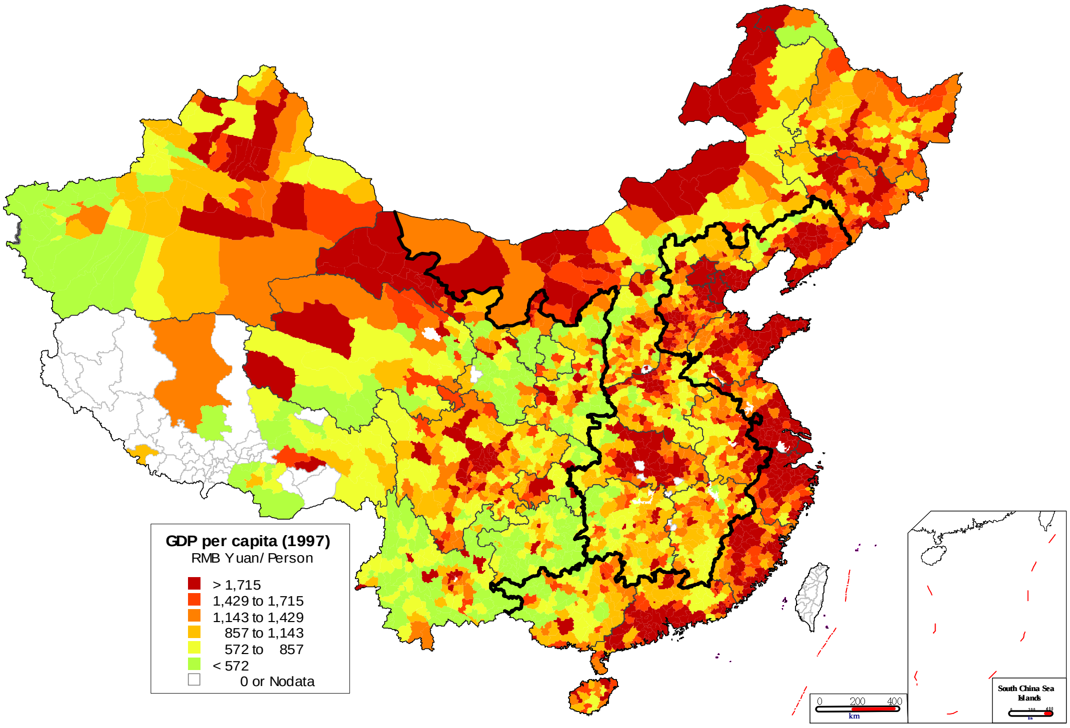


Of course, it is natural to wonder how much information can actually be gleaned from such an aggregated picture, which may conceal substantial heterogeneity or smooth over the impacts of important economic developments within each of the three belts. This is where the county- and city-level data can make a real contribution to understanding the facts of Chinese economic growth 'on the ground', as it enables attribution of economic growth (or lack of) to the specific region from which it emanates, rather than averaging it across large geographic units. Figures 3 and 4 provide colour-coded maps of this county- and city-level data for 1997 and 2005.[5]

What emerges from Figures 3 and 4 is a much more mixed picture than that suggested by the data at either provincial or 'three belt' level. Firstly, it is clear that pockets of relatively high GDP per capita are dispersed across the whole of Mainland China, rather than being confined to the coastal areas. It seems that the relatively high GDP per capita districts in the coastal region are not as cohesive as Figures 1 and 2 might suggest. What is more, it is the western region and northernmost parts of the central region that appear to gain a greater foothold in the relatively high GDP per capita category over the 1997-2005 period.

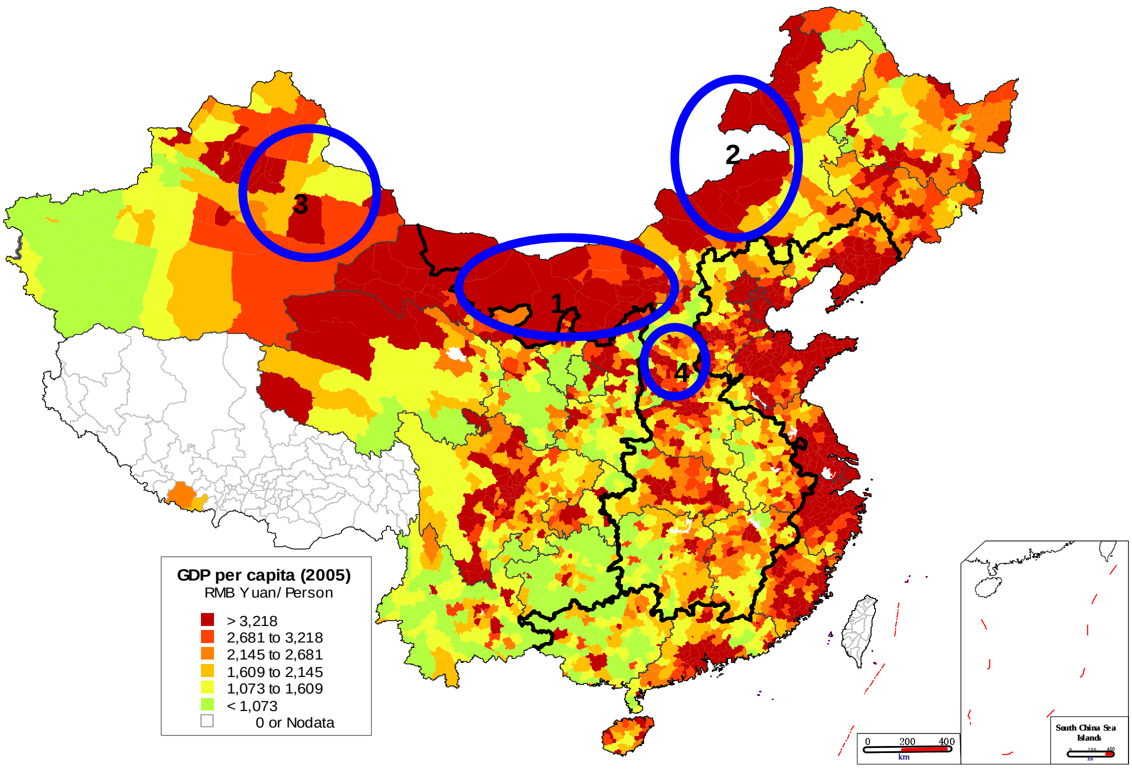
[5] Data prior to 1997 is not available at this level of disaggregation.

Figure 3 County-level and city-level real GDP per capita 1997



Note: Areas in white are the districts for which data are not available.

Figure 4 County-level and city-level real GDP per capita 2005



However, Chinese national accounts data should be treated with some caution. The Chinese National Bureau of Statistics (NBS) is still in the process of fully implementing the principles laid down by the OECD's Standardised National Accounts System (SNA).[6] In this light, we now consider in more detail those districts of the western and central regions that exhibit a notable change in GDP per capita over the 1997-2005 period.

The districts whose GDP per capita grew rapidly in 1997-2005 (circled and numbered in Figure 4 above) are mostly located in central Inner Mongolia (1 and 2) and Xinjiang province (3), as well as in the middle of Shanxi province (4). These pockets of high growth are corroborated in the existing literature: Gao (2004) notes that the central counties in Inner Mongolia experienced rapid economic growth of over 10% per annum in 1995-2002. Luo (2004) also cited Inner Mongolia and Xinjiang as being the fastest growing provinces of the 12 Western provinces (including Inner Mongolia). Zhang et al (2006, 2007), using exploratory spatial data analysis methods to analyse real GDP per capita growth for a sample of 341 districts obtained from dividing sub-provincial regions into counties and municipalities, also identify central Inner Mongolia as a region of high growth in 1990-2004. Table 1 presents the sectoral composition of GDP for the ten districts that generated the highest real GDP per capita in western China in 2005. Primary industry refers to farming, forestry, animal husbandry and fishing, while secondary industry includes mining, manufacturing, electricity production, and construction.

