REGIONAL INCOME INEQUALITY AND URBANISATION TRENDS IN CHINA: 1978-2005

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Abstract - *A long-standing economic literature has delivered rich empirical evidence on the relationship between economic growth and income inequality or urbanisation, since Simon Kuznets' pioneering work on the inverted U curve hypothesis. This paper explores the relationship between urban inequality and urbanisation trends in China from 1978 to 2005, a period that corresponds to the economic opening up of the country to the market economy. One of the main issues, here, is not only to test the correlation between regional income inequality and urbanisation trends, but also to highlight the neighbouring effects of this correlation, mainly through the use of some new spatial analysis tools. This paper delivers two conclusions: firstly, neighbouring effects are stronger when it comes to income inequality than urbanisation; secondly, a distortion in development patterns, between northern and southern coastal China appears: in the first one, growth effects and urbanisation process spread all over the different provinces, while in the second one, Guangdong appears as a regional economic centre.*

Key-words: INCOME INEQUALITY, URBANISATION, CHINA, SPATIAL CLUSTERING.

JEL Classification: R12, 015, 053

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1. ECONOMIC GROWTH AND INCOME INEQUALITY: A THEORETICAL FRAMEWORK

The debate on economic development and inequality was firstly introduced by Kuznets (1955) who provided a theoretical framework suggesting that the relationship between a country's economic growth and income inequality followed an inverted-U curve pattern. According to Kuznets, in early stages of industrial development, the inequality of incomes tends to grow, since wages remain low in order to support the accumulation of capital; once a certain level of industrialisation has been achieved, higher wages and the distribution of profits lead to a decrease in income inequalities.

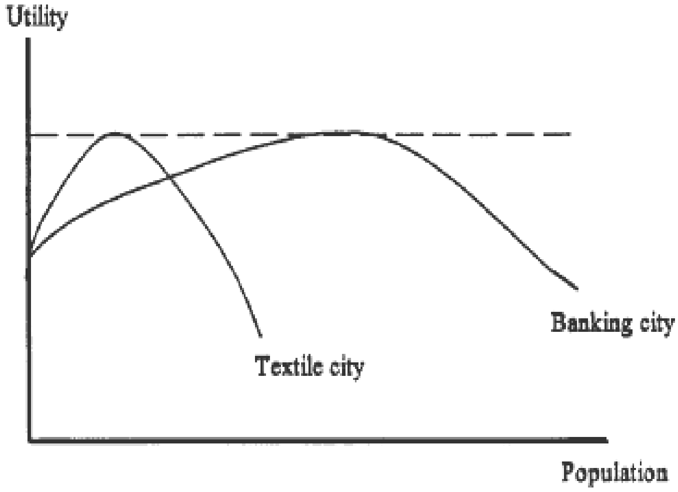
Williamson (1965) adapted the inverted-U curve hypothesis to regional economics, by considering that regional inequalities change according to the general level of a country's development. Williamson's analysis was followed by an important empirical literature (Amos, 1988; Coughlin and Mandelbaum, 1988; Barro and Sala-I-Martin, 1991; Quah, 1993; Fan and Casetti, 1994; Armstrong, 1995; Petrakos and al., 2003). Some of these studies have, more particularly, focused on the relationship between urban concentration and per capita income or utility.

In a pioneering work, Henderson (1974) considered that the relationship between the size of a city and a representative resident' utility can also be described by an inverted-U curve, characterised by a trade-off between city-size and welfare, due to the tension between positive and negative externalities of agglomeration. In Henderson's assumption, this leads to an optimum size city which, as he recognizes, is not quite easy to observe. In order to produce a multiple-size cities' landscape, Henderson needs to relax many restrictive hypotheses of his initial model, by admitting that positive externalities tend to be specific to particular industries, while negative externalities depend on the overall size of a city, whatever it produces. This leads to two consequences: firstly, if agglomeration diseconomies, mainly due to congestion and high costs of commuting, depend only upon city-size, there is no real reason why different industries should locate within the same city; secondly, if cities are specialised in a single production, one can assume that the extent of the external economies, which characterise each city's productive specialisation, is different. The optimal size of a city thus depends on the specialisation patterns of its productive system (Henderson, 1974; Krugman, 1996), as shown in figure 1.

In Henderson's model, the nature of external economies and diseconomies of agglomeration depend upon technology, communication and exchange, which corresponds, by certain means, to the general level of development. One can, therefore, assume that the optimal size of cities changes with respect to a country's development patterns.

Following Henderson's early work, Rosen and Resnick (1980) argue that, in a general way, developing regions feature transitional urban dynamics: urban concentration characterises the first stages of economic development under the pressure of external economies of agglomeration and rural-urban migration, while demographical dispersion appears within more developed countries. MacKellar and Vining (1995) introduced a relationship between urbanisation and the level of per capita income. By actualising Wheaton and Shishido's (1981) work, they produce evidence that most countries feature a 5,000$ per capita income trade-off point, above which urbanisation trends change. More recently, Junius (1999) explored the hypothesis of an inverted U curve relationship between economic development and urban primacy.

Figure 1. Henderson's model

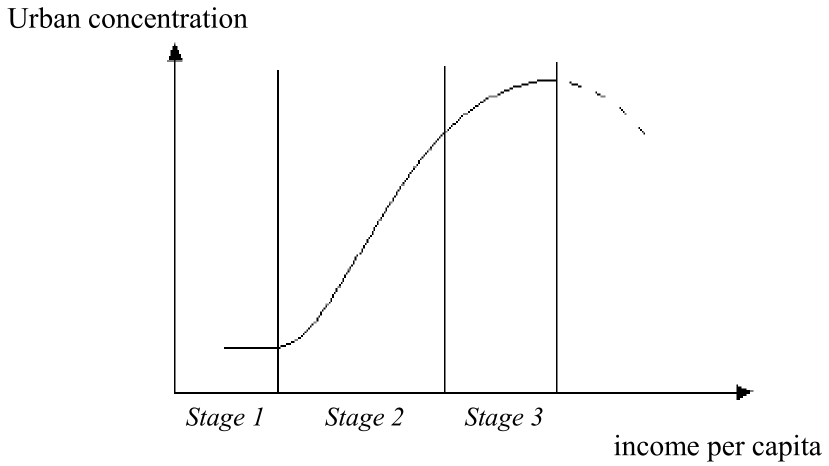


Finally, when it comes to developing countries, Catin and Van Huffel (2003) and Catin and Ghio (2004) examine a three-stage development model with regards to urbanisation dynamics that confirm the inverted-U hypothesis: the first stage features a pre-industrial economy, with low income per capita and weak urbanisation; the second stage corresponds to an industrial take-off, characterised by economic polarisation and urban concentration; finally during the third stage, the production of high-technology goods replaces labour-intensive industry. This results in slowing down, and then reversing, the urban concentration process (see figure 2).

