SPATIAL DISPARITIES IN THE CHINESE ICT SECTOR: A REGIONAL ANALYSIS

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Abstract - *The information and communication technology (ICT) sector is currently one of the most dynamic sectors in China's economy. Based on the number of cell phone users, internet users and workers in telecommunication, we indicate that the ICT sector is not equally distributed across the 31 Chinese provinces. This is also true for the distribution of per capita income growth. Various tools of exploratory spatial data analysis are then used to uncover that this sector displays signs of spatial autocorrelation as the selected variables appear to be more spatially concentrated in a few provinces. However, while cell phones and internet are mostly clustered in the East, workers in telecommunication are relatively more abundant in the Northern part of the country. On the other hand, the provincial growth rate is more randomly distributed. The existence of a positive relation between the number of ICT users in one province and growth in the neighbouring provinces suggests that ICT ought to be considered as one of the potential levers of a policy aiming to reduce regional inequalities.*

Key-words - INFORMATION AND COMMUNICATION TECHNOLOGIES, EXPLORATORY SPATIAL DATA ANALYSIS. GROWTH, CHINA,

JEL Classification : O30, O53, R12

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1. INTRODUCTION

The past two decades have witnessed an explosive growth of information and communications technology (ICT) worldwide. Studies show that many regions and areas have benefited a great deal from ICT in a variety of aspects, including accelerating productivity (Jorgenson 2001; Ark *et al*., 2003; Jalava and Pohjola, 2007), reducing costs, and increasing market share (Laursen *et al*., 2002). As a result, ICT has been identified as a vital factor in boosting the economic growth in many countries in recent years, especially in the developed ones (Seiter, 2005 ; Schreyer, 2000 ; Datta and Agarwal, 2004).

While ICT is a powerful tool to disseminate information and deliver services over space, there is a lot of controversy on its capacity to promote growth and bring about the new age of "death of the distance". On the one hand, Ding and Haynes (2006) list three channels through which ICT impacts growth positively: first, it is a direct input in the production process; second, it improves the productivity of the other production factors by reducing information and transaction costs; and third, its capacity to disseminate information over space helps attracting resources from other regions. Camagni and Capello (2005) and Cairncross (2001) stress this last channel. For them, ICT allows to overcome territorial peripherality and provide isolated regions with new opportunities that "were not available in the economy based on manufacturing industry" (Bonaccorsi *et al*., 2005). In addition, the elasticity of substitution between telecommunication and transportation infrastructures is another element that can play in favor of remote areas. Indeed, Yilmaz *et al.* (2000) indicate that ICT-based services are a good substitute for a long trip to remote and less dense areas where transportation infrastructures are not necessarily well developed.

On the other hand, some claim that the poor regions have both supply-side and demand-side problems that limit their capacity to adopt ICT. For Cohen and Levinthal (1989), Hollenstein (2004) and Richardson and Gillespie (1996), poor regions simply do not have the technological infrastructures and the human capital necessary to implement ICT-based services within their territory. Katz and Shapiro (1985) and de Castro and Jensen-Butler (2003) also raise the issue of insufficient demand for ICT-based services in remote areas. Below a critical level of demand for ICT, the supply side does not experience any economy of scale and thus cannot lower the price of the services. This is why denser areas are more prone to adopt ICT faster (Capello and Nijkamp, 1996). Meng and Li (2002) also add that governments do not necessarily support the adoption of ICT in the poor areas because it could increase unemployment by reducing the demand for low-skilled workers these regions are specialized in. As a result, ICT infrastructures cannot be seen as a sufficient investment to promote growth in every region.

While the debate on the whether ICT has really been able to overcome distance is still open, there is less discussion on how unequal the distribution of ICT across countries is. Whereas developed countries enjoy the ICT booming as a driving force for economic development (Jalava and Pohjola, 2002), the benefits of ICT in the developing countries are not fully realized and the role of the ICT remains unclear, due to the unavailability, slow adoption or ineffective usage of ICT technologies in such countries.

As part of our efforts to investigate the ICT sector in developing countries, we select China, the largest developing country, for our study. Although a few studies have been devoted to examining the ICT diffusion in China, most of the work focused on the years before 2000 (Meng and Li, 2002; Wang, 2001). Their conclusions indicate that there was a severe disparity across three regions[1]: eastern, central and western. In recent years, the government has facilitated the ICT booming with continuous reformation and promotion by highlighting the ICT sector as the important component in the national 10th (2001-2005) and 11th (2006-2010) five-year plans. In addition, China became a member of the World Trade Organization on December 2001, which opens up opportunities for foreign investors and competitors to enter the domestic telecommunication market. China has now become one of the world's fastest growing ICT markets (OECD, 2007a). With the fast pace of the development, we believe there is a need to re-examine China's ICT.