Table 1 Composition of GDP in the 10 western counties with highest GDP per capita in 2005

Area	Province	Primary Industry (%)	Secondary Industry (%)	Tertiary Industry (%)	GDP per capita (yuan)
Eji'na Qi	Inner Mongolia	4	36	60	20,624
Erenhot City	Inner Mongolia	1	18	81	16,390
Yi Jin Huo Luo Qi	Inner Mongolia	4	41	55	16,098
E Tuo Ke Qi	Inner Mongolia	5	75	19	14,935
Zhun Ge Er Qi	Inner Mongolia	3	62	34	12,425
Yanchuan County	Shannxi	3	92	5	12,151
Korla City	Xinjiang	6	79	15	11,744
Golmud City	Qinghai	1	70	29	11,644
Akesaihasake County	Gansu	6	60	34	11,391
Yu Men City	Gansu	6	77	17	10,237
National Total		13	48	40	3,686

Note: Yanchuan county data refers to 2004.

[6] For a detailed account of differences between existing Chinese GDP measurement techniques and 1993 SNA guidelines see Xu (2003), finds concludes that China's ongoing transition to the 1993 SNA does not

The three districts generating the highest real GDP per capita in 2005 are noticeably more tertiary-orientated than the other districts shown. Erji'na, traditionally an agricultural county, has enjoyed strong secondary and tertiary growth since 2000. The annual gross industrial output value of Erji'na has grown to nearly RMB 600 million, over six times that of 2000, while its value-added expanded more than eightfold between 2000 and 2005. Tourism has also increased in Erji'na, the location of Dongfeng Spaceflight City - launch site of China's first and second manned space flights. Since 2004, the local government has invested over RMB 310 million to build the Ceke border crossing, an outlet for cross-border trade which facilitates the export and import of goods, especially coal. Similarly, Erenhot city has recently established two important outlets for cross-border trade, which accounts for its high proportion of tertiary industry (over 80% of total GDP). From 2000 to 2005, the value of imports and exports to and from Erenhot have soared from USD 400 million to USD 2.2 billion, growing at a rate of 41.1% rate per year. Yi Jin Huo Luo Qi, on the other hand, appears to have developed a tertiary sector to complement its well-established mining industry. Yi Jin Huo Luo Qi is the main extractive area of Dongsheng coalfield, which is one of the most important coalfields in China.

Of those districts in Table 1 which are intensive in secondary industry activities, the extraction of natural resources features very strongly. Yanchuan, Korla, and Yumen are heavily dependent on petroleum extraction and refining. In Yanchaun, for example, the Yanchuan Petroleum Company is the district's largest tax revenue contributor, accounting for 65% of local tax revenue. In 2006 Yanchuan's gross industrial output was twice that of the previous year. A similar story is evident in Korla: its total Gross Industrial Output Value grew by over 25% per annum between 2000 and 2005. Korla's secondary industry share of total GDP is approximately 79%, but this figure falls to 27% when the oil sub-sector is excluded. In Yumen, 60% of local government revenue emanates from petroleum exploiting and refining, which contributes over 36,000 jobs to the district (61.7% of the district's total employment). Zhungeer is a coal mining district, which in 2005 experienced 45% growth in its industrial value-added, as a result of higher prices for coal products. Asbestos extraction and production is the main industry of Akesaihasake and accounts for 90% of local government revenue. Akesaihasake's annual asbestos production is 170,000 tons, accounting for over 50% of national asbestos production. Besides asbestos, the district is rich in other minerals and metals, such as gold, zinc, and crystal. Etuoke, tradition-

weaken the international comparability of Chinese GDP estimates.

ally an agricultural district, has in recent times focussed on attracting manufacturing investment. Since 2000 two industrial areas have been constructed in the district. Many industrial companies such as Mengxi Limited and Xingguang Limited have established branches or factories in these industrial areas. In 2005, Etuoke's GDP rose to RMB 600 million, on the back of a 44% annual growth rate since 2000.

Taken as a whole, our dataset indicates that classifications based on provincial data are inadequate in that they conceal considerable heterogeneity within the provinces and may smooth the impact of important localised economic developments over larger economic units. The most important implication of this is that the Chinese province may not be the optimal unit of regional analysis because aggregation leads to a distorted view of reality.[7] The West-Central-Coastal belts and the provinces appear to be inappropriate units for government policies of awarding preferential treatment to specific regions. Although we still need to investigate the mechanisms that underlie the observable uneven patterns of GDP per capita, we can conclude that a large regional variance below the provincial level has been averaged away in many conventional studies. This paper, representing the first attempt to focus on county- and city-level data across the entirety of Mainland China, aims to address this deficit.[8]

4 From the bottom up: Non-parametric evidence on the distribution of county- and city-level GDP per capita

Nonparametric techniques, such as the Kernel density estimator, can reveal interesting features of the data and therefore help to capture stylised facts that need explanation. Such techniques allow one to ascertain the distribution of the underlying data without imposing any parametric restrictions: 'letting the data speak for itself', as the old adage goes. In the

[7] One can draw an interesting parallel between China and Germany. While in China the discussion has been governed by the 'three belt hypothesis', the discussion in Germany after unification was governed by the 'two belt hypothesis' (eastern vs western Germany). Compared with our evidence for China, the German Council of Economic Experts [see Sachverständigenrat zur Begutachtung der Gesamtwirtschaftlichen Entwicklung (1999), pp. 116-133] has demonstrated that the German 'belt view' is only correct superficially. On the surface it appears that such a distinction exists, but in reality the situation is different. Ten years after German unification several prosperous counties and cities exist in eastern Germany and therefore the two belt hypothesis is inadequate as a guide for regional economic policies.

[8] The existing literature that goes to this level of disaggregation has focussed on case studies of provinces. See eg Lyons (1998). So far, there are no national cross-county and cross-city statistical analyses of Chinese regional development. Zhang et al (2006, 2007) recently attempted to disaggregate sub-provincial data in

case of our Chinese real GDP per capita data, such an approach is intuitively appealing given the large number of county- and city-level observations available and the possibility of a number of distinct distributions or patterns being present in the underlying data.