Closely related to the inverted-U curve approaches, Janikas and Rey (2005) identify a recent strand of economic literature that explores the spatial dimension of inequality within regional systems (Rey and Montouri, 1998; Fujita and Hu, 2001; Azzoni, 2001). The methodology used here is to partition the regional units into exhaustive and mutually exclusive groupings and then decompose the total inequality into two parts: the first one is due to inequality internal to the partitions; the second to inequality across the partitions.

What makes these approaches attractive is the fact that they introduce spatial heterogeneity by admitting the existence of forms of spatial interaction leading to clustering (Anselin and Rey, 1991). Clustering can either be the result of spillovers effects from one region (or city) to another or may be due to similarities between regions (or cities) owing to exogenous factors such as climate, institutions, technologies (Abreu and al., 2005). Recent findings in exploratory spatial analysis and spatial econometrics (Anselin, 1995; Anselin and Florax, 1995; Le Gallo, 2004; Dallerba and Le Gallo, 2005; Ertur and Koch, 2005) have boosted the production of empirical evidence on spatial dependency and clustering, within the general study of regional inequalities.

Figure 2. The inverted-U shape and the stages of development



By using some of these analytical tools, this paper aims to examine the relationship between regional income inequality and urbanisation in China, using data from 1978 to 2005, in order to investigate the spatial patterns of the inverted-U curve hypothesis. This period corresponds to the progressive opening up of China to the market economy.

One should note that an important empirical literature has explored these issues, over the last few years. Firstly, numerous studies have focused on the patterns of inter-provincial inequality in China, and tried to identify the contributing factors for cross provincial variations of income growth (Lyons, 1991; Tsui, 1991 and 1996; Chen and Fleisher, 1996; Kanbur and Zhang, 1998; Demurger, 2001; Fujita and Hu, 2001; Yao and Zhang, 2001; Zhang and al., 2004; Fu, 2004; Aroca, Guo and Hewings, 2006) Most of these studies have shown that income disparity between the inland and the coastal provinces have been increasing since the beginning of economic reforms and the progressive opening of China to the global economy.

Secondly, some other studies have drawn attention to urbanisation patterns and city-growth dynamics in China, during these two last decades. They stressed the fact that the rapid urbanisation process, that has accompanied economic growth, was essentially generated by the emergence of new medium-size cities, rather than large conglomerations, due to restrictive migratory policies, best known as the *Hukou* system (Chen, 1991; Chan, 2000; Wu, 2002;

Zhao and al., 2003; Anderson and Ge, 2005; Au and Henderson, 2006; Dimou and Schaffar, 2007; Chen and Fu, 2007; Henderson and Wang, 2007).

Thirdly, many authors have examined the links between China's urbanisation and per capita GDP growth, producing numerous models that test more or less successively the 'S-shape' relationship introduced by Northam (1975), the political variables that affect urbanisation and the role of centrally controlled migration flows (Zhang, 2002; Davis and Henderson, 2003; Chang and Brada, 2006).

Very few studies, however, attempt to investigate the way spatial interaction affects the relationship between the urbanisation process and regional GDP or income inequality. By focusing on the spatial structure of the relationship between the two aggregates, this paper shows that while China appears to be in the second stage of economic development, which features a general trend of economic polarisation and urban concentration, its coastal region has reached the third stage, where high-technology activities replace older labour-intensive industries in the most important economic centres, while the latter re-localise on the new peripheral urban areas of these centres. The spread of economic growth goes from the most developed provinces to their immediate neighbours, where new cities appear.

Sections 2 and 3 recall the characteristics of China's regional disparities, during the 1978-2005 period, with respect to the issues that matter in our analysis, i.e. urbanisation and income inequality. Section 2 produces a rank-size model, allowing one to observe the growing importance of medium-size cities in China's urban landscape. Section 3 applies the Theil index in order to measure the evolution of the disparities in per capita income within and between the coastal and the inland regions. Section 4 delivers a non-linear 'S-shaped' specification model, exploring the possible relationship between income inequality and urbanisation. Section 5 examines the relationship between these two figures, on the one hand, and spatial clustering, on the other hand. Finally section 6 is made up of the conclusion.

The data are provided by China's Statistical Yearbooks, the 1985, 1990 and 1999 census and the University of Michigan's database, which is directly related to China's Statistical Office. From a statistical point of view, the main problems that have occurred concern the provinces of Hainan and Chongqing, which were created by splitting from Guangdong and Sichuan in 1985 and 1996 respectively. We have managed to isolate data for the first one during the reference period of our study, but we have included the second one in the Sichuan statistics, so we work on 29 provinces instead of 30.

Finally, from a methodological point of view, some studies (Catin, Luo and Van Huffel, 2005) prefer separating China into three or more large groupings (coastal, intermediate and inland), when it comes issues related to regional disparities. In this paper, we keep the dichotomous coastal/inland approach as it reveals stronger spatial dependence between the provinces.

