

## Digital Divide: Adoption of Internet in China

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### ABSTRACT

With the development of information and communications technology (ICTs), Internet has been one of the major driving forces of the new economy. Nevertheless, access to the new technology remains extremely unequally distributed across and within societies, and there have a good deal of popular discussions about this "digital divide" in academia and business communities of every society. This study provides empirical evidence on China's Internet development and diffusion in recent years. Findings show that there is a clear digital divide among the nation's three economic zones, and while the growth rate for new Internet users is accelerating and the infrastructure of network is improving, the digital divide is growing narrower. In addition, by undertaking a set of regression analysis, the paper also finds that income and education play a critical role in shaping the divide. Based on the result, the paper offers some related policy suggestions to promote a wider diffusion of internet in poorer regions.

**Keywords:** Digital divide, Internet, Gini coefficient

### 1. INTRODUCTION

Information technology is changing the way people communicate, learn and work, and the competitive advantage enjoyed by those having Internet access is becoming increasingly obvious. However, not everyone has access to this technology. The idea of the "digital divide" that put forward by NTIA firstly refers to the growing gap between those who have access to computers or Internet and those who have not access, ranging from the global level, to nation states, to communities, and to individuals [1]. Though these applications have some common features, there are differences on the response of policy and the composition of stakeholders.

Digital divide has been a continuing buzzword in public discourse and international agendas after it had been put forward. However, existing studies have largely been confined to the boundaries of national states. The explosive growth of information and communications technologies (ICTs) in recent years, particularly the rise of Internet and its related applications, has created unprecedented opportunities, but also created threats for developing countries. From the opportunity aspect, some believe that ICTs will be a lever that may advance developing countries to enter into "leapfrogging" seedtime. This perspective is in line with Barlow's (1998) comment that Africa should skip industrialism entirely and leap directly into the information era [2]. This conclusion is shared by Hudson (2001) who suggests that the potential for "leapfrogging" lies in the use of wireless communication technology [3]. Nevertheless, According to Braga (1998), some believe that ICTs have and will contribute to even wider economic divergence between developing and developed countries [4]. This view is consistent with Brown's (2001) argument that there is still a lot of skepticism with regard to whether ICTs can reduce poverty in the developing countries [5]. This idea is also evident in Chowdhury (2000) that some skeptics

still do not see any positive role of ICTs in poverty alleviation. In his words, "the poor can't eat high-speed Internet access, of course" [6]. Opportunity may be outweighed by considerable threat arising from their second-mover position on the adoption of new technologies. Therefore, it is more difficult for an entire nation to leapfrog other nations technologically because of the infrastructure and human capital bottleneck [7]. What most important is that the developed countries have an advantage of exploring new technologies. While the developing countries learn, assimilate and understand original technologies, the developed countries have already applied the advanced ones. Therefore, there is a widening digital divide between the developed countries and the developing countries.

Research on Internet diffusion is accompanied by the evolution of Internet itself. With the increasing use of Internet in developed countries, research about its applications has been on the rise. Most studies have taken place in OECD countries, especially the US, Japan and Western European countries. The Department of Commerce's National Telecommunication and Information Administration's reports, generally entitled Falling Through the Net, have been the primary and most consistent way to track computer ownership and network access across broad demographic categories over a relatively long period of time (since 1995) [1]. Even though there is a deeper and wider digital divide, little research has paid attention to how Internet access and use fit into everyday life in developing countries, such as India and countries in Africa [8, 9]. These studies suggest that digital divide has been one of the leading economic and civil rights issues, and call for government action to ensure that all people are able to enjoy the competitive advantages gained by Internet participation.