4.1 Kernel density estimation and real GDP per capita

The kernel estimator for the density function *f*(*x*) at point *x* is

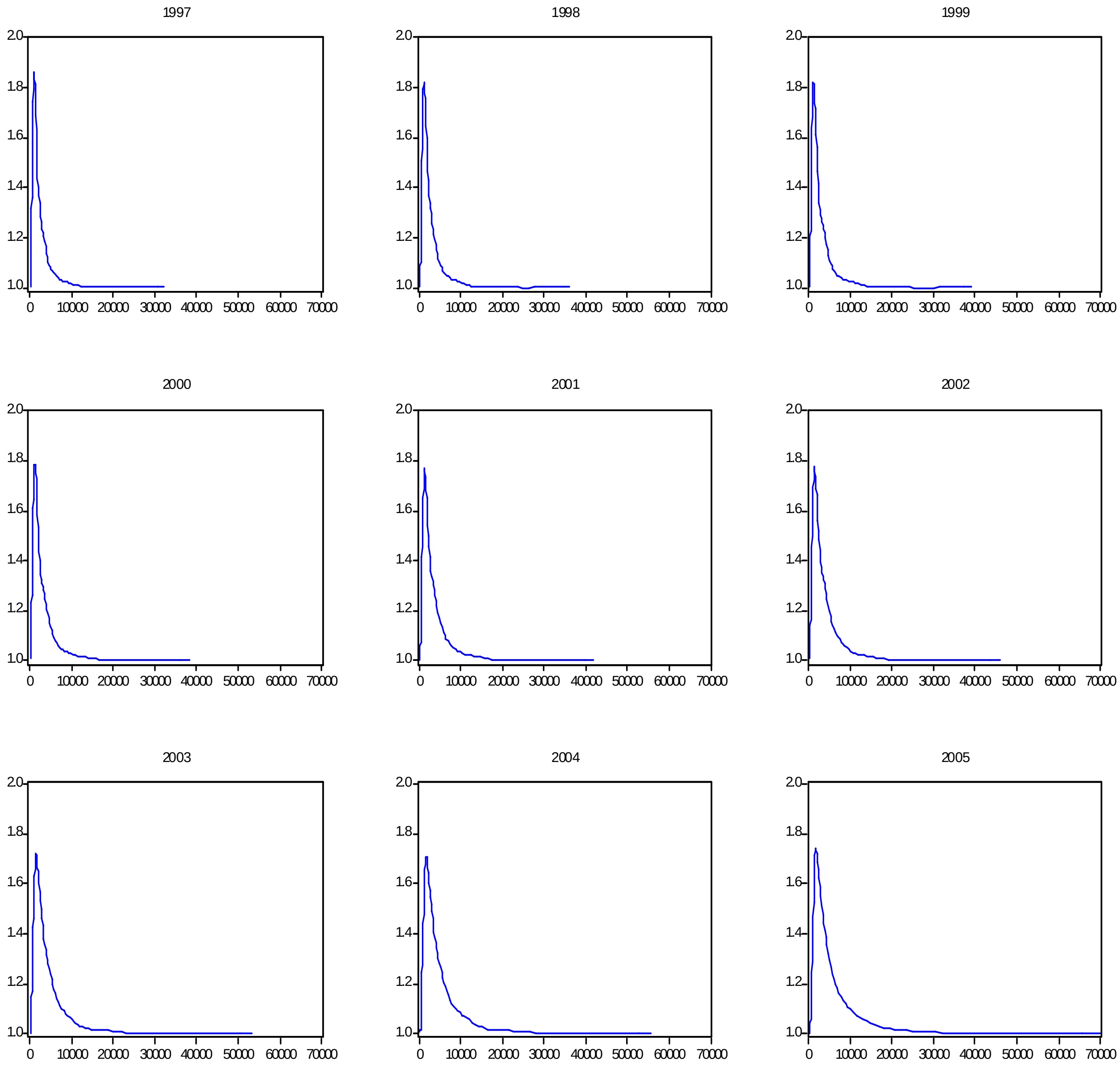
(1) $$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x_i - x}{h}\right)$$

where $x = x_1, x_2, \ldots, x_n$, is an independent and identically distributed sample of random variables from a probability density *f*(*x*) and $K(\cdot)$ is the standard normal kernel with window width *h*. The window width essentially controls the degree to which the data are smoothed to produce the kernel estimate. The larger the value of *h*, the smoother the kernel distribution. A crucial issue is the choice of this smoothing parameter. Here we employ the two-stage direct plug-in bandwidth selection method of Sheather and Jones (1991), which has been shown to perform quite well for many density types by Park and Turlach (1992) and Wand and Jones (1995).[9] The distributions have been fitted to the logarithm of real GDP per capita. Figure 5 presents the kernel density estimations for (log) *GDP* from 1997 to 2005 obtained using the above-mentioned bandwidth selection method and transforming the income variable to the original scale.

their analysis of real GDP per capita growth using a sample of 341 districts obtained from dividing sub-provincial regions into counties and municipalities

[9] Given the crucial role played by the bandwidth selection method, it is important to assess the performance of alternative bandwidth selectors. When the Silverman (1986) rule of thumb bandwidth selector was used for the above kernel density estimation, similar trends were exhibited by the distributions. Detailed results are available from the authors on request.

Figure 5 Kernel density estimates with seater and Jones plug-in bandwidth selection method



Note: The horizontal axes in the above kernel density estimates are given Rmb.

In the kernel density estimation context, a convergence process occurs if, for instance, a bimodal density is detected at the start of the sample period and over time there is a tendency in the distribution to move towards unimodality. Alternatively, if there already is a unimodal distribution at the start of the time span in question, convergence occurs when the dispersion of this density, and thus per capita income, declines over time. The kernel density estimates of Figure 5 reveal a number of interesting features: first, there is clearly no multimodality present in the distribution – suggesting that there are not three distinct distributions or patterns in the county- and city-level Chinese real GDP per capita data. This confirms that talking about Chinese growth in terms of a Western-Central-Coastal division is overly simplistic. Second, the kernel density estimates are clearly skewed, with one high real GDP per capita generating region in particular, Shenzhen, which visible as an outlier in the right tail.10 Third, the high GDP per capita regions appear to be pulling further away to the right over the 1997-2005 period.11 It also seems that the mode of the distribution, representing the main body of the observations, has widened somewhat over time.

These visual impressions of the kernel density estimates also receive some support from descriptive statistics for 1997 and 2005 real GDP per capita, given in Table 2. In 2005 both the maximum and minimum real GDP per capita are approximately twice their 1997 values. That said, the skewness decreases somewhat over this period – suggesting that the main body of observations moves upwards in the distribution, as evidenced by the noticeable increase in the median value.

Table 2 Summary statistics for county- and city-level real GDP per capita, 1997 and 2005

	1997	2005
Mean (Rmb)	1,562.50	3,170.90
Median (Rmb)	1,142.50	2,148.00
Standard Deviation	1,555.78	3,472.48
Maximum (Rmb)	32,377.35	69,962.88
Minimum (Rmb)	158.53	310.00
Skewness	6.25	5.91
Kurtosis	87.18	77.76
Jarque-Bera	662,436.90	523,941.40

In all, the kernel density estimates and descriptive statistics convey the following message: there are some obvious movements in the tails of the distribution, with the highest and lowest GDP per capita districts exhibiting the clearest changes. But this should not overshadow the fact that the main body of observations appears to have moved to a position of

10 Shenzhen, which forms part of the Southern China's Pearl River Delta region, has experienced phenomenal growth since being designated as a Special Economic Zone in 1979. While it was initially associated with labour-intensive industries, since the 1990s Shenzhen has focused on the manufacture of electronics, attracting substantial technology-based investment flows from Hong Kong, Taiwan, Japan, Europe and the United States. In 2002 Shenzhen accounted for around 20% of Mainland China's computer production and 15% of its semiconductor integrated circuits, according to Enright et al (2005, pp. 47-49). Shenzhen's population rose from 321,000 in 1979 to more than 7 million in 2000. Shenzhen Goverment Online reports that in 2004 average per capita GDP in Shenzhen was the highest in China, while its total import and export volume accounted for 1/7 of the country's total and ranked first in China for 12 consecutive years. Container throughput in the city ranked second in China and fourth worldwide (see: http://english.sz.gov.cn/)

11 One data limitation arises from gaps, as the population data are still based on the 'hukou system'. This leads to distortions in regions with large inflows of workers who should be counted as part of that region's regular population from an economic point of view.

higher real GDP per capita over the 1997-2005 period. In the next sub-section, the visual impressions conveyed by the kernel density estimates are further probed using transition probability matrices and stochastic kernel estimates.