2. THE EVOLUTION OF CHINA'S REGIONAL URBANISATION TRENDS: 1978-2005

China's urbanisation process mainly took place during the 1990s, with the appearance of coastal-inland disparities. Table 2 provides some information about urbanisation in Chinese provinces in 1978, 1993 and 2005. The first date corresponds to the beginning of the early economic reforms' period, when agricultural development was the engine of the country's economic growth, with the *Hukou* system still on – this system involved restrictions on migration movements, with an internal passport system, where each inhabitant registered as a 'citizen' in his province and district (Chan, 2000). The second date is characterised by new accelerated economic reforms which initiated export-orientated industrial development, mainly for coastal regions (Fujita and Hu, 2001). In 1993, China already featured the highest rate of attraction of foreign direct investment (FDI) among developing countries. This year witnessed a relaxation of the Hukou rules, allowing more migratory movements within each province, mainly from rural to urban areas, but still severely limiting migrations across provinces. Until 1990, only 20.7% of internal migrations take place between provinces (most often concerning 'immigrant workers', travelling from the inland to the coastal regions). After the reforms of 1993, movements from the inland to the coastal regions increased, even though the anti-mega-cities policies pursued. Finally, the last date corresponds to the most recent situation.

Table 1 shows that in 1978, except for Shanghai, Beijing and Tianjin, most provinces had low urbanisation rates. Northern provinces are historically more urbanised than the southern rice-producer ones, characterised by important rural population. When one compares the 2005 to the 1978 distribution, two main changes appear. Firstly, contrary to what happened in 1978, the provinces in the eastern and coastal region rank much higher in the distribution: in 2005, the first eight most urbanised provinces belonged to this region, while the eleven less urbanised provinces belonged to the inland region. Secondly, the disparities between provinces tend to increase, with three groups of provinces appearing: the upper group features urbanisation rates above 40%, against under 25 % for the lower one.

These results should be compared with the ones obtained by the study of the Chinese city-size distribution, during the same period. By using Gabaix and Ibragimov's (2006) OLS specification, in order to correct the bias that appears when one uses small finite samples (Dimou and Schaffar, 2007b), we estimate the Pareto exponent for the rank-size distribution of the Chinese cities from 1980 to 2000, then we split the distribution in coastal and inland provinces :

$\ln(R_j - \theta) = \alpha - \beta \ln T_j$ where θ equals ½

with the asymptotic standard deviation of the estimator β equal to $\beta\sqrt{\frac{2}{n}}$.

Table 1. China's Provinces Urbanisation Rates

Province	Urbanisation rate 1978	Urbanisation rate 1993	Changes in rank 1993/1978	Urbanisation rate 2005	Changes in rank 2005/1993
Shanghai	0,587	0,679	(-)	0,845	(-)
Beijing	0,536	0,583	(-)	0,745	(-)
Tianjin	0,495	0,563	(-)	0,599	(-)
Guangdong	0,200	0,300	(+2)	0,517	(+5)
Liaoning	0,317	0,428	(+1)	0,485	(-1)
Heilongjiang	0,353	0,422	(-1)	0,484	(-1)
Jilin	0,307	0,398	(-)	0,452	(-1)
Jiangsu	0,125	0,218	(+4)	0,433	(+7)
Xinjiang	0,270	0,335	(-)	0,427	(-2)
Hubei	0,146	0,232	(+2)	0,399	(+3)
In. Mongolia	0,254	0,311	(+1)	0,398	(-3)
Hainan	0,146	0,218	(-)	0,383	(+2)
Ningxia	0,172	0,242	(-)	0,359	(-1)
Shandong	0,088	0,205	(+12)	0,342	(+2)
Fujian	0,137	0,171	(-2)	0,314	(+4)
Shanxi	0,260	0,269	(-3)	0,301	(-5)
Qinghai	0,240	0,274	(-)	0,301	(-7)
Zhejiang	0,114	0,169	(-)	0,275	(+2)
Hebei	0,109	0,153	(-1)	0,269	(+5)
Jiangxi	0,144	0,189	(-2)	0,258	(-2)
Shaanxi	0,147	0,193	(-4)	0,253	(-4)
Hunan	0,107	0,159	(+2)	0,234	(+1)
Gansu	0,133	0,167	(-3)	0,234	(-2)
Sichuan	0,111	0,147	(-3)	0,233	(+1)
Henan	0,081	0,136	(+2)	0,212	(+2)
Anhui	0,107	0,162	(+2)	0,210	(-4)
Guangxi	0,106	0,144	(-)	0,186	(-1)
Yunnan	0,105	0,127	(-1)	0,164	(-)
Guizhou	0,114	0,125	(-8)	0,158	(-)

Between brackets the changes in the rank of such province.
Data: China Statistical Yearbook.

Table 2 gives the results of the regression for the 1980, 1990 and 2000 samples of the 250 largest Chinese cities. One can see that the Pareto exponent increases steadily during this period for the entire distribution (from 1.109 in 1980 to 1.282 in 2000), which shows the growing importance of medium-size cities. This confirms Au and Henderson (2006) and Henderson and Wang's (2007) conclusions (but differs slightly from the findings of Anderson and Ge, 2005, for the end of the period), according to which the Chinese urban system is characterised by the lowest ratio (0.072) between the metropolitan and the total population (international average: 0.27) and the highest rate of medium-size cities in the world.

Table 2. Changes in the rank size distribution of Chinese cities (1980-2000)

Year	China	Coastal Region	Inland Region
1980	1.109 (0.135)	1.013 (0.176)	1.159 (0,200)
1990	1,239 (0.115)	1.173 (0.152)	1.267 (0.168)
2000	1.282 (0.118)	1.356 (0.174)	1.284 (0.170)

Standard deviation between brackets.
Data: Chinese Urban Statistical Yearbooks.

When studying separately the coastal and the inland regions, it is obvious that both subsets follow the same trend as the national city-size distribution. However, this evolution is much more marked for the coastal region where the Pareto exponent increased from β_c=1.013 in 1980 to 1.356 in 2000 (compared to β_i =1.159 in 1980 and 1.284 in 2000 for the inland region). This particular urban landscape depends heavily upon the Chinese government's migration policies; however, it also leads one to assume the hypothesis that within the coastal provinces, economic and demographic growth spreads towards new industrial locations and emerging medium size cities.

One should note that in some recent research, Le Gallo and Chasco (2008) find evidence for spatial autocorrelation and heterogeneity, when using an OLS regression on city-size distribution. These quite interesting aspects are not, however, examined in this paper.