Widespread diffusion does not imply ubiquity, even within developed countries. Digital divide appeared at the very start of Internet [10]. There is the same

challenge in China too. Adoption and development of ICTs drives the development of new economy in China. Meanwhile, there has always been great regional variation in three zones: the eastern, the central and the western zones [11]. From 1990 to 2002, the percent of GDP of the eastern zones contributed to the nation increased from 51.5% to 57.86%. But this percentage in the central and the western zones decreased 3.14% and 3.23% respectively. GDP of the eastern zones was 2.0 and 2.6 times than that of the central and the western zones in 2002 respectively. The Gini coefficient in China, the important index measuring the income inequality, reached 0.41 in 2000, which was well beyond the normal level. These indicate the increase of regional gap in economic development. Moreover, the number of Internet users in the eastern zones was 1.95 and 3.03 times than that of the central and the western zones respectively in 2003. There are some studies on digital divide in China at present. But most of them focus on the qualitative analysis [12, 13, 14]. In addition, there are also few studies on how Internet diffused in China [15]. Empirical researches on digital divide in China are scarce.

By undertaking a set of regression analysis on Internet-related data in China, this paper aims to analyze the status quo of Internet development and diffusion in China, and provides empirical evidence on the digital divide of Internet adoption across China. Moreover, it discloses the relation between the development of economy, education and Internet. These results may offer some implications to the policies that may bridge the digital divide.

## 2. RESEARCH QUESTIONS

At present, digital divide not only exists in the development of information technology, but also in the application of information technology. So, digital divide has multiple dimensions. This study focuses on the digital divides between users and non-users of Internet in China.

Early characterizations of the divide singled out income and educational attainment as correlating strongly to computer and network access [16]. Thus, although there are strong relations between income and education in this early data (one-third of the income gap can be attributed to education), education (and other variables) cannot completely account for the fact that the wealthy own more computers and have greater access to computer networks than the poor. Income and education considered as separate variables are significant contributors to the access. Among OECD countries, the digital divide between high income households and low income households varies from country to country, ranging from a gap of more than 60% in the UK to less than 20% in Denmark [10]. With respect to the NTIA's historical concerns, the effects of income and education still exist as well: the better educated and compensated

far outpace those of alternate class positions. Thus income and education continue to be the variables that correlate most strongly with Internet access and computer ownership [17]. Whether there is similar relation between these two factors and Internet digital divide of China is an important factor in formulating related policy to solve the problem.

China accesses firstly Internet by its CSTNET at April 1994, which has been a great development in recent years. By reports on Internet development in China (CNNIC, 2004), the number of Internet users is more than 79.5 million, and the number of computers that can access Internet is more than 30.89 million. However, there is serious regional inequality on development and diffuse of Internet. Recent report shows that the number of Web sites in three regions (eastern China, northern China and Southern China) is 90% of all sites across China. The digital divide is widening the gap of among these regions, which could bring serious social problems. Some domestic studies find that there is a regional digital divide. There are great differences in Internet host and Internet users among these regions. In general, the number of Internet users in the rich regions is far excess that of the poor regions [13]. But to what extent is the gap in Internet?

Computer and Internet use at home and work are increasing rapidly, but there is disagreement on whether access is increasing among all groups at similar rates. One analysis suggested that the divide may shrink in the near future because the number of computer users with lower incomes is increasing more rapidly than the total number of computer users overall [18]. In addition, Howard (2001) noticed the dynamics of digital divides, and he agreed that infrastructural access gaps are narrowing, though narrowing in unequal ways [19]. However, other researches have found that the digital divide also continues to grow at an alarming rate. On the one hand, the connected ones - such as those with higher income and better education - are adopting newer technologies faster and are connecting even more. On the other hand, groups with limited Internet and computer access continue to lag far behind [20]. One study concluded that these digital divides are increasing even after taking into account that "adoption of new technologies tends to be fairly slow at low penetration levels, faster thereafter and slower again as it reaches saturation" [18]. Then what direction does the digital divide of Internet adoption in China changed in several years ahead?

Based on above discussion, this paper aims to investigate the following questions:

- Is there any relation between the number of Internet users and the levels of income and education across different regions in China?
- To what extent are there digital divides in Internet adoption among three zones: the eastern, the central and the western zones?

- What direction will the digital divide in Internet adoption change across different regions?

### 3. METHOD

#### 3.1 Sample

The data summarized here emerged from all survey reports on Internet development in China published by CNNIC [21]. In addition, the study refers to relevant data in China Statistical Yearbook and Regional Statistical Yearly Report (2004) [22, 23]. The object of the study includes 31 provinces or regions of mainland China. Thus analysis is done on two aspects: one is the relation between income, education and digital divide across different regions of China, another is the status quo and the trend of the digital divide origins from inequitable diffuse of Internet.