4.2 Distribution dynamics of Chinese real GDP per capita

While the kernel density estimates in Figure 5 provide snapshots of the entire distribution of Chinese real GDP per capita as it evolves over time, it may well be the case that the skewness of the estimates conceals a convergence process among those central and western districts which were seen to enjoy such strong growth in Figures 3 and 4. Additional techniques are required to uncover the movements of the individual districts over time. This underlying process is further examined by considering the intra-distributional dynamics of the observations over the 1997-2005 period. This involves modelling directly the evolution of relative real GDP per capita distributions by constructing transition probability matrices that track changes over time in the relative positions of districts within the distribution. This is an exercise that a number of authors have undertaken (see Quah, 1996a, 1996b). The modelling of distribution dynamics assumes that the density distribution ϕ_t has evolved as

(1) $$\phi_{t+1} = M\,\phi_t,$$

where M is an operator that maps the transition between income distributions for periods t and t+1. Since the density distribution ϕ for the period t depends solely on the density ϕ for the immediately previous period, this is a first-order Markov process. The controlling factor in a Markov chain is the transition probability, ie the conditional probability that the system goes to a particular new state, given the current state. The maximum-likelihood estimate of transition probabilities can be expressed as

(2) $$\hat{P}_{ij} = \frac{n_{ij}}{n_i}$$

where n_{ij} is the number of districts that were in income category *i* in the previous period and have migrated to income category *j* in the current period, and n_i is the number of districts in income category *i* in the previous period. In other words, the estimate equals the proportion of time that the process, after leaving state *i*, next enters state *j*.

The main advantage of the transition matrix is that it allows one to summarise the random ups and downs of regional fortunes in a handful of numbers. The transition probability matrix in Table 3 reports transitions between the 1997 and 2005 distributions of real GDP per capita relative to the median value. The main diagonal of the matrix gives the proportion of districts that remained in the same range of the distribution throughout the period in question, while the off-diagonal probabilities are those associated with moving from one state to another. Table 3 also provides information about *n*, the number of districts that begin their transitions in a given state. Furthermore, the classes that divide up the state space are provided.

Table 3 Matrix of transition probabilities relative to median real GDP per capita

	GDP PER CAPITA 2005							
	n		*405*	*447*	*346*	*245*	*169*	*583*
GDP PER CAPITA 1997	*372*	[0-0.50]	77.42	18.01	3.23	1.08	0.00	0.27
	435	[0.50-0.75]	19.77	51.03	21.15	4.83	0.92	2.30
	391	[0.75-1.00]	5.63	29.16	34.78	17.90	8.95	3.58
	298	[1.00-1.25]	2.01	10.74	22.48	30.87	17.79	16.11
	169	[1.25- 1.50]	0.59	4.73	12.43	19.53	21.30	41.42
	530	[1.50- ∞]	0.38	0.75	3.40	4.72	7.74	83.02
			[0-0.50]	[0.50-0.75]	[0.75-1.00]	[1.00-1.25]	[1.25- 1.50]	[1.50- ∞]

The transition probability matrix in Table 3 reveals a number of noteworthy behavioural patterns in the distribution of real GDP per capita over time. It is clear from the probabilities that lie along the diagonal that some states are more susceptible to movement than others. Districts in the lower two states and those in the highest state appear to be relatively more static, as their probabilities of staying put is quite high. These large diagonal entries at the start and end of the distribution are consistent with the Markov chain analysis in Bhalla et al (2003), who used provincial-level data.

However, the districts residing in the middle of the distribution appear to be far more mobile. These middle states exhibit a greater degree of shuffling between relative categories. Both the diagonal and off-diagonal probabilities for the third, fourth, and fifth states suggest large potential for movement – forward and backward.

In Table 3, the operator *M* was constructed by assuming that the distribution ϕ_t has a finite number of states. This discrete modelling approach leads to the problem that the researcher must determine the number of intervals and limit values of each interval in an ad hoc manner. Furthermore, the discretisation process may eliminate the property of Markovian dependence in the data, as Bulli (2001) has pointed out. Resolution of these shortcomings consists of carrying out a continuous analysis of transition, which avoids discretisation through the use of conditional densities that are estimated non-parametrically and referred to as stochastic kernels. A stochastic kernel amounts to a transition matrix with an infinite number of infinitely small ranges. The results of this operation are displayed in three-dimensional graphs in Figure 6 and a two-dimensional contour map in Figure 7.

Figure 6 Stochastic Kernel estimates, 1997-2005

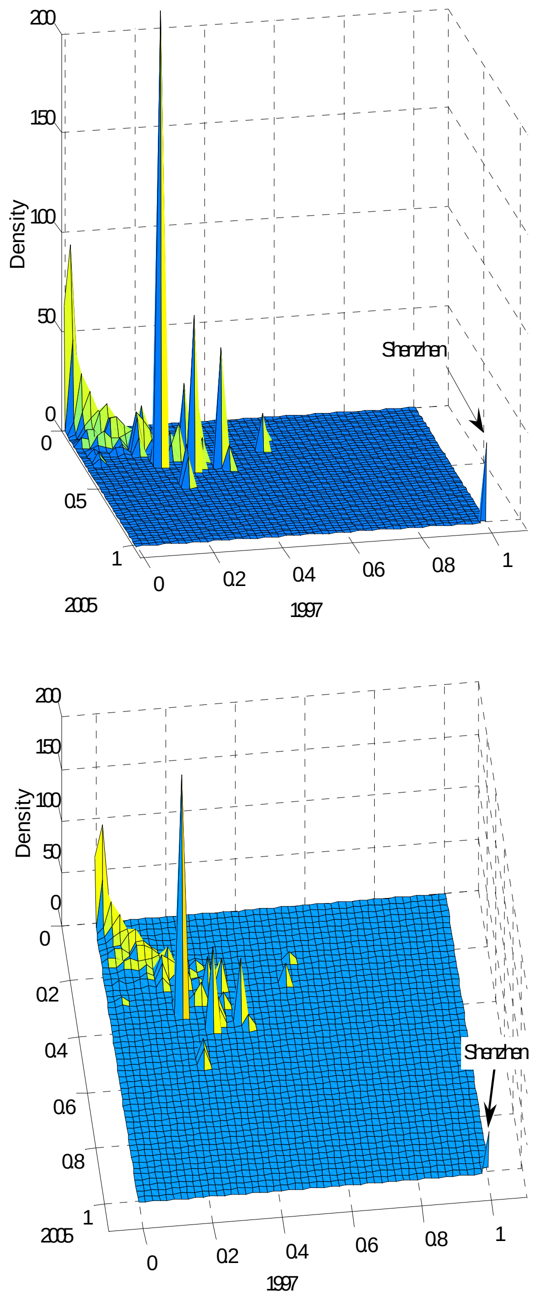
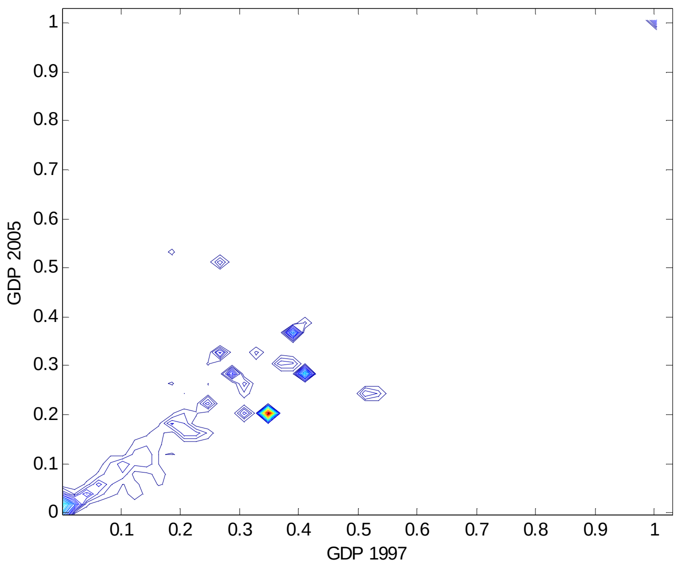