3. MEASURING CHINA'S REGIONAL DISPARITIES : COASTAL vs INLAND PROVINCES

As some authors have pointed out (Dimou and Schaffar, 2007), China's urban population increased at an astonishing pace: from 15.1% of the population in 1960, it shot up to 26.4% in 1990 and to 42.6% in 2005. It practically doubled over the last two decades, propelling China out of the group of least-urbanised countries (Zhao, Chan and Sit, 2003) and into the intermediate group – still far from the industrialised countries, but with a constantly reducing gap. The increase in GDP per capita is ever more impressive, as it was multiplied by six, from 1978 to 2005. China's per capita GDP annual growth rate stood at 7.9% during the 1978-1989 period, 9.9% from 1989 to 1999 and 7.5% from 1999 to 2005.

Table 3. Urbanisation and GDP per capita (1996 PPP$)

Year	Urban population as % of total	GDP per capita (1996 PPP$)
1978	17.92	700.092
1985	23.71	1143.08
1990	26.41	1611.73
1995	29.04	2743.94
2000	36.22	3719.63
2005	42.65	4875.87

Source: Chang and Brada, 2006.

Table 3 provides some information about the evolution of urbanisation and per capita GDP, from 1978 to 2005, which can be seen as a direct consequence of China's opening policies.

By the end of the 1990s, with a per capita GDP of 4020 $ (in 2001 PPP$) and a growing urbanisation, China still seems to follow an upward trend in the inverted-U curve of figure 2. However, regional disparities are high. In order to measure the evolution of these disparities, the Theil index provides useful information. The Theil index can be defined as follows (Theil, 1967; Shorrocks, 1984; Jayet, 1993; Janikas and Rey, 2005; Combes, Mayer and Thisse, 2006):

$$T = \ln n - \sum_{i=1}^{n} \frac{x_i}{n\mu} \ln\left(\frac{n\mu}{x_i}\right) \Rightarrow T = \frac{1}{n}\sum_{i=1}^{n} \frac{x_i}{\mu} \ln \frac{x_i}{\mu}$$

from which one can derive:

$$T = \sum_{i=1}^{n} \frac{x_i}{n\mu} \ln\left(\frac{x_i}{\mu}\right)$$, where $n\mu = X$ is the sum of the x_i

with x_i an individual i's income (i = 1,2,3,….n), μ the average of the observed incomes and α an entropy parameter which measures the distance between incomes in different parts of the distribution. Theil's index is bounded by 0, when all incomes are equal, and ln*n*, when all incomes equal 0, except one ($0 \prec \alpha \prec +\infty$). An infinitesimal transfer dh from an individual *m* with high income to an individual *j* with low income involves a reduction dT of the index given by:

$$dT = \frac{dh}{n}\left(\ln \frac{y_m}{\mu} - \ln \frac{y_j}{\mu}\right) \prec 0$$

Like all entropy indicators, Theil's index has a useful property of 'additive decomposability'. Considering that the observed population can be decomposed into *k* distinct classes (for example regions), Theil's index takes the following form:

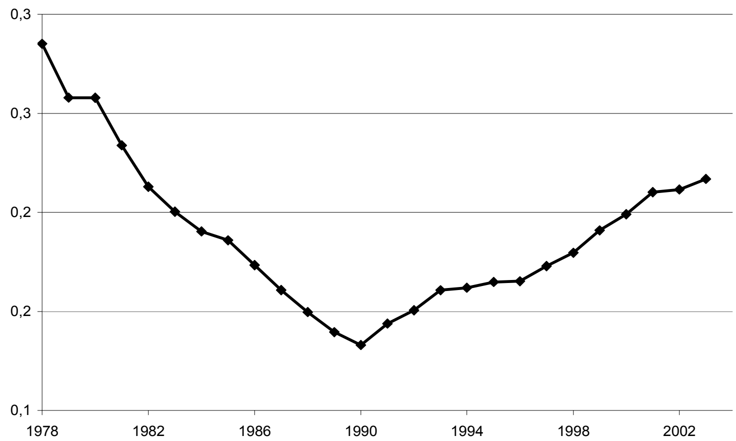
$$T = \underbrace{\sum_{g=1}^{k} \left[\frac{n_g}{n} \cdot \frac{\mu_g}{\mu} \cdot \ln\left(\frac{\mu_g}{\mu} \right) \right]}_{Between\,Theil} + \underbrace{\sum_{g=1}^{k} \left[\frac{n_g}{n} \cdot \frac{\mu_g}{\mu} \cdot \sum_{i=1}^{ng} \frac{x_i}{n_g \mu_g} \cdot \ln\left(\frac{x_i}{\mu_g} \right) \right]}_{Within\,Theil}$$

The first term (Between Theil) is a cross-class term and shows the disparities between regions. The second one (Within Theil) is an in-class term and measures the extent of inequalities within each region. The global Theil's index is given by the sum of the two terms:

$$T_{global} = T_{BT} + T_{WT}$$

When applied to the Chinese distribution of per capita income, Theil's index produces two interesting results. Firstly, as one can see in Figure 3, the global Theil features a double trend: a drop from 1978 to 1990, followed by a rise from 1990 to 2005, albeit with a levelling off since 2000. According to Fujita and Hu's (2001), the 1990 inflexion point shows the transition from a decade when the agricultural sector fuelled Chinese economic growth (and regional disparities lessen) to a period, characterised by industrial development and economic liberalisation (with regional disparities increasing).