Also, while several authors have already documented the regional development gap that has taken place in China over the last few decades (see, for instance, Lin *et al.,* 2003; Hansen and Zhang, 1996; Weeks and Yao, 2003), there is little work on the link between ICT and economic growth in China. Some exceptions include Mody and Wang (1997), Demurger (2001), and Ding *et al*. (2008). Further, as noted by Ding and Haynes (2006), most existing literature does not pay attention to the role of interregional linkages when focusing on the ICT sector. Its capacity to promote the diffusion of ideas and technologies across space is unanimously accepted, but most empirical analyses still fail to formally model the property of spatial dependence that is inherent in this sector. A notable exception is Bonaccorsi *et al*. (2005) who use the tools of spatial statistics and spatial econometrics to model ICT's spatial diffusion across Italian regions. We intend to contribute to filling this gap by providing background information on the ICT sector in China in section 1. Next, we perform an Exploratory Spatial Data Analysis (ESDA) on the distribution of three variables representative of the ICT sector (the percentage of the population with access to the internet, to a cell phone, and the share of workers in telecommunication), as well as on the per capita income growth at the provincial level. It should be made clear that an ESDA will give us some insights into the spatial distribution of these variables but will not provide us with formal inference on the statistical relationship between these variables. The last section will provide some concluding remarks.

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[1] The eastern region includes Beijing, Shanghai, Tianjin, Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, Guangxi, Guangdong and Hainan. The central region consists of Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan. The western region contains Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang (Meng and Li, 2002). These three regions can be seen in figure 1.

2. THE ICT SECTOR IN CHINA

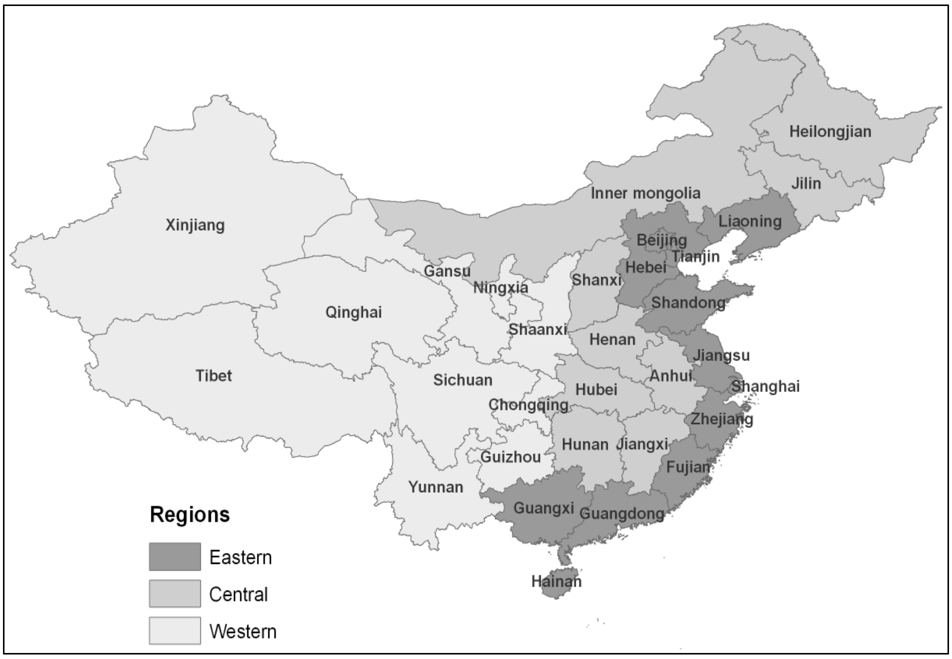
During the last 25 years, China's economy has expanded tremendously with an annual increase of around 10%. China is now identified as the world's fourth largest economy (OECD, 2007b). In addition, China is continuously increasing its role as an important global player in high-technology. Among others, the information and communication technology (ICT) is the most dynamic sector in China's economy and has played a "pillar" role and served as a driving force for innovation and growth of other industries. The growth of ICT is astonishing, with the average annual growth rate over 20% from 1980 to 2006, accounting for a significant portion of the GDP (OECD, 2007b). Although as a late starter, China's ICT still has gaps compared with developed countries, such as U.S. (Peng, 2007), the fast pace of the catching-up progress is very promising (Meng and Li, 2002).

The rapid ICT development is closely related to the reforms conducted during the past decades. For instance, recognizing the benefits provided by being a WTO member, China conducted a series of reforms to show its determination for creating a fair competition environment. In 1994, a joint venture China Unicom was established, putting the end to the monopoly status of telecom market by China Telecom of the Ministry of Posts and Telecommunications (MPT). In the following years more operators were introduced to encourage competition and separation of regulation from the telecom market. Now there are six major operators in the telecom market, including China Telecom, China Netcom, China Mobile, China Unicom, China Tietong, and China Satellitecom (Yuan and Zhang, 2006). The introduction of fair competition has brought about technical innovation, improvement of service quality and reduction of operational costs, enabling the boosting of the China's telecom market (Chen *et al.,* 2007). Till 2006, China has established the largest fixed telephone and mobile phone networks (Yuan and Zhang, 2006). By the end of 2007, there were 400 million mobile phone subscribers in China, accounting for the largest market in the world (OECD, 2007b). Meanwhile, other regulations on ICT were also issued accordingly and a more detailed description refers to Yuan and Zhang (2006). The internet users have increased to 210 million in 2007 (CNNIC 2008), over 9 times the 22.5 million users in 2001.

