Measuring Digital Divide: The Exploration in Macao

Jianbin Jin, Tsinghua University, Beijing, China
Angus Weng Hin Cheong, University of Macao, Macao

Abstract

Digital divide is one of the most ill defined concepts in Internet-related social science investigations. This paper begins with the review of literature of digital divide and introduces problematic examples of conceptualization and operationalization of the concept. In particular, we focus on the methods researchers have been using for the purpose of quantifying the magnitude of digital divide. As previous research efforts have been largely made from a descriptive approach, which has inevitably yielded diverse presentation and interpretation, we then justify the necessity of using a standard measure of distribution inequality, i.e., Gini coefficient, in the studies of digital divide. A defining framework which encompasses three key constitutive components--levels of analysis, inequality types and types of ICT involved is also elaborated. With these theoretical and methodological preparations, we then attempt to explore the dynamic nature of digital divide by constructing six digital divide indexes from the survey databank over a period of six years collected in Macao. The empirical investigation of the "dynamic disequilibria" of digital divide reveals that different evolutive patterns between access divide and usage divides exist.

Keywords: digital divide; access divide; usage divide; Macao.

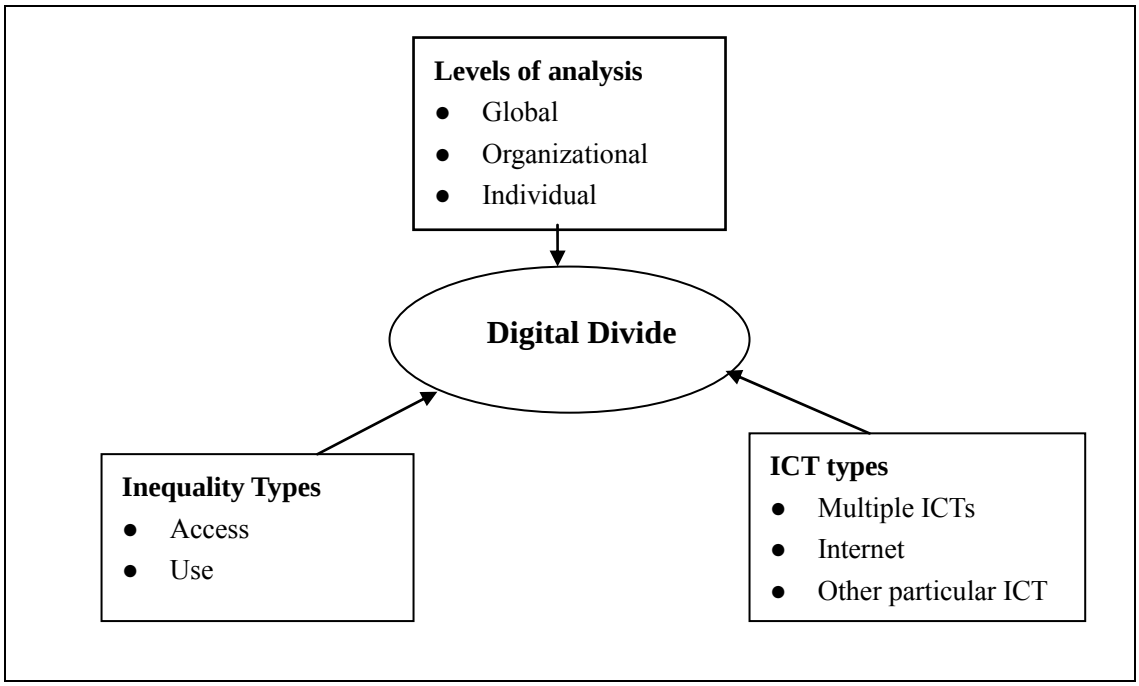
Measuring Digital Divide: The Exploration in Macao [1]

One of the most prominent and persistent concerns in the Internet-related social science studies in recent years has been the issue of digital divide. As an issue "rooted at the heart of the Information Society" (Sciada, 2005, p.299), since its very beginning of being coined in 1995 and popularized in the late 1990s to describe the social division among people in terms of their involvements of using information and communication technology (Hawkins, 2005), digital divide has been a "catchy expression" among academics, administrators, and policy makers (Hawkins, 2005, p. 172). The underlying reasons for the "increasing currency" (Joseph, 2001, p. 333) of this term lie in the wide recognition that the Internet has both empowering and discriminating ability to the citizens of a society (Guillen & Suarez, 2005) which, in Eamon's (2004) summarization, at least embodied in four major aspects: educational advantages, future employment and earnings, opportunities for social and civic involvement, and equity and civil right issues. The digital divide, therefore, represents "a major challenge"[2] confronted by any information-based network society and knowledge economy. Meanwhile, empirical evidence regarding the existence of digital divide has been accumulated rapidly in literature.