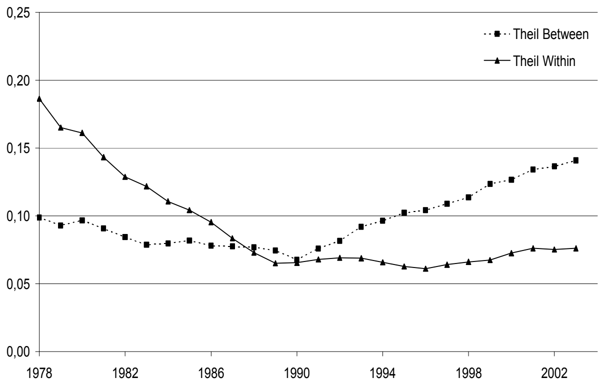
Figure 3. The evolution of the global Theil's index measuring regional disparity in per capita income (1978-2005)

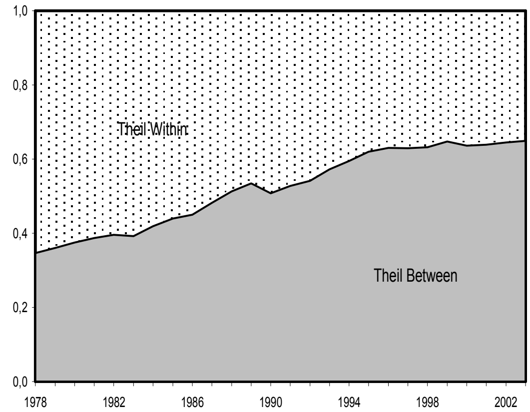


Data: Chinese Statistical Yearbooks.

Secondly, one can decompose Theil's index into $T_{between}$, representing the disparities between coastal and inland provinces, and T_{within}, which represents the disparities within each group of provinces. The study of the two indices shows that the $T_{between}$, which is fairly stable until 1990, increased between 1990 and 2000, before levelling off in recent years. The T_{within} dropped steadily from 1978 to 1996, then picked up slightly until 2005 (Figure 4a). These changes reveal significant and opposite trends of the shares of $T_{between}$ (from 0.23 in 1978 to 0.60 in 2005) and T_{within} (from 0.77 in 1978 to 0.40 in 2005) in the global Theil's index (Figure 4b).

Figures 4a/4b. Evolution and shares of $T_{between}$ and T_{within} in the global Theil's index





Fujita and Hu (2001) argue that despite divergences between coastal and inland provinces, there is a convergence process for per capita GDP within each of the two regions. Our findings confirm this analysis. As assumed by Catin and Van Huffel (2004), the coastal region seems closer to Stage 3 characteristics: Shanghai, where the average income per capita is 6.1 times as high as the average national level, Beijing and Tianjin (where the above ratio is of 2.5), Jiangsu, Zhejiang and Guangdong (with a ratio of 1.7), all are provinces where economic development is much higher than the rest of the country (Catin, Luo and Van Huffel, 2005). However, the increasing disparities between coastal and inland provinces have progressively become a source of social unrest within the latter in recent years.

4. AN S-SHAPED MODEL FOR URBANISATION AND PER CAPITA INCOME GROWTH

The study of the relationship between urbanisation and per capita GDP growth was initiated by Chenery and Syrquin's (1975) original work. The two authors claimed that there is a positive correlation between per capita income and urbanisation; however this correlation diminishes uniformly, when per capita income grows. Northam (1975) and more recently Davis and Henderson (2003) tested the 'S-shaped' relationship between urbanisation and income growth, in order to confirm or infirm Chenery and Syrquin's assumption, but reached diverging conclusions. Moomaw and Shatter (1996) founded a positive correlation between urbanisation and industrialisation, international opening and liberalisation, while Davis and Henderson (2003) proved that urbanisation was also correlated to some political variables designing the country's degree of democracy.

By applying different non-linear models to Chinese regional time series data, Li and Chen (2001) and Chang and Brada (2006) provide evidence of an urbanisation gap in China, when compared to other countries with similar level of income per capita. However, their conclusions diverge when it comes to the long-term trends of Chinese urbanisation, as Li and Chen consider that this gap has increased over the last years, while Chang and Brada assume that it has diminished since the beginning of economic reforms.

We measure the relationship between regional urbanisation processes and per capita income growth, by applying a popular non-linear 'S-shaped' specification model (Taylor and Martin, 2001; Chang and Brada, 2006) on Chinese provincial data, from 1978 to 2005:

$$URBANPOP_{i,t} = \frac{1}{1 + a_0 e^{-\rho(IPC_{i,t} - C)}} + \varepsilon_{i,t}$$

with *URBANPOP* the urbanisation rate of each province *i* in year t, and *IPC* its per capita income. We have run three regressions, one for the whole sample of the 29 provinces from 1978 to 2005 and one for each sub-region (coastal/inland). Results appear in Table 4.

The positive relationship between income per capita and urbanisation rate seems stronger within the coastal provinces which feature higher income per capita rather than the inland ones. This goes against Chenery and Syrquin's assumption, even though Feng and Li (2006) argue that when per capita income level is lower than 1600 PPP$, the relationship between the two aggregates is rather loose. It is only above this threshold – but below 25000 PPP$ – that it becomes progressively stronger. These findings confirm that the industrialisation and urbanisation processes in China are strictly linked, throughout the two decades that followed the beginning of the reforms in favour of a market-oriented economy.

Table 4. The relationship between provincial urbanisation and per capita income growth in China (1978-2005)

	All China	Coastal Region	Inland Region
ρ	0.0650 (7.575)	0.0830 (4.601)	0.0424 (5.629)
Stand. error	0.009	0.018	0.008
Adj. R^2	0.436	0.430	0.375

Student T between brackets.
Data: Chinese Urban Statistical Yearbooks.

One must, now, answer the question raised by the spatial implications of this relationship. Does it lead to spatial clustering or not and, if this is the case, how do spatial interaction processes appear?

5. THE SPATIAL STRUCTURE OF URBANISATION AND INCOME INEQUALITY IN CHINA

This section focuses on the spatial structure of the urbanisation process and per capita income regional disparities. The study of spatial auto-correlation allows one to quantify the spatial regularity of different economic phenomena and even to determine the range of spatial dependence.