Despite the recent successes and rapid growing pace, as a developing country, China's ICT industry is facing challenges that may not sustain the current development. One major concern has been that China's ICT is unevenly distributed and the disparity may intensify the rising inequalities in income and opportunities. In the country, there are 31 administrative provinces, autonomous regions and cities and they are generally classified into 3 regions: eastern, central and western, as can be seen in figure 1.

Overall, the eastern regions are relatively highly developed in ICT than the other two regions. For instance, in 2007 the internet penetration rates in Beijing and Shanghai in the eastern region, the most developed cities in China, are 46.6% and 45.8%, respectively, as opposed to 9.6 % of Anhui in the central region and 6.8% of Yunnan in the western region. In part, the disparity pattern has been associated with the variation of geographic accessibility and economic development across the three regions (Wang, 2001). For instance, the eastern region is dominated by plain and also close to the sea. The high accessibility of eastern region combined with favorable tax policies for special economic zones has successfully attracted foreign investment and resulted in a relatively high level of economic development (Lin *et al.*, 2003). The central and western regions, where hills or mountains are more prominent, however, are less developed due to their historically low level of accessibility.

Figure 1. The 31 Chinese provinces divided by official regions



Although attention has been paid to the disparity among the three regions (Meng and Li, 2002), yet no work has been conducted to study the detailed geographic distribution that goes beyond the generally defined 3 regions. In addition, we believe the progress of the project "develop of the west", initiated in 1999 by Former president Jiang Zeming aiming to promote the development in the western and interior region of the country (Goodman, 2004), and further liberation of China's market after the accession to WTO in 2001, should have pushed forward the development of the ICT industry in some of the central or western areas, if not all. The spatial distribution of the ICT sector and of per capita income growth is therefore what we are to examine in the next section.

3. SPATIAL ANALYSIS

Our analysis relies on the increasingly popular tools of exploratory spatial data analysis (ESDA), which explicitly focuses on the geographical characteristics of the data. ESDA is a Geographical Information Science-based technique that allows users to describe and visualize spatial distributions, identify atypical locations or spatial outliers, discover patterns of spatial association, clusters or hot spots, and suggest spatial regimes or other forms of spatial heterogeneity. The strength of ESDA relies in its "data mining" capacity that is particularly useful when the existing data appear not to conform to existing theoretical frameworks, as is often the case in multidisciplinary fields of social sciences. It utilizes a wide range of largely graphical methods that explore the properties of datasets without the need for formal model building (Anselin, 1988, 1999; Haining, 1990).

We start our analysis with four quartile maps that display for each province 1) the share of the population with access to the internet; 2) the share of the population owning a cell phone; 3) the number of workers in telecommunications per 1,000 workers[2] and 4) the annual per capita growth rate over 1978-2004. Data 1 to 3 represent the situation in 2005. The per capita growth rate is calculated in 1952 *Yuan.* All our data come from the Chinese National Bureau of Statistics (2007). It is the most comprehensive source for regional data in China because most data start as early as 1949. We exclude the provinces of Hong Kong, Macao and Taiwan from our sample because of data incompatibility, so that we work on a sample of 31 provinces as shown in figure 1. Note also that the provinces of Hainan and Chongqing, which separated from Guangdong (in 1985) and Sichuan (in 1999) respectively, are treated as separated provinces.

As shown in figures 2 to 5, the provinces located on the eastern coast display the highest shares of internet and cell phone users per inhabitant. However, the Northern provinces also display pretty high levels of cell phone users (Xinjiang, Inner Mongolia, Heilongjian, Jilin) whereas it is not necessarily the case for internet use. Surprisingly, none of the four provinces (Qinghai, Inner Mongolia, Jilin and Shanxi) that show the highest percentages of workers in telecommunication are among the richest or the fastest growing areas. Indeed, as has been documented in previous studies, the most dynamic provinces are on the coast, in addition to Sichuan, Hubei and Beijin. Focusing now on the least attractive areas of the countries, some provinces appear to consistently display relatively low levels of ICT or growth. These regions are in the center of the country (Jiangxi and Anhui) or in the West (Gansu and