[1] Acknowledgement: The authors of this paper would like to acknowledge Prof. William Dutton and Prof. Jonathan Zhu for their contribution to the original collaboratie work.
[2] Cited from Dr. Abdul Waheed Khan, UNESCO, retrieved on December 20, 2005 from http://www.idrc.ca/en/ev-67626-201-1-DO_TOPIC.html

As relevant researches proliferated and policy debates continued, however, more and more accusations were raised regarding the validity of the concept of digital divide (e.g., Arquette, 2001; Hawkins, 2005; Guillen & Suarez, 2005; Servon, 2002; Van Dijk & Hacker, 2003). To cite Bertot's (2003, p. 185; cf: Hawkins, 2005, p.184) comment regarding this, the term of digital divide seems "too narrow at best and quite problematic at worst". The problem with the term "digital divide", as Hawkins (2005) puts it, is that while many researchers use it, "they did not always conceptualize the digital divide in the same manner" (p.174). Based on the review of numerous studies published in the past years under the umbrella of "digital divide", Dewan & Riggins (2005) summarized that in terms of levels of analysis, three different levels of digital divide are frequently explored, i.e., global level, organizational level and individual level. In terms of the types of inequality, similar to what Van Dijk and Hacker (2003) distinguished, they found that there are at least two inter-related but conceptually different types of divide, i.e., ICT access inequality and ICT use inequality, which they labeled as first order digital divide and second order digital divide respectively. Furthermore, it only takes a quick scrutiny to find out that the concrete content of so-called ICT in different studies also varied among numerous studies. For example, while some studies compare a wide range of ICTs' penetration in different countries (e.g., Dewan et al, 2005; Venkatesh & Shih, 2005; Wong, 2002; Arquette, 2002; Sciadas, 2005), some studies exclusively focus on the penetration of the Internet (e.g., Hargittai, 1999; Kiiski & Pohjola, 2002), and still some other studies might exclusively focus on other particular ICT such as digital wireless (e.g. , Kauffman & Techatassanasoontom, 2005). Bear all these different conceptualizations of so-called digital divide in mind, a defining framework of the concept can be proposed, with three key components in the scheme, as is shown in Figure 1 below.

Figure 1 The Key Components in the Conceptualization of Digital Divide



However, this is not the end of elaboration of this "misleading concept" (Paterson, 2004, p.123) of digital divide. For example, in his explication of the multifaceted nature of access, one of the two types of inequality identified above, Van Dijk (1999; cf: Van Dijk & Hacker, 2003) further distinguish four types of access, i.e., mental access, a concept related to the digital experience; material access which reflects the possessing of computers and network; skills access, the aspect related to people's digital skills or literacy, and usage access which is basically a reflection of usage opportunities. This somehow resonates with Hawkins' (2005) notice about the multilayered nature of the concept of access, that besides being conceptualized as physical access, other alternative ways of access should also be taken into consideration, including "information literacy and content" (p.178). Paterson (2004) similarly pointed out that access to ICT is embedded in a complex array of factors encompassing physical, digital, human and social resources and relationships.

In addition, there could also be different schemes of inequality types. For example, while Servon (2002) argued that digital divide is composed of three interrelated components, i.e., access, training and content, Corrocher & Ordanini (2002) employed a synthesis of six composite factors, including markets, diffusion, infrastructure, human resources, competitiveness and competition, in their analysis of global digital divide. Since many digital divide studies seek to identify the determinants of digital divide (e.g., Dewan et al.,

2005; Guillen & Suarez, 2005; Paterson, 2004; Hawkins, 2005, Norris, 2001), it is not surprising to have the observation that "the biggest differentiator of the research efforts has been the choice of dependent variable" (Dewan et al., 2005, p. 412), i.e., the choice of specific definition of digital divide. However, whatever the specific definition of the digital divide is, it can always be described with the framework we summarized in Figure 1.