Moran's index *I* is one of the most popular tools of spatial analysis. It can be defined in the following way:

$$I = \frac{N}{S} \cdot \frac{\sum_i \sum_j w_{ij} (x_i - \mu)(x_j - \mu)}{\sum_i (x_i - \mu)^2}$$

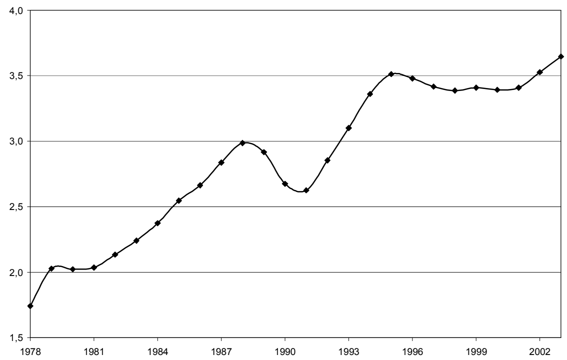
with N the number of provinces, x_i the observation in province *i*, x_j the observation in province *j*, and w_{ij} an element of the binary spatial weight matrix. The weight matrix W used here is a normalised simple contiguity matrix: w_{ij} equals 1 if $i \neq j$ and if province *i* neighbours province *j*, equals to 0 otherwise (Anselin and Bera, 1998).

Moran's *I* is not strictly restricted to the interval [-1, +1], even if this is most often the case, and a value of zero does not necessarily mean a total absence of spatial auto-correlation (Getis and Ord, 1992). However, in a general way, a lower value of the expected value E[*I*] for Moran's index indicates a negative spatial auto-correlation, while a higher value indicates a positive auto-correlation.

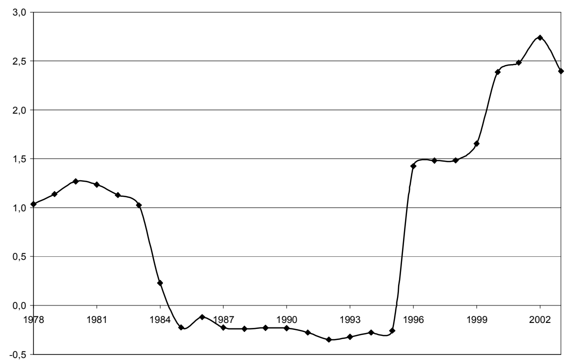
Using normalised *I*s, figure 5a shows quite clearly that from 1978 to 2005, increasing spatial auto-correlation characterised the Chinese provinces' economic growth. This is also confirmed by Aroca, Guo and Hewings (2006) in their study for spatial convergence in China from 1952 to 1999. The trends are less marked when it comes to urbanisation (figure 5b), as Moran's *I* values are close to 0 until 1997; after this date, they increase in a more subsequent way.

Figures 5a/5b. Moran's I for per capita income and urbanisation in China (1978-2005)

Moran's Index – Income per capita



Moran's Index – Urbanisation rate



Along with Moran's index, the Moran scatterplot, suggested by Anselin (1993), allows one to plot a province's per capita income against its 'spatial lag'. The spatial lag can be defined as the weighted average of the incomes of its neighbouring provinces with the weights being obtained from the simple contiguity matrix (Rey and Montouri, 1999). The same analysis goes for a province's urbanisation degree.

Four types of local association between a province and its neighbouring provinces may appear: a province featuring a high value (of per capita income or urbanisation rate), surrounded by provinces with high values (positive spatial associations HH); a province featuring a high value, surrounded by provinces with low values (negative spatial associations HB) ; a province featuring a low value, surrounded by provinces with high values (negative spatial associations BH); and finally, a province featuring a low value, surrounded by provinces with low values (positive spatial associations BB).

Moran's scatterplot allows one to visualise the local forms of spatial auto-correlation and dependence. However, in order to test the appearance of spatial clustering, it is necessary to calculate the local spatial association indicators, best known as *LISA* (*Local Indicator of Spatial Association*) or 'Moran locals'. Anselin (1995) defined the *LISA* of each province *i* as follows:

$$I_i = \frac{(x_i - \mu)}{m_0} \sum_j w_{ij} (x_j - \mu) \quad \text{where} \quad m_0 = \frac{\sum (x_i - \mu)^2}{N}$$

Table 5. LISA statistics for ln income per capita Chinese provinces with Bonferroni adjustment

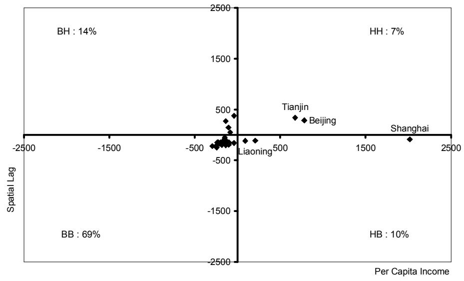
Year	*% of significant statistics*	*% of significant statistics HH*	*% of significant statistics BB*	*% of significant statistics BH*	*% of significant statistics BH*
1978	13,79% (4 provinces)	6,89% (2 provinces)	6,89% (2 provinces)	0 (0 provinces)	0 (0 provinces)
1993	24,14% (7 provinces)	10,33% (3 provinces)	13,79% (4 provinces)	0 (0 provinces)	0 (0 provinces)
2005	34,48% (10 provinces)	17,24% (5 provinces)	17,24% (5 provinces)	0 (0 provinces)	0 (0 provinces)

Table 6: LISA statistics for urbanisation rates Chinese provinces with Bonferroni adjustment

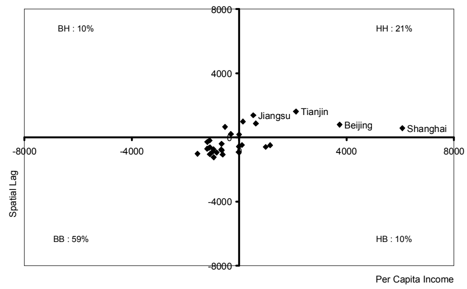
Year	*% of significant statistics*	*% of significant statistics HH*	*% of significant statistics BB*	*% of significant statistics HB*	*% of significant statistics BH*
1978	6,90% (2 provinces)	0 (0 provinces)	0 (0 provinces)	6,90% (2 provinces)	0 (0 provinces)
1993	6,90% (2 provinces)	0 (0 provinces)	0 (0 provinces)	6,90% (2 provinces)	0 (0 provinces)
2005	17,24% (5 provinces)	6,90% (2 provinces)	10,34% (3 provinces)	0 (0 province)	0 (0 provinces)