Figure 7 Stochastic Kernel contours, 1997-2005



Note: In Figures 6 and 7 the district with the highest GDP per capita was used as numeraire. Scaling real GDP per capita relative to median value was also explored but yielded the same results. The outlier, Shenzhen, is indicated in Figure 6 by an arrow.

The three-dimensional stochastic kernel estimates of Figure 6, together with the associated stochastic kernel contour of Figure 7, address some of the shortcomings of the transition probability matrices and replicate the main findings of the previous sections. In order to fully exploit the information content of this construct we adjust the perspective by tilting the graph downwards, as if looking down on the three dimensional distribution from above. This 'aerial view' is further enhanced by means of a contour image of the distribution. The graphs in Figure 6 highlight two features: the pronounced peaks at the start and very end of the distribution (the outlier, Shenzhen); and a middle section of the distribution which, apart from a few spikes, is relatively lower and suggests the possibility of either slippage or enhancement of relative position. The contour image in Figure 7 highlights the diagonal pattern of the distribution over time, illustrating the tendency of districts at the extremities of the distribution in 1997 to be there also in 2005. The districts in the middle, however, clearly scatter from this diagonal pattern, with this off-diagonal movement supporting the findings of the transition probability matrix, which pointed to a clear tendency for movement of districts in the middle of the distribution during the 1997-2005 period.

5 Empirical growth regressions

After establishing both the spatial disparity and underlying distributions of Chinese county- and city-level real GDP per capita, we now set about identifying those factors which may explain the trends observed in Chinese regional growth over the 1997-2005 period. We expand our original dataset by introducing a wide range of explanatory variables and then estimate a growth equation using the now-standard Barro (1991) framework, which tests for conditional β-convergence by incorporating a set of explanatory variables reflecting differences in the steady-state equilibrium. Despite constraints stemming from data availability, our expanded dataset covers a broad spectrum of economic and demographic factors.

The explanatory variables introduced in our analysis address a number of key features which have emerged from the literature as being influential in the economic growth process. Foremost among these are education and human capital formation, which are necessary for raising productivity. Investment in education leads to acquisition of skills that improve efficiency through better use of technologies. Education also reduces the imitation lag. With this in mind, we include the secondary-level education enrolment rate (as per cent of district population) in our growth equation.[12] Another factor widely regarded as influential in modern-day Chinese regional growth is the country's substantial inflow of overseas investment. China has attracted foreign direct investment (FDI) as part of a concerted development strategy.[13] The resulting dramatic expansion of FDI has allowed China to reap growth-enhancing benefits from FDI in several areas. First, the opening up of the economy has contributed to the acceleration of growth because increasing efficiency hinges on the implementation of new technologies, managerial skills, and labour training. Second, FDI has increased China's export competitiveness. Third, FDI helped to broaden the knowledge of Chinese authorities about market mechanisms during the transition process.[14] To capture this Chinese FDI phenomenon, utilised foreign capital (as per cent of district GDP) is also included in our growth equation specifications. A related issue is the ex-

[12] China already had a high literacy rate prior to our sample period. The 1986 Compulsory Education Law increased mandatory education from five years to nine. According to official estimates, 93% of the country had achieved nine-year basic education in 2004.

[13] Opening up of the Chinese economy began in 1979 with the promulgation of the Chinese-Foreign Joint Venture Law. A new phase in the reform process began in 1992 when FDI was allowed in all major inland cities. The open-door policy eventually led to a surge in FDI, making China the largest single FDI recipient in the world.

[14] Wen (2007) investigated the mechanisms whereby FDI has contributed to China´s regional development.

tent to which GDP composition influences regional economic performance. To explore this further, the proportion of each district's agricultural GDP and secondary industry GDP (each as per cent of district GDP) are included in our specifications. As in Section 3, primary industry refers to farming, forestry, animal husbandry and fishing, while secondary industry includes mining, manufacturing, electricity production, and construction.

A further factor thought to be influential in Chinese regional growth is the disparities in infrastructure networks across Chinese districts. Démurger (2001), for example, demonstrated that transport facilities are a key differentiating factor in explaining regional growth disparities. Of course, there are many types of infrastructure and measures thereof, and any one measure can only capture part of the story. However, a measure that gets at the essence of the infrastructure problem will presumably be highly correlated with other measures. We incorporate this infrastructure disparity into our growth equation specification by including the number of hospital beds per capita in each district. Traditionally, health care was provided by state-owned enterprises. Reform, however, has severely disrupted this system, as market pressure has led many firms to abandon their social services. This has led to an unevenly developed healthcare network across China.

Various new economic geography, new trade theory, and endogenous growth models have been applied to highlight the nexus between geographic location and economic growth. Findings from this line of inquiry are: (i) landlocked regions and countries trade less than coastal regions or countries, and (ii) coastal regions and maritime countries experience on average higher growth than landlocked regions and countries.[15] In order to consider the influence of geographic location on China's regional growth, we construct a set of dummy variables which indicate whether districts lie within the western, central, or coastal belts of China, as well as dummy variables which indicate the proximity of airports and seaports to the districts under observation. Figures 8 and 9 map the locations of these airports and seaports and categorise airports by passenger flows. As illustrated in Figures 8 and 9, we identified all the airports and seaports of mainland China, matched them to their respective county- and city-level districts, and highlighted the neighbouring regions that are likely to benefit from proximity to these transport facilities. We have also classified China's airports in terms of passenger flows, with the number of airports in each classifica-

[15] The specifics of the trade and growth umbrella comprise one of the greatest puzzles in economics. Studies on this phenomenon include Sachs and Warner (1995) and Edwards (1992, 1998). Similarly, Vamvakidis (2002) demonstrated in a historical context that trade is associated with growth after 1970 but not before. Another strand of the openness and growth literature seeks to improve cross-country regressions by employ-

tion provided. The airports are categorised as follows: 1 = airport with 0-50,000 passengers or no available passenger data; 2 = airport with 50,000-1,000,000 passengers; 3 = airport with 1,000,000-1,500,000 passengers; 4 = airport with over 1,500,000 passengers.

A number of caveats should be noted before we proceed with estimation of the growth equation regressions using our county- and city-level data. From a methodological perspective, one weakness of cross-region regressions is that of reverse causality and endogeneity. We used regressors dating from 2000, due to the fact that most county- and city-level data are not available for the years 1997-1999. These regressors dating from 2000 are assumed here to be weakly exogenous, thus obviating the need for instrumental variable techniques. Furthermore, the existing empirical growth literature based on 'Barro-regressions' has been criticized for its lack of robustness. Durlauf and Quah (1999) and Temple (1998, 2000) stress that applied macroeconomists are inclined to follow theory rather loosely and to simply try variables to establish factors determining economic growth. In these empirical specification searches, econometric problems such as robustness are often ignored [Durlauf (2001)].