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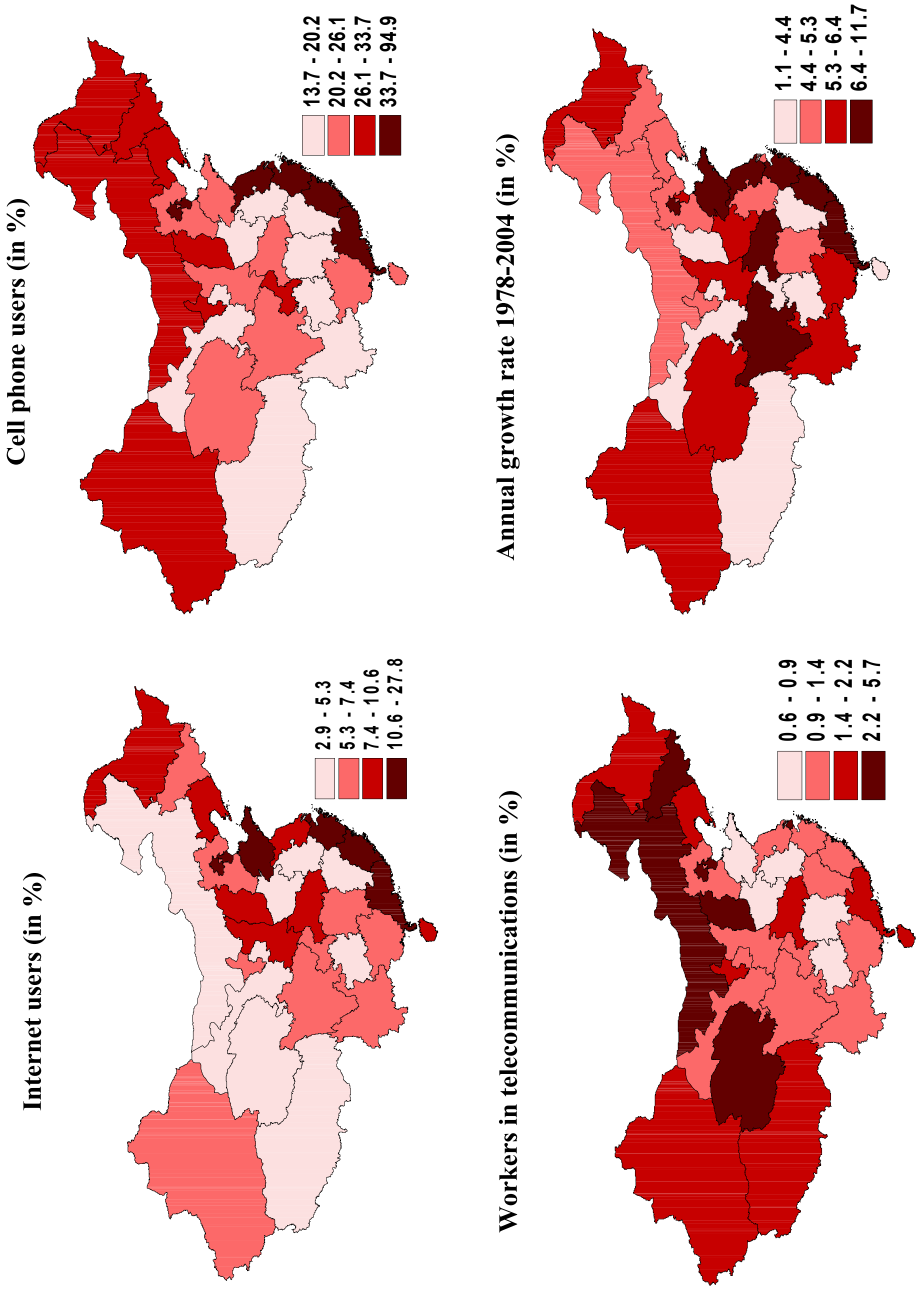
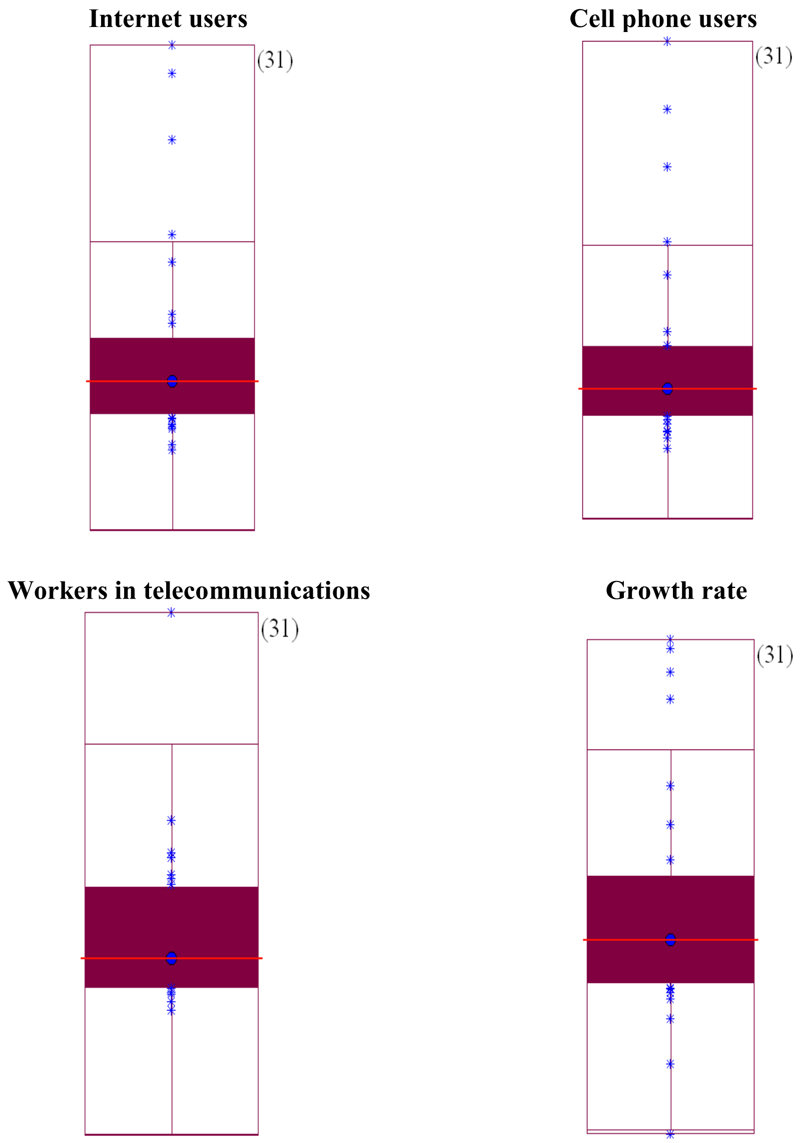
[2] Other studies have used ICT variables which are very close to the ones we have chosen here: Ding *et al*. (2008) use the number of telephones per capita; Wong (2002) uses the number of cellular mobile phone users as well as the number of computers and internet hosts per 1,000 inhabitants; Meng and Li (2002) use the share of labour force in ICT as a percentage of the nation's non-farm labour force; Kolarova *et al*. (2006) use the % of internet users.