#### 3.2 Variables

As the dependent variable, the digital divide on adoption of Internet is measured by the number of Internet users. According to CNNIC, Internet users include Chinese who accessed Internet for at least one hour per week in average. Income, as an independent variable, is measured by a common index, which is GDP per capita [24]. As another independent variable, education was measured by the number of primary, secondary and tertiary students [24], but these three types of students have a strong relation. It was also measured by the number of people who own senior secondary education [15], but it doesn't take into account of the fluidity of them. To avoid these problems, this paper measures education by the number of student enrolled at colleges and universities. To some extent, the index reflects the level of education in a region.

### 4. MODEL AND FINDINGS

#### 4.1 The relationship between income, education and Internet users

What relation is there between the number of Internet users and income, education across different regions in China? Simple regression results, as reported in Table 1, suggest the following.

Table 1. The relationship between income, education and Internet users

Variables	Internet users	Income	Education
Internet users	1		
Income	0.931**	1	
Education	0.876**	0.798**	1

Note. *Internet users* is measured by the number of Internet users per 1,000 people, *income* is measured by GDP per capita and *education* is measured by the number of student enrolled at colleges and universities. All data is calculated by a natural logarithm scale.

\*\* Statistical significance at the 1% level.

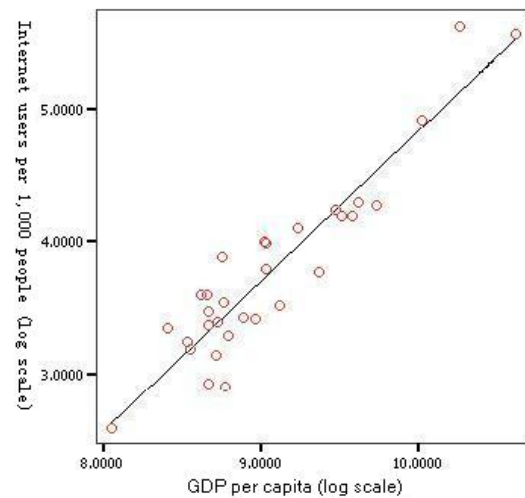


Figure 1. Internet user density and GDP per capita in 23 regions, 2002

Data source: *China Statistical Yearbook and Report on Internet Development in China (2003)*

We observed that the number of Internet users is still highly correlated with income and education. Income is the primary factor influencing the access and adoption of Internet, which possibly origin from the inequality of regional economy development (see Fig. 1). In addition, the level of education has a strong relation with the number of Internet users (87.6%), which can be attributed to two reasons. Firstly, education contributes directly towards basic literacy, and reading and writing skills are essential in using this technology. Well-educated people are also likely to be faster to adopt new innovations than people with little education. Secondly, given that the early users of Internet were people working in higher education and research, academic institutions may play an important role in spreading Internet. They are often among the first institutions in a nation to be wired. Moreover, there is a tight relation between income and education (coefficient is 0.798). The result has a little difference with prior conclusion [15], for the reason of the difference of index to measure education.

#### 4.2 Extent of digital divide

In order to measure extent of the digital divide in Internet adoption among three zones: the eastern, the central and the western zones, the number of Internet users of every region in China for the years 1997-2003 were analyzed. Table 2 summarizes the number of Internet users per 1,000 people for this period in different regions. It shows that there is a clear digital divide in Internet adoption among these three zones, though the adoption of Internet in the central and the western zones has been developing quickly from years 1997-2003. In 2003, the number of Internet users per 1,000 people in the central and the western zones was 1/3 of that in the eastern zones.

Moreover, the increase rate of Internet adoption in the western zones has been higher than that in eastern zones since year 2000, which is highest among three zones. The result maybe attributed to two reasons. One is the support of the central government policy. The central government released the Western China Development policy, which had a great promotion to information infrastructure development. Secondly, there was a great development in western economy. It brought more people to access the new technology.