In order to shed further light on the robustness issue, and to make our cross-region estimates more reasonable in the face of the common pitfalls of OLS estimation, we use the *L*east *T*rimmed *S*quares (LTS) estimator and the *B*ounded *I*nfluence *F*unction Regression (BIF) estimator as specification devices and diagnostic tools.[16] The LTS estimator is very similar to OLS, differing only in that the largest squared residuals are not used in the summation, thereby allowing the fit to avoid the outliers. In other words, the LTS estimator searches for a core subset of data that best accords with a certain model without taking into account the rest of the observations. The LTS estimator is $\sqrt{n}$-consistent and asymptotically normal. With k unknown parameters, the LTS method attains the highest possible breakdown value, namely $\{[(n-k)/2]+1\}/n$, which asymptotically equals 50%, ie it can withstand a lot of bad leverage points occurring anywhere in the data.[17]

The BIF estimator is a robust estimator proposed by Krasker et al (1983).[18] The purpose of the method is to attribute a lower weight to the impact of potentially influential observations using a chosen weighting function. The estimator is constructed by means of

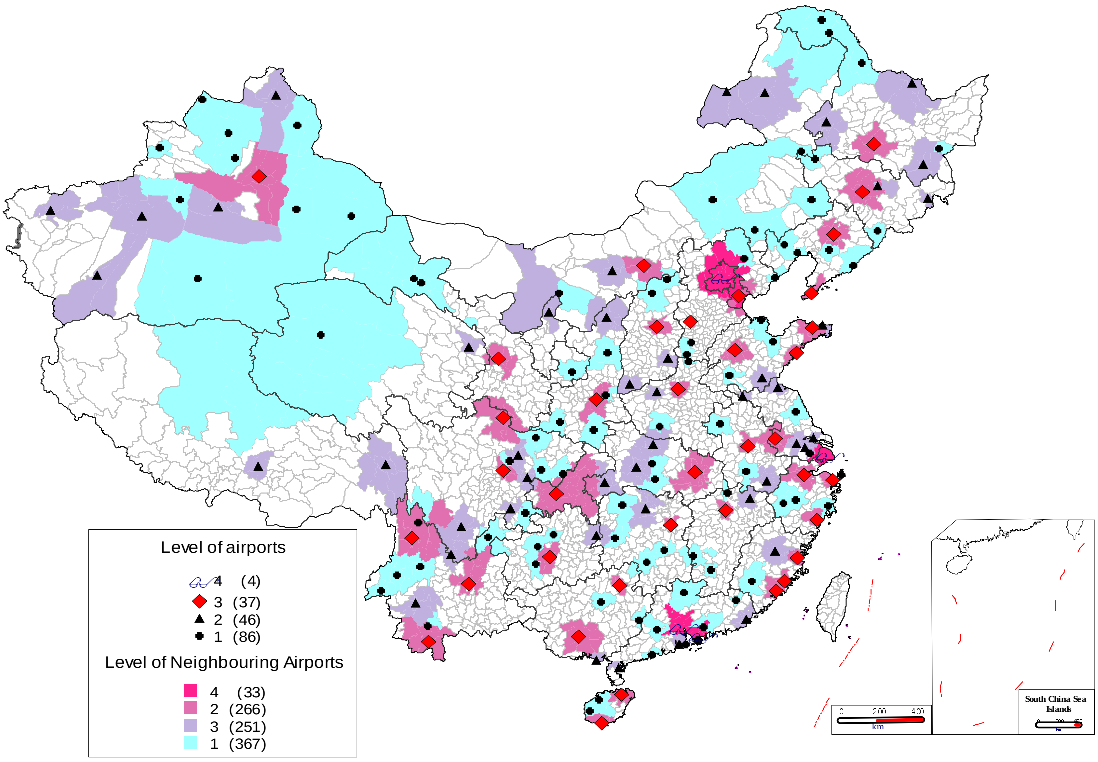
ing panel methods, geared at controlling for time-invariant unobservable fixed effects. Wacziarg and Welch (2003) provide evidence for a strong effect of openness on growth in a panel set-up.

[16] For an excellent survey of robust estimation methods and applications, see Rousseeuw and LeRoy (1987).

[17] In order to obtain the LTS regression a large number of subsamples, each of size k (the number of regression coeffcients, incl. the constant term) must be drawn and evaluated. In this paper 3000 subsamples were drawn.

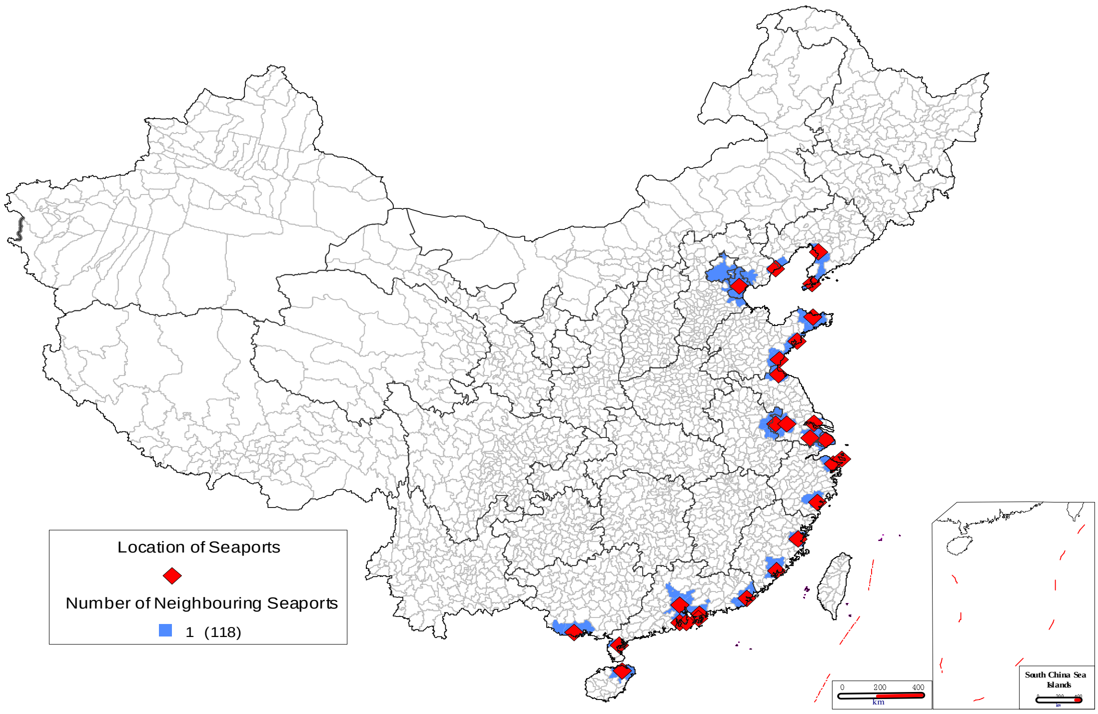
the 'influence function', which measures the impact of outlying observations. Optimal choices for the weighting function have been suggested by Hampel et al (1986). Rousseeuw and Leroy (1987) found in experiments that the BIF estimator achieves a breakdown point of slightly over 30%.