Guizhou). Tibet could belong to this category except that its share of workers in telecommunication is relatively high compared to the rest of the country.

Figures 2 – 5 : Quartile maps



Figures 6-9 : Box plots



Because the range of the categories chosen in the figures above is quite large, another tool, called a box plot, is necessary to get a better understanding of the outliers, i.e. the provinces that display a very high (or very low) value of the variable under study. In essence, a box plot not only displays the median, first (Q_1) and third (Q_3) quartile of the distribution (respectively the 50%, 25% and 75% percentile in the cumulative distribution) but also the outliers defined as values above or below a given multiple (standard 1.5 or 3) of the difference between the first and third quartile. For example, a lower outlier is defined as a value below $Q_1 - 1.5*(Q_3 - Q_1)$ and an upper outlier is defined as a value above $Q_3 + 1.5*(Q_3 - Q_1)$. Figures 6-9 below display the box plots for our variables of interest, using a multiple of 1.5.

All box plots rely on the same principles: the bar in the middle of the dark area corresponds to the median while the upper (resp. lower) part of the dark area is the third (resp. first) quartile of the distribution. The thin line on the upper part of figures 6-9 is called the hinge, here corresponding to the default criteria of 1.5 times the difference between the first and third quartile. Beijing is the largest upper outlier for the three ICT variables and also an outlier for growth. Guangdong is an upper outlier for all variables except workers in telecommunication. On the other side of the spectrum, the three regions with some of the lowest levels for most variables are Guizhou, Tibet and Gansu (but the share of workers in telecommunications is around the average for these last two provinces).

Quartile maps and box plots are useful tools to understand the distribution of a variable over space, but they do not pay attention to the particular spatial linkages that influence the distribution of a variable. There are several reasons that make us believe that our variables may not be randomly distributed over space. This phenomenon, called spatial autocorrelation, refers to the coincidence of attribute similarity and locational similarity (Anselin 1988). For example, positive spatial autocorrelation indicates that nearby regions tend to display similar characteristics. It may come from a) a variety of measurement problems, such as a mismatch between the administrative boundaries used to organize the data and the actual boundaries of the process under study[3], or b) from a substantive phenomenon. Measurement problems may occur because the telecommunication network connects several regions with each other; or because cell phone and internet users bring with them their habits when they migrate to neighboring regions. Spatial dependence may also come from a substantive phenomenon such as trade, migration and technology diffusion (Dall'erba and Le Gallo, 2008).

The first step of the analysis of spatial autocorrelation lies in the definition of a spatial weight matrix. Traditionally in spatial statistics, spatial weights are based on pure geographical distance, as exogeneity of geographical distance is unambiguous. More precisely, we use a rook contiguity matrix so that contiguous provinces are treated as neighbors while non-contiguous provinces are not. Distance is based on the great circle distance between centroids which are the gravity centers of the provinces under study. The great circle distance allows us to consider that the relevant direction of the dependence can take place in every direction. We are aware that the choice of a spatial weight matrix is always somewhat arbitrary. However, in order to limit the influence of the choice of the matrix on our results, we compute other

[3] Cheshire and Carbonaro (1995) propose the definition of the "correct" boundaries but for another topic, the labor pool of various European cities.

weight matrices based on queen contiguity, k_4 nearest neighbors and a distance-based matrix with a cut-off of 1,000 miles. Queen contiguity is another way of delimiting contiguous areas (see Anselin, 1988, for details). K-nearest neighbour matrices mean that for every single area, the *k* nearest areas constitute the neighbors, no matter how much distance separate observations. There is a major difference with the latter matrix which defines as neighbour all the observations located within 1,000 miles from the province under study. Building several matrices will allow us to confirm our findings.

Now that various spatial weight matrices have been defined, we further analyze the spatial distribution of our variables with the use of Moran's *I*, which measures the presence of global spatial autocorrelation in the distribution of each variable. Moran's *I* gives the degree of linear association between the value of a variable at one location and the spatially weighted average of the same variable, i.e. the average of the neighboring provinces. In order to draw inference, we use a random permutation procedure which recalculates the statistic to generate a reference distribution and a pseudo-significance level (Anselin, 1995). The essence of this approach is to assume that each observation could equally likely have occurred at all locations. The number of permutations we have chosen is 9,999. Formally, for each variable of interest, Moran's *I* is given by the following formula (Anselin, 1995) :

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} \overset{*}{w}_{ij}(k) x_i x_j}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j} \qquad (1)$$

where $\overset{*}{w}_{ij}$ is the (row-standardized) degree of connection between the spatial units *i* and *j,* and x_i is the variable of interest in region *i* (measured as a deviation from the mean value for that year). Table 1 below indicates the value of Moran's I for the three spatial weight matrices mentioned above[4].