Table 2. Internet users per capita 1,000 people by zones, 1997-2003

	Eastern	Central	Western
1997	3.05	0.37	0.18
1998	6.10	0.71	0.66
1999	27.71	3.26	2.53
2000	48.44	11.68	11.31
2001	70.25	17.11	15.26
2002	100.19	34.45	31.13
2003	123.65	42.63	45.53

Data source: *China Statistical Yearbook* (1998-2003), *China Regional Statistical Yearly Report* (2004) and *Report on Internet Development in China* (1997-2004)

Fig.2 characterizes the changing status of Internet users per capita in the three zones. It shows that the adoption of Internet is nearly similar between the central and the western zones, but there is a great gap by comparing with that of the eastern zones, and the gap is widening along with time. Therefore, there is a trend that the digital divide on the adoption of Internet is widening.

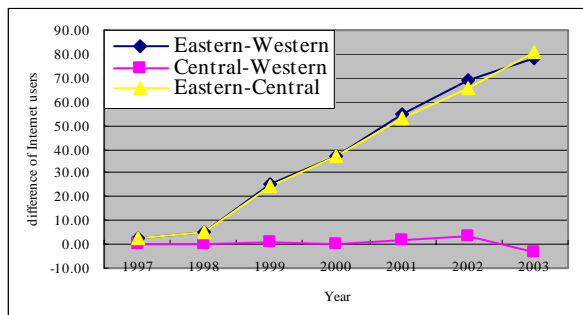


Figure 2. The difference of Internet users between three zones, 1997-2003

#### 4.3 Trend of digital divide

Because there is a gap in regional economy and education, the adoption of Internet has been developing unevenly. With government's regulating the policies of IT, whether the digital divide of regional unequal development is narrowing? By comparing two or more figures, or columns of figures, it can see which one is greater or lower. For example figures for the eastern zones can be compared with that of the central and the western zones to see which one is greater or lower. This is the easiest way to look at disparities. It is a simple way that every one interested can work out and get a feeling

of the level of disparity between different zones. However, it is crude, and may not tell us much. At times it is not possible to scan through all the figures at a time. This section utilizes Gini coefficient to measure the digital divide across regions. Gini coefficient can quantify the level of inequality.

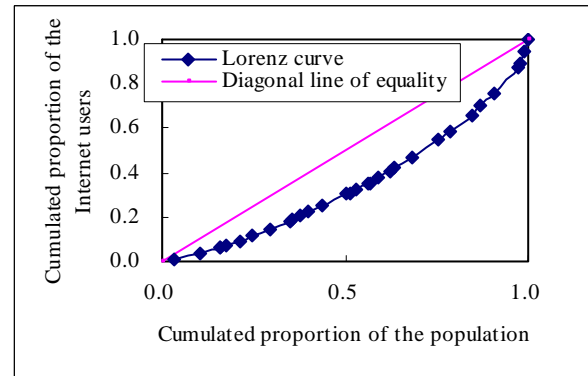


Figure 3. The calculation of Gini coefficient, 2003

The Gini coefficient is based on the Lorenz curve, a cumulative frequency curve that compares the distribution of a specific variable with the uniform distribution that represents equality (See Fig. 3). This equality distribution is represented by a diagonal line, and the greater the deviation of the Lorenz curve from this line, the greater the inequality [25]. In general, scientists still use this coefficient to measure the level of wealth distribution between nations, income between households, health among community etc. When applying this index to Internet variables, the cumulative proportion of the population is generally shown on the X axis, and the cumulative proportion of Internet users on the Y axis. The greater the distance from the diagonal line, the greater the inequality.

The Gini Coefficient ranges from 0 to 1, 0 representing perfect equality and 1 total inequality. It corresponds to twice the area between the Lorenz curve and the diagonal. There are different methods to calculate the Gini Coefficient, but a simple formula, shown below, was provided by Brown (1994) [26].

$$Gini = 1 - \sum_{i=0}^{k-1} (Y_{i+1} + Y_i)(X_{i+1} + X_i)$$

where, Y=cumulated proportion of Internet variable;  
X=cumulated proportion of the population variable.