Compared to the seemingly confusing situation of the conceptualization, the measurement of digital divide shows a different picture. In the situation of conceptualization of digital divide, the problem is that there are "too many" divergent understandings of what the concept actually means when it is used in various specific contexts. People have made great efforts to develop their own definitions about the term. Contrast to that, quite surprisingly, as Corrocher and Ordanini (2002, p.10) observed, there have not been so many efforts at developing and/or improving the theoretical approaches and the statistical methodology directed at measuring this divide. While different measures of the digital divide can result in very different inferences about the nature of the divide (Dewan et al., 2005, p.412), measurement efforts have been challenged by the "lack of an instrument capable of systematically quantifying the digital divide" (Sciada, 2005, p.299). This situation, at least partly, is due to the absence of a clear definition of the concept (Corrocher & Ordanini, 2002). Therefore, it is worthy of paying particular attention to the proposal of new measurement frameworks in order to further our studies of digital divide so that we might assess its "actual magnitude" with "appropriate evaluation techniques" (Corrocher & Ordanini, 2002, p.10). In fact, many voices were raised and pleas were heard regarding the quantification of digital divide, that "reliable measurement and analysis of the digital divide" is desperately needed (Sciada, 2005, p. 299). Notably, these pleas and comments were made very recently, implying that the appropriate measurement of digital divide is still a major challenge confronted by multiple players of the digital divide agenda.

This study attempts to make some unique contribution on this direction. Based on a critical review on the ways hitherto people employed to measure the digital divide, we propose a measure of digital divide based on the established approach in assessing the distributional inequality, i.e., the Gini coefficient. While we do justify the appropriateness of this approach in measuring different levels of analysis, as we depicted in Figure 1, this article will put its emphasis on the individual level analysis, that we view digital divide as a social divide in nature. While there do exist different levels of analysis in the studies of digital divide, it is our belief that individual level analysis represents the most essential and complex or subtle one. Accordingly, social divide constitutes the primary divide of varied levels of divide, may it be organizational level or global level. Logically, the analytical framework and measurement instruments developed in the individual level analysis should be easily applicable to the higher levels of analyses.

With this specification, we explore the digital divide situation in both types of inequalities, i.e., access divide and usage divide from the data drawn from a longitudinal Internet research project conducted between 2001 and 2007 in Macao. Furthermore, in this study, we are especially interested in the relationships between these two types of divide, that whether they have some inherent connection. Therefore, the first research question of this study is:

RQ1: What is the relationship between access divide and usage divide over time in Macao?

Many researchers have empirically revealed the dynamic nature of digital divide, that is, both the digital divides themselves and their determinants might evolve over time (Servon, 2002; Dewan et al., 2005; Sciada, 2005; Van Dijk & Hacker, 2003; Chakraborty & Bosman, 2005). More specifically, researchers are increasingly focusing on the forementioned second level digital divide or usage divide (Chakraborty & Bosman, 2005). This echoes Van Dijk's (1999) argument that there will be a "shift" in people's concern of digital divide from access gap to more complicated and socially important usage gap. The underlying hypothesis for this might be that, compared to access divide, usage divide might be more difficult and persistent. Here a longitudinal analysis is needed to examine the possible different evolutive patterns of two types of divides. Therefore, the second research question of this study is:

RQ2: Does usage divide evolve differently from access divide?

To summarize, the dynamic nature of digital divide (Servon, 2002) is highlighted and discussed based on our longitudinal analysis. As mentioned previously, since in numerous studies on digital divide, the situation of digital divide is most frequently treated as dependent variable, that researchers are tempted to identify various determinants of digital divide, it is evident that our study about the appropriate measurement and quantification of digital divide is of fundamentally important.

The Quantification of Digital Divide: An Instrumental Review

Digital divide research can be clustered based on different angles or dimensions, as Figure 1 illustrated. For example, in their summarization of current digital divide research, Dewan and Riggins (2005) conduct an overview basically according to the inequality types and levels of analysis. We can also categorize the numerous digital divide researches based on the ICTs involved in the studies.

An alternative approach for reviewing the relevant literature is simply to see whether a study is basically a demonstration of the existence and magnitude of digital divide, or it focuses more on the identification of various determinants of such divides. In other words, the former type of studies focuses on and explicitly describes or measures the digital divide per se. For the latter type of research, on the other hand, by putting its emphasis on the exploration of various causes of digital divide, the magnitude of divides per se

might not be the key concern. As been frequently shown (e.g., Dewan & Riggins, 2005; Dewan et al., 2005; Quibria et al. 2003), in this latter case, the situation of either ICT access or use is treated as dependent variable(s), and various regression analyses are typically employed to determine the significant factors related to such ICT access or usage. During this process, while the underlying assumption is that there do exist divides in ICT access or usage, the magnitudes of these divides per se are not necessary the key concern.