The significant presence of positive global spatial autocorrelation is confirmed by all the weight matrices for all the ICT variables at 5% significance level, except for the share of cell phone users using the spatial weight matrix k_4-nearest neighbors where the statistics is significant at 8%. It means that the Chinese provinces with a high (respectively low) level of ICT tend to be surrounded by regions with a high (respectively low) level of ICT. Therefore, the geographical location of the Chinese provinces has a significant impact on their level of ICT. The standardized value of Moran's I also tells us that the extent of spatial autocorrelation is slightly greater for the internet users than for the other two variables. This may reflect the disparity of income across provinces since internet usage is often linked to the purchase of a personal computer. Finally, when focusing on the per capita growth rate, the Moran's *I* is

[4] All the computations have been performed in Geoda.

significant at 9% for the two matrices based on contiguity only. This variable is therefore more randomly distributed than the other three, which was not necessarily a straightforward conclusion to reach when only looking at figures 2-5.

Table 1 – Univariate Moran's I values, p-values and standardized values

	Rook	*Queen*	*K_4*	*W(1000)*
Internet users	0.357 (0.002) 3.794	0.357 (0.002) 3.833	0.200 (0.023) 2.316	0.069 (0.027) 2.211
Cell phone users	0.224 (0.018) 0.525	0.224 (0.021) 0.520	0.109 (0.086) 1.421	0.057 (0.035) 1.991
Workers in telecommunications	0.290 (0.001) 3.250	0.290 (0.002) 3.323	0.157 (0.028) 2.042	0.064 (0.025) 2.272
Per capita GDP growth	0.119 (0.092) 1.382	0.119 (0.089) 1.386	0.027 (0.261) 0.580	-0.010 (0.737) 0.479

In order to investigate the relationship between our variables, we first measure the degree of linear relationship between one ICT variable and growth. Simple correlation return a coefficient of 0.429 (p-value = 0.345) for workers in telecommunications, 7.477 (p-value= 0.000) for cell phone users and 20.320 (p-value= 0.003) for share of the internet users. While these results seem to indicate that the last two variables are the only ones to positively and significantly influence growth, a formal econometric estimation of a regional growth model would be necessary to draw conclusions. This approach is left for future research as it is beyond the scope of this paper.

The second tool we can use to explore the relationship between the spatial distribution of our variables is a multivariate Moran's I. It calculates the degree of linear relationship between one ICT variable and the spatial lag of growth, of which results are displayed in table 2 below. We find a positive and significant relationship between internet users and the spatial lag of growth which means that more users in region *i* will increase growth in the regions neighboring *i*. This is also true for the relationship between cell phone users and the spatial lag of growth (at 6% level and for two weight matrices only), while we do not find any significant relationship between workers in telecommunications and the spatial lag of growth.

The Moran's *I* is useful to detect global spatial autocorrelation, but it is not able to identify local patterns of spatial association, such as local spatial clusters or local spatial outliers of high (or low) values that are statistically significant. For instance, the Moran's *I* statistics is positive and significant for all the three ICT variables, but it seems from figures 2-4 that the concentration of internet and cell phone users is not located in the same areas as the concentration of workers in telecommunications.

Table 2 – Multivariate Moran's I values, p-values and standardized values

	Rook	***Queen***	***K_4***	***W(1000)***
Growth vs. Internet users	0.233 (0.009) 2.667	0.233 (0.011) 2.590	0.168 (0.053) 1.942	0.035 (0.424) 0.885
Growth vs. Cell phone users	0.176 (0.057) 1.949	0.176 (0.058) 1.944	0.124 (0.171) 1.415	0.025 (0.594) 0.631
Growth vs. workers in telecommunications	-0.038 (0.629) -0.481	-0.038 (0.624) -0.483	0.049 (0.558) 0.619	-0.027 (0.391) -0.770

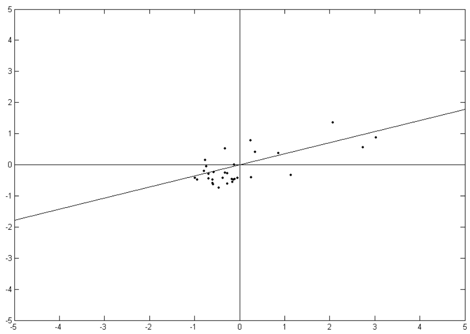
Identifying the groups of provinces belonging to clustering of high (or low) values is based on the results of a Moran scatterplot. As suggested by Anselin (1996), it displays the distribution of variables for each province (on the horizontal axis) against the standardized spatial weighted average (average of the neighbors' values, also called spatial lag) on the vertical axis. The Moran's scatterplot allows us to assess both global spatial association (since the slope of the line is the Moran's *I* coefficient) and local spatial association (according to which quadrant a province is located in). The Moran scatterplot is divided into four different quadrants corresponding to the four types of local spatial association between a province and its neighbors :

- quadrant I (top right) displays the provinces with values above the average (high) surrounded by provinces with dependent variable values above the average (high). This quadrant is usually denoted HH.
- quadrant II (top left, LH) shows the provinces with low values surrounded by provinces with high dependent variable values.
- quadrant III (bottom left, LL) displays the provinces with low values surrounded by provinces with low dependent variable values.
- quadrant IV (bottom right, HL) shows the provinces with high values surrounded by provinces with low dependent variable values.