Table 3 summarizes the Gini coefficients of Internet for years 1997-2003. Generally, Gini coefficient of Internet has been decreasing. Internet Gini coefficient is 0.422 in 1997, which is twice of that in 2003. It indicates that there was a serious inequality in early period of Internet development. There was a wide decrease from 1999 to 2000. It should benefit from the government policies and intervention of venture capital. Since then, Internet has served Chinese people and enterprises really.

Table 3 Internet Gini coefficients in China, 1997-2003

Year	1997	1998	1999	2000
Gini coefficient	0.422	0.438	0.412	0.289
Year	2001	2002	2003	
Gini coefficient	0.293	0.248	0.215	

Data source: *China Statistical Yearbook* (1998-2003), *China Regional Statistical Yearly Report* (2004) and *Report on Internet Development in China* (1997-2004)

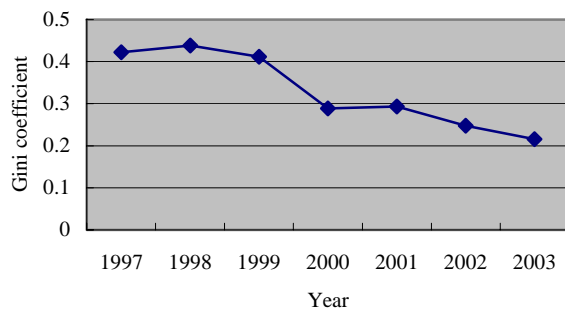


Figure 4. The trend of Gini coefficients in China, 1997-2003

Fig. 4 is based on data of Table 3. It shows that the digital divide on adoption of Internet is narrowing across regions for years 1997-2003.

## 5. BRIDGE THE DIGITAL DIVIDE

For any nation, the adoption of information technology doesn't stop its steps because of the lagger. The digital divide can be seen as both a symptom and a cause of underlying disparities in society. So whether the digital divide can be bridged quickly and effectively relate to sustainable development of a society, and this requests nation and local government to make great efforts. In this section, some policy suggestions for bridging the digital divide are proposed

### 5.1 Expediting establishment of info infra-structure

For a region to succeed in Internet area, information infrastructure plays a critical role. That is to say, establishment of information infrastructure is a basis for bridging the digital divide. Government plays an important role in creating such infrastructure, especially in the poorer regions. This role stems from a number of important considerations. First, in very poor regions, the market forces may be weak both because of lack of effective demand and because of lumpiness of investment. Second, in order to attract the private sector to invest in information infrastructure, government may have to play the role of a catalyst by instituting various innovative incentive mechanisms such as build-own-operate, build-own-transfer, etc. Finally, government opens its market to foreign investors, which can speed up transfer of technology and encourages investments on Internet infrastructure. Bridging the digital divide between the eastern and the western zones requires that the establishment of information infrastructure such as computer network and

communication links be expedited. Government should take network as a public establishment. They should offer more chance to access Internet and knowledge about IT for the public. In addition, the establishment of information infrastructure should be an important component of Western China Development Strategy. This can promote the popularization and development of Internet in the western zones.

### 5.2 Increasing investment in education

As above analysis suggests, the relationship between education and Internet is critical. Education is important because it provides basic skills required for creating, adapting, and utilizing such technologies. This is not to deny that even illiterate or near-literate can possibly take advantage of certain technological applications. But to go beyond elementary applications, education becomes increasingly important. Indeed, international evidence suggests that education is a strong complement, especially secondary and higher education. Therefore, if a region aspires to exploit in significant ways the opportunities offered by Internet, the creation of new industries in particular, it needs to emphasize secondary and higher education.

By the Report on Internet Development in China (CNNIC, 2004), those who have education level below senior secondary education is 13.5% of all Internet users [21]. It indicates that higher education basically provides trainings of Internet skills to students in China, but not for people below senior secondary education. There are two possible ways to deal with it. First, while developing higher education, government should pay much attention to Internet education for primary and secondary schools; Second, in addition to formal education, a rapidly changing technology like Internet would require continuous training on the part of the workforce. However, the government can also play an important role in inducing firms to impart such training through various types of tax incentives.