Figure 6A
Moran I for per capita income

1978



1993



2005

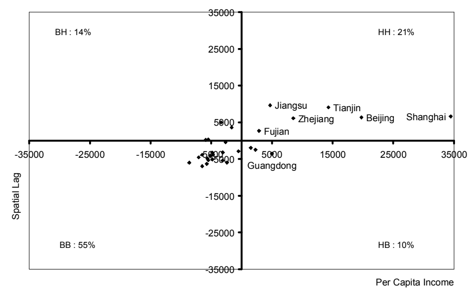
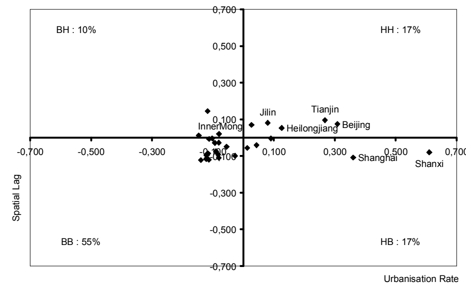
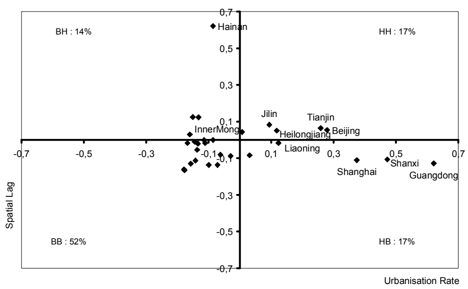


Figure 6B
Moran I for Urbanisation rates

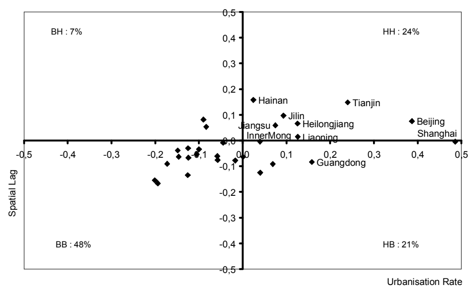
1978



1993



2005



A positive-value LISA indicates a positive spatial auto-correlation, with a grouping of similar values neighbouring the observation under consideration. Conversely, a negative value indicates the absence of spatial clustering. We have run these analytical tools on our data in order to visualise the spatial patterns of income and urbanisation disparities in China, during the reference period of our study. In addition to the sign of the LISA statistics, its magnitude informs on the extent to which neighbouring provinces value differ (Ertur and Koch, 2005). To test whether this difference is significant or not, a Monte Carlo simulation has been conducted. The computation was repeated a 1000 times. The multiple tests are not all independent as some provinces share similar neighbours, so we used the Bonferroni adjustment which amounts to dividing an adjusted significance level $\alpha = 0.05$ by the average number of neighbours in each test (N).

Table 5 provides results for LISA statistics for ln income per capita for 1978, 1993 and 2005. Table 6 provides the same information as Table 5 for urbanisation rates.

Tables 5 and 6 show that during the 1978-2005 period, spatial dependence increased among provinces both for per capita income and urbanisation. However, spatial dependence is stronger for per capita income than for urbanisation. Moreover, while all cases in table 5 concern positive auto-correlation, which confirms spatial clustering, table 6 clearly shows that clustering in urbanisation trends appeared after 1993, when the loosening of migration rules led to the appearance of positive spatial dependence, while before this day, one can only find some cases of negative spatial auto-correlation.

Figures 6A and 6B contain Moran's scatterplots indicating eventual spatial auto-correlation for the different Chinese provinces' level of per capita income and urbanisation, for 1978, 1993 and 2005.

Figure 6A provides a very clear illustration of how the dramatic economic changes of these last twenty years led to spatial instability and clustering. In 1978, 80% of the Chinese provinces are concentrated next to 0, indicating an absence of spatial auto-correlation. The 1992 and 2005 scatterplots show the progressive changes that took place. In 2005, 21% of the Chinese provinces had a higher per capita income than the average national level and were neighbouring provinces equally with a high income. All these provinces are coastal ones. A second clustering appears in the lower left quadrant with almost half of the Chinese provinces featuring lower per capita income while neighbouring other low income provinces. Except for the north-eastern province of Jilin, all these provinces are inland ones.

One can proceed to the same analysis concerning the urbanisation rates. In 1978, isolated highly urbanised provinces appear, with Shanghai, Beijing, the port of Tianjin and the north-eastern provinces of Jilin and Heilongjiang. Twenty five years later, there was a much higher general dispersion in provincial urbanisation rates. However, all the north-eastern coastal provinces, from Heilongjiang down to Shanghai have high urbanisation rates compared to the rest of the country. On the opposite, the south coast provinces do not cluster as highly urbanised Guandong seems surrounded by less urbanised provinces.

In order to get a more accurate view of spatial dependence, scatterplots in figures 7A and 7B map spatial-autocorrelation of provincial average annual growth rates of per capita income and urban population, for the 1978-2005 period.

They confirm the previous results. The Moran scatterplot for per capita income growth rate shows that the provinces of the upper-right quadrant are all coastal, nevertheless one can not find among them Shanghai, Beijing or Tianjin which were the wealthiest provinces in China. The increasing congestion within these large economic centres and the development of intra-provincial transport infrastructures in the coastal areas have led to relocating of some industrial activities from these centres to their close periphery, in order to gain lower real estate and labour costs (Ng and Tuan, 2003; He, 2003). This allows one to consider that economic growth is spreading from the above older well-established centres to their neighbouring periphery.

Figure 7A
Moran I for annual growth of per capita income (1978-2005)

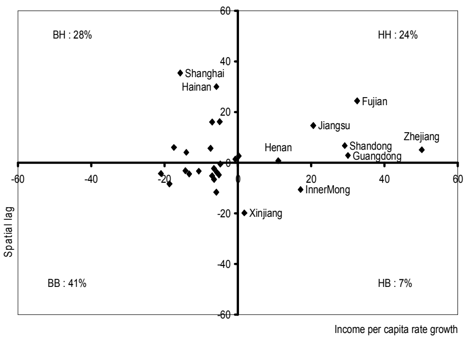
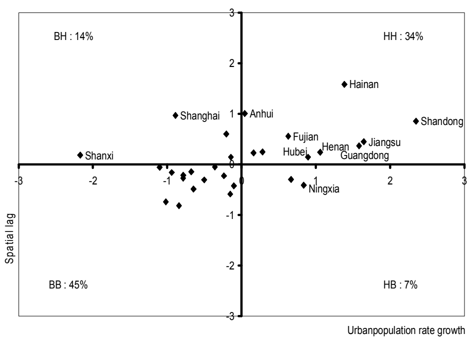


Figure 7B
Moran I for annual growth of urban population (1978-2005)



The same conclusions can be drawn for the growth rates of urban population: again a form of clustering appears with significant positive spatial association of coastal provinces which feature extremely high growth rates of urban population, with the notable exception of Beijing and Shanghai, where demographics are undermined by the anti-mega-cities policy.