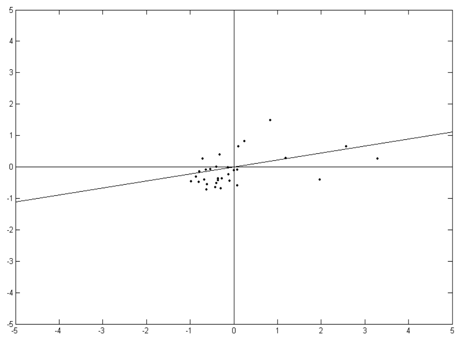
Provinces located in quadrants I and III refer to positive spatial autocorrelation indicating the spatial clustering of similar values, whereas quadrants II and IV represent negative spatial autocorrelation indicating spatial clustering of dissimilar values. Figures 10 to 13 display the Moran's scatterplot of our four variables of interest with the weight matrix based on rook contiguity. All of them indicate positive global spatial autocorrelation, which was previously detected by the value of Moran's *I*. It is reflected by 1) the positive slope coefficient of the linear regression of $W_i z_i$ on z_i with $W_i z_i = \sum_j w_{ij}$ (a slope of one, passing through the origin, would indicate perfect spatial association) and 2) the fact that most of the data points are located in quadrants I and III.

Figures 10-13 : Moran scatterplots with the rook matrix

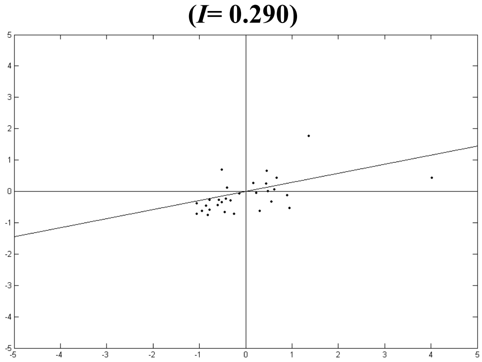
Internet users (*I*= 0.357)



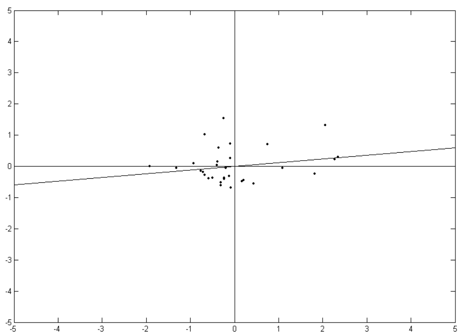
Cell phone users (*I*= 0.224)



Workers in telecommunications (*I*= 0.290)



Growth rate (*I*= 0.119)



Figures 10 to 13 indicate that most of the observations are located in quadrants LL or HH. In addition, the greater slope of the line of internet users reflects the greater extent of spatial autocorrelation of this variable. The distribution of the points in the scatterplot also reflects the outliers that have been noticed previously. For instance, the three areas with the highest percentages of internet users (the three points located the furthest away from the average value in the quadrant HH of figure 10) are Shanghai, Beijing and Tianjin. All of them are surrounded by neighbors with high values of internet users.

The quadrant of the Moran scatterplot where a province lies provides us with an indication of local spatial autocorrelation, but it does not give any information on the significance level of spatial clustering. In order to treat this problem, we calculate a Local Indicator of Spatial Autocorrelation (LISA) for each observation (Anselin, 1995) in order to capture the extent to which there is a significant spatial clustering of similar values around that observation. While LISA statistics are not the only statistics for local spatial autocorrelation, it is the only one to split our sample according to the four quadrants of the Moran's scatterplot described above. Formally, LISA statistics can be written as follows:

$$I_i = \left(\frac{x_i}{m_0} \right) \sum_j w_{ij} \, x_j \quad \text{with } m_0 = \sum_i x_i^2 / n \qquad (2)$$

where w_{ij} are the elements of the row-standardized weights matrix **W** and x_i (x_j) is the observation in region *i* (*j*) (measured as a deviation from the mean value). The significant results (at 5%) of the LISA statistics are presented in table 3 below. Their significance level is based on a randomization approach with 9,999 permutations of the neighboring provinces for each observation (Anselin, 1995). The pseudo-significance level is 5%. However, due to a problem of multiple statistical comparisons, since the neighborhood sets of two regions may contain common regions (Ord and Getis 1995 ; Anselin 1995), we indicate also when the results are significant at a 1% and 0.1%.