Figure 8 Airports in mainland China, categorised by passenger flows



[18] The BIF estimator is also referred to as the generalised M-estimator (GM-estimator) in the literature.

Figure 9 Location of seaports in mainland China



Tables 4-7 below present OLS, LTS, and BIF linear regressions of average county- and city-level GDP per capita growth on initial 1997 log GDP per capita *(lnGDP per capita$_{1997}$)* and a selection of explanatory variables detailed above – the standard test for conditional β-convergence, where a negative significant coefficient on initial log GDP indicates convergence and a positive significant coefficient indicates divergence. Tables 4 and 5 use all 2,199 observations of the dataset, while Tables 6 and 7 are based on a sample of 1,150 observations due to constraints on availability of utilised foreign capital data.[19] Tables 5 and 7 introduce the dummy variables into our specifications.[20]

[19] A breakdown of districts bearing missing values for utilised foreign capital is as follows (total number of districts in each province in brackets): *Coast*: Beijing 0 (3), Tianjin 0 (4), Liaoning 8 (58), Hebei 29 (147), Shanghai 0 (2), Jiangsu 1 (65), Zhejiang 8 (69), Fujian 2 (67), Shandong 4 (108), Guangdong 10 (88), Hainan 12 (18), and Guangxi 56 (89); *Central*: Shanxi 64 (93), Jilin 20 (49), Heilongjiang 42 (77), Anhui 30 (78), Jiangxi 16 (89), Henan 64 (126), Hubei 24 (76), Inner Mongolia 54 (88), and Hunan 21 (100); *West*: Sichuan 99 (105), Chongqing 15 (26), Guizhou 70 (82), Yunnan 103 (123), Tibet 73 (73), Shaanxi 64 (93), Gansu 71 (81), Qinghai 39 (40), Ningxia 9 (16), and Xinjiang 73 (86).
[20] Dummy variables cannot be included as regressors in the BIF estimation procedure.

Table 4 OLS, LTS, and BIF estimation of growth equations

Dependent Variable: Growth of real GDP per Capita (1997-2005)			
	OLS	LTS	BIF
Constant	0.228	0.197	0.202
	(0.00)	(0.00)	(0.00)
lnGDP per capita$_{1997}$	-0.023	-0.021	-0.023
	(0.00)	(0.00)	(0.00)
Hospital Beds/ pop (%)	0.036	0.027	0.035
	(0.00)	(0.00)	(0.00)
Secondary Enrolment / pop (%)	0.000	-0.001	0.000
	(0.57)	(0.15)	(0.76)
Primary GDP/total GDP (%)	-0.001	-0.0003	-0.0002
	(0.00)	(0.00)	(0.03)
Secondary GDP/total GDP (%)	0.001	0.001	0.001
	(0.00)	(0.00)	(0.00)
Adjusted R^2	0.13	0.18	0.16
Total no. of observations	2,199	2,112	2,199
No. of outliers	--	87	109

Note: Probabilities in brackets.

Table 5 OLS, LTS and BIF estimations of growth equations

Dependent variable: Growth of real GDP per cCapita (1997-2005)			
	OLS	LTS	BIF
Constant	0.239	0.182	0.202
	(0.00)	(0.00)	(0.00)
lnGDP per capita$_{1997}$	-0.024	-0.015	-0.023
	(0.00)	(0.00)	(0.00)
Hospital Beds / pop	0.018	0.001	0.022
	(0.02)	(0.58)	(0.01)
Enrolment Sec/ pop (%)	0.000	-0.001	0.001
	(0.79)	(0.19)	(0.11)
Utilised Foreign Cap/ GDP (%)	0.022	0.082	0.067
	(0.09)	(0.00)	(0.02)
Primary GDP/total GDP (%)	-0.001	-0.001	-0.0003
	(0.00)	(0.00)	(0.04)
Secondary GDP/total GDP (%)	0.001	0.0003	0.001
	(0.00)	(0.00)	(0.00)
Adjusted R^2	0.11	0.11	0.18
Total no. of observations	1,150	1,084	1,150
No. of outliers	--	66	58

Note: Probabilities in brackets.

Table 6 OLS and LTS estimation of growth equations including foreign capital

Dependent Variable: Growth of real GDP per Capita (1997-2005)				
	OLS		LTS	
	(1)	(2)	(3)	(4)
Constant	0.229	0.229	0.207	0.199
	(0.00)	(0.00)	(0.00)	(0.00)
lnGDP per capita$_{1997}$	-0.023	-0.023	-0.021	-0.023
	(0.00)	(0.00)	(0.00)	(0.00)
Hospital Beds/ pop (%)	0.036	0.036	0.018	0.042
	(0.00)	(0.00)	(0.00)	(0.00)
Secondary Enrolment / pop (%)	0.001	0.000	0.001	0.001
	(0.58)	(0.58)	(0.05)	(0.16)
Primary GDP/total GDP (%)	-0.001	-0.001	-0.001	-0.0002
	(0.00)	(0.00)	(0.00)	(0.01)
Secondary GDP/total GDP (%)	0.001	0.001	0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Coast	0.001	0.001	-0.002	0.001
	(0.71)	(0.70)	(0.39)	(0.75)
Central	-0.001	-0.001	-0.003	-0.004
	(0.61)	(0.61)	(0.05)	(0.03)
Seaports		-0.002		0.018
		(0.81)		(0.01)
Airports		0.000		0.001
		(0.91)		(0.80)
Adjusted R^2	0.12	0.12	0.17	0.17
Total no. of observations	2,199	2,199	2,105	2,106
No. of outliers	--	--	94	93

Note: Probabilities in brackets. Western China is base region for 'three-belt' geography dummies.

Table 7 OLS and LTS estimation of growth equations including foreign capital

Dependent Variable: Growth of real GDP per Capita (1997-2005)		
	OLS	LTS
Constant	0.240 (0.00)	0.177 (0.00)
lnGDP per capita$_{1997}$	-0.024 (0.00)	-0.020 (0.00)
Hospital Beds / pop	0.015 (0.07)	0.006 (0.39)
Enrolment Sec/ pop (%)	0.000 (0.76)	0.001 (0.27)
Utilised Foreign Cap/ GDP (%)	0.022 (0.08)	0.136 (0.00)
Primary GDP/total GDP (%)	-0.001 (0.00)	0.000 (0.13)
Secondary GDP/total GDP (%)	0.001 (0.00)	0.001 (0.00)
Seaports	-0.002 (0.79)	0.015 (0.02)
Airports	0.003 (0.47)	0.001 (0.77)
Adjusted R^2	0.11	0.17
Total no. of observations	1,150	1,074
No. dropped due to LTS	--	76

Note: Probabilities in brackets.

The econometric evidence provided in Tables 4-7 offers a number of insights into the determinants of county- and city-level regional growth over the 1997-2005 period. First, there is strong evidence across all estimators and specifications that a convergence process occurred during the 1997-2005 period.[21] The OLS, LTS and BIF estimates of the *lnGDP per capita*$_{1997}$ coefficient are between -0.015 and -0.023 in each specification, indicating a speed of convergence of approximately 2% per annum.[22] R^2 for our specifications is quite low, ranging from 0.11-0.18. This, however, is common in studies estimating cross-sectional growth equations for Chinese regions. Jones et al (2003, pp. 194-197), for example, report R^2 values of 0.12-0.22. Second, hospital beds per capita appears to be positively significant in the majority of specifications - replicating the contribution of infrastructure networks in the regional growth process. The secondary-level education enrolment rate,

[21] When using the LTS estimator, it is important to examine the observations identified as outliers. Inspection of the outliers reveals that they are not concentrated in one region. The western provinces of Shaanxi, Gansu, and Xinjiang do contain outliers, but no more than the central regions of Inner Mongolia, Shanxi, and Heilongjiang. The coastal provinces of Jiangsu, Guangdong, and Hebei also produce outliers. A complete list of outliers for each LTS specification is available from the authors on request.