6. CONCLUSION

The purpose of this paper is to examine the spatial characteristics of the relationship between regional income inequality and urbanisation in China, during the period 1978-2005. The main findings of the paper reveal the transitional dynamics that characterise China's regional development, through an overall divergence process, with the appearance of spatial clustering. It is thus difficult to consider whether China's development trends follow an inverted-U curve patterns, as regional differentiation is quite important.

The spatial analysis tools used in this paper seem to validate the idea that the coastal provinces of this country have entered a new stage of economic development, where economic growth starts spreading, contrary to what happens in the inland regions. This strengthens the assumption that, China, as a country, follows stage 2 of economic development with increasing regional urbanisation and per capita income disparities, some of its coastal provinces enter progressively stage 3, characterised by a diffusion of economic growth.

This paper mainly describes the urbanisation and income inequality trends for the Chinese provinces. Further investigation should however bring more information about the patterns of growth and specialisation within each province, as an explanatory factor for the divergences between the Coast and the Inland, but also between the Northern and Southern coastal provinces which seem to follow a different pathway of development, especially when it comes to urbanisation issues.

APPENDIX

Moran's indice of income per capita				
year	I moran	Sdt	I normalised	p-value
1978	0,12410	0,09176	1,74168	0,04
1979	0,15668	0,09487	2,02802	0,021
1980	0,16207	0,09779	2,02263	0,022
1981	0,15956	0,09592	2,03588	0,021
1982	0,17377	0,09813	2,13469	0,016
1983	0,19417	0,10255	2,24168	0,012
1984	0,21627	0,10614	2,37416	0,009
1985	0,23289	0,10549	2,54636	0,005
1986	0,25185	0,10798	2,66313	0,004
1987	0,27509	0,10956	2,83681	0,002
1988	0,29583	0,11103	2,98617	0,001
1989	0,29167	0,11224	2,91673	0,002
1990	0,26284	0,11163	2,67446	0,004
1991	0,25565	0,11098	2,62532	0,004
1992	0,27958	0,11052	2,85288	0,002
1993	0,30394	0,10957	3,09983	0,001
1994	0,33342	0,10984	3,36055	0,000
1995	0,35105	0,11015	3,51124	0,000
1996	0,34587	0,10967	3,47926	0,000
1997	0,33241	0,10775	3,41657	0,000
1998	0,32752	0,10728	3,38598	0,000
1999	0,32905	0,10702	3,40839	0,000
2000	0,32522	0,10640	3,39213	0,000
2001	0,34050	0,11039	3,40805	0,000
2002	0,35718	0,11142	3,52608	0,000
2003	0,37228	0,11191	3,64574	0,000

Moran's indice of urbanisation rate				
year	I moran	Sdt	I normalised	p-value
1978	0,08590	0,11745	1,03544	0,15
1979	0,09948	0,11878	1,13817	0,128
1980	0,11696	0,12034	1,26874	0,102
1981	0,11355	0,12072	1,23644	0,108
1982	0,10142	0,12158	1,12790	0,13
1983	0,08928	0,12206	1,02406	0,153
1984	-0,00727	0,12428	0,22884	0,41
1985	-0,06320	0,12228	-0,22478	0,589
1986	-0,05046	0,12343	-0,11950	0,548
1987	-0,06346	0,12227	-0,22694	0,59
1988	-0,06498	0,12213	-0,23963	0,595
1989	-0,06370	0,12217	-0,22908	0,591
1990	-0,06409	0,12202	-0,23251	0,592
1991	-0,06927	0,12105	-0,27722	0,609
1992	-0,07787	0,12066	-0,34934	0,637
1993	-0,07454	0,12062	-0,32192	0,626
1994	-0,06918	0,12071	-0,27720	0,609
1995	-0,06676	0,12066	-0,25732	0,602
1996	0,13996	0,12336	1,42402	0,077
1997	0,14678	0,12328	1,48031	0,069
1998	0,14741	0,12342	1,48374	0,069
1999	0,16902	0,12369	1,65515	0,049
2000	0,25361	0,12121	2,38703	0,008
2001	0,26684	0,12189	2,48215	0,007
2002	0,29821	0,12196	2,73789	0,003
2003	0,25668	0,12205	2,39573	0,008

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DISPARITÉS RÉGIONALES DE REVENU ET DYNAMIQUES URBAINES EN CHINE : 1978-2005

Résumé : *Les travaux de S. Kuznets et son hypothèse de courbe en cloche sont à l'origine d'une littérature importante sur la relation entre croissance économique, disparités de revenu et urbanisation. Cet article examine la relation entre disparités régionales de revenu et dynamiques d'urbanisation en Chine durant la période 1978-2005 qui correspond à l'ouverture du pays à une économie de marché. L'objectif recherché est non seulement de tester la corrélation entre ces deux phénomènes, mais également de mettre en évidence les effets de contiguïté qui les caractérisent, à travers l'utilisation d'un certain nombre d'outils d'analyse spatiale exploratoire. Cet article aboutit à deux conclusions : en premier lieu, les effets de contiguïté sont plus importants dans la distribution provinciale des PIB par tête que dans celle des taux d'urbanisation ; en second lieu, le développement des régions côtières n'est pas uniforme et un clivage Nord-Sud apparaît. La côte nord de la Chine est caractérisée par une prolifération régionale des effets de croissance et une urbanisation diffuse, tandis que dans le Sud, on assiste à un effet de polarisation autour de la province de Guangdong.*