Table 3 – Regions with significant univariate LISA statistics at 5% (rook matrix)

	Internet users	**Cell phone users**	**Workers in telecommunications**	**Per capita GDP growth**
Hainan	LH**	LH**	LH**	LH**
Jiangxi				LH*
Fujian				HH
Inner Mongolia				LL
Guizhou			LL*	
Chongqing		HL	LL	
Hubei	LL	LL	LL*	
Anhui			LL*	
Shandong			LL	
Tianjin	HH	HH	HH	
Sichuan	LL*	LL*		HL
Qinghai	LL	LL		
Xinjiang	LL	LL		
Yunnan	LL	LL*		
Shaanxi	LL			
Hebei			LH	

*Note: * denotes a significance level of 1% ; ** denotes a significance level of 0.1%;*

The results indicate that the distribution of local statistics for cell phone and internet users is very similar. They confirm what has been found previously: there is a cluster of low values in the western part of the country (Xinjiang, Qinghai, Sichuan, Yunnan, Hubei). Hainan is LH for these variables as well as the other two variables. Tianjin is HH for all the ICT variables. The share of workers in telecommunications displays significant local spatial autocorrelation (LL-type) in a band stretching from Yunnan to Shandong and including the contiguous regions of Anhui, Hubei, Chongqing and Guizhou. Finally, the results for the growth rate confirm the cluster of dynamic regions around Fujian, and it is encouraging to note that the poor region of Sichuan grows significantly faster than its neighbors. When we increase the level of significance to 1% or 0.1% because of the problem of multiple statistical comparisons mentioned above, few regions remain significant. Hainan is the only one to be significant at 0.1% and to display a LH pattern for all our variables of interest.

Finally, table 4 below displays the results of the multivariate LISA statistics, in the spirit of the multivariate Moran's I statistics of table 2, but for local spatial autocorrelation. Results are very similar to those of table 3.

Table 4 – Regions with significant multivariate LISA statistics at 5% (rook matrix)

	Internet users	**Cell phone users**	**Workers in telecommunications**
Hainan	LH**	LH**	LH**
Guizhou			LL*
Chongqing		HL	LL
Hubei	LL	LL	LL*
Anhui			LH*
Shandong			LL*
Tianjin	HH	HH	HH
Sichuan	LL*	LL*	
Qinghai	LL	LL	
Xinjiang	LL	LL	
Yunnan	LL	LL*	
Shaanxi	LL		
Hebei			LH

*Note: * denotes a significance level of 1%; ** denotes a significance level of 0.1%;*

4. CONCLUSION

This paper has examined territorial imbalances in the distribution of economic growth and the ICT sector across 31 Chinese provinces. The tools of exploratory spatial data analysis are used to discover underlying patterns in recent years. Results have highlighted the fact that their distribution is correlated over space, indicating that provinces tend to register very similar levels than their neighbors. It also highlights the fact that remoteness, natural settings and more generally geographical location are closely linked to economic performance and ICT distribution. For instance, the provinces with the highest shares of internet and cell phone users are systematically in the East while the presence of a local cluster of low values for both variables is significant in the West (Xinjiang, Qinghai, Sichuan, Yunnan, Hubei). This supports the idea that these technologies are still considerably underdeveloped in this part of the country. An optimistic result of this paper is that the Western provinces are not the ones with the lowest shares of workers in telecommunications, which may reflect the government's effort in developing the west. We also note that Sichuan, one of the poorest Chinese provinces in the west, indicates significant signs of growing faster than its neighbors.

The techniques used in this article do not allow us to draw a formal conclusion on the role of the ICT in promoting growth, as an estimation of the relationship between variables via spatial econometric regressions would be necessary. This is left for future research.

Considering the abundant theoretical and empirical literature that emphasizes the potential of ICT in reducing territorial inequalities, we hope that the Chinese authorities will seriously consider it for regional policy purposes. Based on the results of this work, we also hope the effects of spatial spillover that characterize the ICT sector will be considered when investing in remote areas. Further, we believe that another reason for investing in ICT technologies is that their capacity to diffuse information rapidly over great distances is a key factor for coordinating rescue operations in the case of unexpected events, such as the terrible earthquake that shook Sichuan in May 2008.

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DISPARITÉS SPATIALES DANS LE SECTEUR DES TECHNOLOGIES DE L'INFORMATION ET DE LA COMMUNICATION EN CHINE

Résumé - *Le secteur des technologies de l'information et des communications (TIC) est à présent l'un des secteurs les plus dynamiques de l'économie en Chine. Sur la base du nombre d'utilisateurs de téléphones portables et d'internet ainsi que des effectifs employés dans le secteur des télécommunications, nous montrons que le secteur des TIC n'est pas réparti de manière égale entre les 31 provinces chinoises. Cela est également vrai pour la répartition de la croissance du revenu par habitant. L'analyse exploratoire sur données spatiales montre que ce secteur est marqué par la présence d'autocorrélation spatiale. Alors que les utilisateurs de téléphones portables et d'internet sont regroupés dans la partie Est du pays, les travailleurs dans le secteur des télécommunications sont relativement plus concentrés dans la partie Nord. En revanche, nous trouvons que le taux de croissance du PIB par tête des provinces est distribué de manière plus aléatoire. L'existence d'une relation positive entre le nombre d'utilisateurs de TIC dans une province et la croissance des provinces voisines suggère que les TIC devraient être considérées comme un des leviers possibles d'une politique de réduction des inégalités régionales.*