[22] The LTS and BIF estimators identify a similar set of outliers, as evidenced by their correlation coefficient of 0.7. The BIF outliers are detected using the Studentized Residuals method. See Judge et al (1988) for a summary of outlier detection methods.

however, does not yield a significant coefficient in the majority of specifications. This suggests that, in the Chinese case, further analysis may be required in order to identify the channels through which secondary-level education contributes to the economic performance of the district where the secondary-level education was actually obtained. The positive significant estimates for utilised foreign capital are as one would expect, reflecting the investment-led nature of Chinese regional economic growth in the 1997-2005 period. Regarding the issue of industry composition, it appears that a propensity for secondary GDP production exerts a positive influence on the growth of county- and city-level districts, while being an intensive producer of primary GDP exerts a negative influence.

The dummy variables included in our regression specifications offer insights into the influence of geographic location and the importance of proximity to transport facilities in China's regional growth process. The inclusion of airport and seaport dummies allows us to distinguish between passenger flows, on one hand, and imports and exports of raw materials and finished goods, on the other. As illustrated in Figures 8 and 9, China's geography dictates that its seaports are located exclusively on the eastern and southeastern coasts. Its airports appear to be spread across the entire mainland, though there is clearly a higher concentration in the coastal and central regions. All the airports catering for passenger flows exceeding 1.5 million are located close to major seaports on the coast, while all airports catering for 1-1.5 million passengers are located either in the coastal or western provinces. According to the coefficients estimated in Tables 6 and 7, it is the seaport dummy that is the influential one in terms of regional growth during the 1997-2005 period, at least in our LTS regressions. This dummy variable may capture the role of China's massive intake of raw materials, coupled with its surging export outflow in the last decade, as a key driver of its economic success. The insignificance of the airport dummy in Tables 6 and 7 may be related. Inflows and outflows of passengers through regional airports may not have fuelled China's regional growth to anything near the extent of its seaports.

The dummy variables indicating whether districts are within the western, central, or coastal belts of China appear to be broadly indicative of a convergence process. Relative to the western belt (the base region), estimated coefficients for the central belt are negatively significant, while estimated coefficients for the coast do not appear to be significant. This suggests that the western regions, perceived generally as lagging behind in terms of growth, experienced faster growth than their central counterparts and a rate of growth not significantly different from that of coastal districts. This western catch-up occurs in spite of the coast's many economic advantages, such as preferential economic policies enjoyed by the coast's Special Economic Zones and its prime location for international trade. This finding lends further support to the impression created by Figures 3 and 4 that pockets of high growth are not confined to coastal region, but permeate the entirety of mainland China.

6 Conclusions

Having employed an array of complementary techniques to analyse the development of Chinese county- and city-level real GDP per capita in the 1997-2005 period, it remains for us to collect the various findings and identify any coherent trends that may emerge. The opening salvo of this paper is the observation that much of the existing literature investigating Chinese regional growth has focused on large geographic units which are not suitable for that purpose. This paper introduces a new dataset comprising of county- and city-level data that spans the entirety of mainland China over the 1997-2005 period. In this way we hope to uncover the stylised facts of Chinese regional growth dynamics, which will be of use to policymakers and academics alike. The colour-coded maps of Section 3 provide a vivid illustration of the enhanced level of detail available when one moves from provincial-level data to county- and city-level data: in comparing growth performance of large geographic units, such as provinces, to that of the districts comprising those units; the full extent of cross-province disparities in GDP per capita becomes patently clear. What is more, it becomes clear that pockets of high GDP per capita districts permeate the entirety of mainland China rather than being confined to a certain 'belt' or province. We delve further into this county- and city-level disaggregation by ascertaining the evolution of the entire cross-sectional GDP per capita distribution using non-parametric kernel density estimation. Visual inspection indicates that the distribution is characterised by outliers in the upper-value tail and a main body of districts which exhibit real GDP per capita growth over the 1997-2005 period. In order to track the dynamics of each individual district over time we rely on the transition probability matrix technique and the associated stochastic kernel estimations. What emerges from this exercise is a picture of relatively static districts at both tails of the distribution, but a robust potential for movement among districts in the middle of the distribution. In light of this fluidity in the middle of the distribution, we ask the question: is there evidence of a convergence process at work across Chinese county- and city-level districts? This question is answered unequivocally in the affirmative with the conditional β-convergence regressions of Section 5. Our OLS, LTS, and BIF linear regressions of average county- and city-level GDP per capita growth on initial log GDP per capita, and a set of explanatory variables, yield estimates of the log GDP per capita coefficient between -0.015 and -0.023 in each specification. This indicates a speed of convergence of approximately 2% per annum.

The explanatory variables included in our conditional β-convergence regressions offer an opportunity to pinpoint influential factors in the regional growth process. The significance of hospital beds per capita, which captures disparities in the infrastructure network at district level, is supportive of findings from provincial-level studies. The insignificance of secondary-level education enrolment, on the other hand, may come as a surprise, but it does raise questions regarding the ability of a given district to capture the benefits of secondary-level education provided by that district. The significance of utilised foreign capital in the regional growth process comes as no surprise given the concerted efforts of China's policymakers to attract FDI inflows. The fact that the proportion of secondary industry GDP that a district generates positively influences its growth rate may indicate that secondary industry-intensive districts have proved to be the more fertile locations for these investment inflows, while districts predominantly dependent on the primary sector (represented by primary GDP in our regression specifications) get left behind. Geographic location has long been regarded as a key factor in the regional growth process. The set of dummy variables we constructed appears to confirm this finding in the case of Chinese county- and city-level districts. The inclusion of airport and seaport dummies allows us to distinguish between passenger flows, on one hand, and imports and exports of raw materials and finished goods, on the other. Given China's massive intake of raw materials, coupled with its surging export outflows, it is understandable that the seaport dummy appears to be the more influential one for the 1997-2005 period. The West-Central-Coastal dummy variables appear to be broadly indicative of a convergence process. Relative to the western belt (base region), estimated coefficients for the central belt are negatively significant, while estimated coefficients for the coast do not appear to be significant. This suggests that the western regions, perceived generally as lagging behind in terms of growth, experienced faster growth than their central counterparts and a rate of growth not significantly different from that of the coastal districts.

Taken as a whole, these findings provide ample food for thought for Chinese policymakers. At the time of writing, there appears to be a cohort of districts that are persistently poor, a core of districts whose ability to generate GDP per capita growth seems to be variable, and a clique of affluent districts. That said, there does appear to be a catching-up process at work across districts. What is more, pockets of high growth districts appear to be spread across the whole of mainland China. Further good news is the strong performance of some western and central districts in the 1997-2005 period. Having set out the current state of affairs as regards Chinese districts, the gauntlet is now passed to the policy-makers: after years of preferential economic policies for the chosen regions and neglect of the rest, can the fledgling catch-up process identified in this paper be properly cultivated?

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Bank of Finland
BOFIT – Institute for Economies in Transition
PO Box 160
FIN-00101 Helsinki

☎ + 358 10 831 2268
bofit@bof.fi
http://www.bof.fi/bofit