### 5.3 Reducing cost

Many countries in the world concern the problem of digital divide, and make every people take the advantage of IT by improving IT, infrastructures and service actively. In China, expense of accessing Internet is too high, which is a bottleneck hampering the popularization of Internet. Though the charge is lower than some developed countries in the world, but considering the level of income, the rate of network expenses to income is much higher, which restrict the diffusion of Internet. So government should develop leasing and low-cost purchasing schemes, and coordinate, develop and identify a range of low-cost technical solutions to Internet access provision, particularly in poorer regions. This would help to reduce the number of people who perceive Internet as unaffordable and increase the effectiveness of using limited resources. Moreover,

government should reduce cost of accessing network by continuing to develop a national infrastructure of low-cost or free access points in under-served regions. Income is one of most important factors affecting the digital divide. The reduced cost of Internet access may attribute to income increase. So reducing cost is one of essential measures to bridge the digital divide.

#### 5.4 Fostering favorable environment

Although the rapid development of Internet requires an open and competitive market, China still maintain strong barriers against entry in this market. The entry barrier, along with the heavy government involvement in such ICT-related sectors as telephones, has spawned pervasive corruption in many regions and has raised the cost of communication. It results in difficult access to Internet. Therefore, to bridge the digital divide and promote the adoption of Internet, government must foster a favorable environment. Open and competitive market is essential, which can ensure enterprises to take part in the establishment of information infrastructure, including private enterprises and foreign enterprises. This can decrease the pressure of government. In addition, governments in poorer countries should foster an environment that would encourage innovation through research and development. It may be noted that developed countries that have established their lead in Internet have invested heavily in R&D activities. With fiscal incentives and proper enforcement of property rights, the private sector would have the impetus to engage in R&D activities. However, in areas where the market fails, particularly in basic research, government should take the lead. Aside from direct investments in R&D, government can encourage linkages between universities and Internet industry in technology transfer.

#### 5.5 Cooperation between government, enterprise and community

In addition to regional efforts, national and international organizations can play a role in promoting Internet in poorer region. It is essential that regional government cooperate with enterprises and society in the establishment of information infrastructure. First, sector of telecommunication in China is generally regulated by government. It is difficult for international organizations to enter into the industry without admission. So central and regional governments should issue deregulation policies gradually, which ensure enterprises free entry of the private sector, including foreign firms. These firms can support a specific set of policy initiatives to bridge the digital divide through technical assistance and policy advice, such as free ISP. Second, regional governments should attract enterprises, multinational companies and venture capital, which is likely to be critical in the growth of the local Internet access. Governments can offer the necessary financial assistance to them.

Moreover, if governments in poor regions channel their

scarce financial and political resources to developing social and human capital, building the basic infrastructure and creating a proper playing field for the private sector, Internet access will flourish and digital divide will diminish. Thus, notwithstanding the concerns voiced on the perils of being left behind in this digital age, poor regions should carefully balance the resource conflict of adopting modern technology and economic development.

### 6. CONCLUSION

The ability to access internet has become increasingly important to completely immerse oneself in the economic, political, and social aspects of the world. The digital divide is arguably an indicator of deeper divides within society. It can be seen as both a symptom and a cause of underlying disparities in society. This paper investigates the adoption of Internet across different regions in China. The Gini coefficient is calculated using data on Internet users per capita for the years 1997-2003. The basic finding is that there is a clear digital divide about Internet adoption across regions, and the divide has grown narrower. In contrast with some earlier findings (Bikson, 1999; Besser, 2001), these access gaps are narrowing [18, 19]. This paper also finds that the divide is still highly correlated to income and education, the conclusion is consistent with early result (Grabill, 2003) [17]. Based on this analysis, the paper also offers some policy suggestions as to how to promote a wider diffusion of Internet in poorer societies.

There are at least two important avenues for future researches. One avenue is to analyze the factors affecting the adoption of Internet except for income and education, such as cost and race etc. This will help to understand the digital divide deeply. Another avenue is to study in greater detail the adoption of the cluster of Internet-related technologies, because digital divides on other technological aspects have an important effect on society.

### ACKNOWLEDGEMENT

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