For the purpose of this study, however, we aim to focus more on the issue of digital divide quantification. Based on our review of publicly available digital divide studies, it is eminent that by and large the illustration of the existence of digital divide is descriptive in nature, usually with simple comparison of the mean values of particular indicators, a situation which echoes Sciada's (2005, p.299) mourn that "an instrument capable of systematically quantifying the digital divide" is yet to be recommended. The key problem with such simple comparison of aggregate values is twofold. On the one hand, by only use mean value rather than the whole distributional information of the indicators, this method of description could be misleading since the important information on the dispersion level of the distribution is methodologically neglected. On the other hand, this method is incapable of quantifying the magnitude of digital divides. This will especially become a problem when multiple ICTs and levels of analysis are considered together. The univariate nature of this illustration will make the supposedly intuitionistic description of digital divide extremely complex and confusing. Even though, it is still impossible to assess scientifically the magnitude of the divides.

As a remedy or improvement for this descriptive approach, some researchers attempt to employ some statistics to quantify the digital divide. For example, Dewan et al. (2005) employ the ratio of deviation to mean as the indicator of divide magnitude. Jin & Xiong (2002) also took the same criterion to assess the level of national digital divide, while Corrocher & Ordanini (2002) employ this approach to evaluate the magnitude of global digital divide.

Chakraborty and Bosman (2005) comment about the situation of measurement methods researchers have been using in their digital divide studies this way:

> Most of these empirical studies have relied on conventional statistical methods to measure differences in Internet access or PC ownership between races or income groups. Standard measures of distributional inequality, however, have rarely been used to analyze racial or economic disparities in the digital divide research literature. (p. 396-397)

Chakraborty and Bosman (2005) then argue that the Gini coefficient, "the best-known measure of inequality" (p.367), should be especially suitable as a standard measure of digital divide. As an established approach, this measure of inequality has been widely applied in many social sciences, including economics,

demography, epidemiology, and geography (See Chakratorty & Nosman, 2005 for a review). With this argument, they demonstrate how the Lorenz Curve and the Gini coefficient can be applied to measure income inequalities in the ownership of home PCs at the national, regional, and state levels. At least to our best knowledge, this is the only research which explicitly uses Gini coefficient to quantify the magnitude of digital divide in literature.

Importantly, for a "good" or standard measure of inequality, there are usually a set of criteria or properties that is expected to be satisfied (Allison, 1978; Dagum, 1983; cf. Chakraborty and Bosman, 2005). Gini coefficient satisfies all of these desired properties. Specifically, compared to the prior methods we reviewed, Gini coefficient is more succinct with a standardized format which makes its meaning clear and definite, comparable across different kinds of divides. That is why it becomes one of the most frequently used standard measures of distributional inequality in multiple fields.

This study follows the suggestion of employing a standard measure to quantify the magnitude of digital divides. Different from the focuses of Chakraborty and Bosman (2005), our analyses of digital divide will basically focus on individual level, i.e., the digital divide among different social groups defined by a couple of individual level demographic variables.

The Gini coefficient adopted in this study is defined as a ratio with values between 0 and 1: the numerator is the area between the Lorenz curve and the uniform (perfect) distribution line;[3] the denominator is the area under the uniform distribution line. Taking the income distribution as example, the computational formula of Gini coefficent is:

$$G = \sum_{i=1}^{n} W_i Y_i + 2\sum_{i=1}^{n-1} W_i (1 - V_i) - 1$$

Where W_i is the percentage of group i's population in the total population, Y_i is the percentage of group i's income in the total income of the population, and $V_i = Y_1 + Y_2 + Y_3 ... + Y_i$

Research Design

Operational Definition of Digital Divide

As explicated in Figure 1, our conceptualization of digital divide consists of three dimensions: levels of analysis, inequality types and ICT types involved. In this study, we focus on the investigation of the level of analysis and the inequality in access and usage of the Internet among social members. In their study about the digital divide in the United States, Lindsay and Poindexter (2003) took the same definition. More

[3] A detailed description of Lorenz curve can be found at Wikipedia, URL: http://en.wikipedia.org/wiki/Lorenz_curve.

specifically, we will investigate the distributional inequality of Internet access and usage among social groups defined by following key demographic variables:

a) Sex. A dummy of male and female was coded.
b) Educational level. Educational level of respondents was grouped into two categories: below university and university or above.
c) Employment. Three categories for this variable were constructed: employed, unemployed non-students, and students.
d) Age. Respondents' ages were grouped into three categories: less than 25, between 25 and 54, and older than 54.

With the specification of these factors, the respondents will be fallen into one of the 36 (2×2×3×3) groups defined by them. The digital divide is therefore operationally defined as the inequality of Internet access and use among these social groups.

The selection of these defining variables is actually based on the findings of numerous studies on the determinants of digital divide (e.g., Dewan et al., 2005; Hawkins, 2005; Lindsay & Poindexter, 2003). While income level is a widely used factor in researches of digital divide, especially among those with global level of analysis (e.g., Dewan et al., 2005; Guillen & Suarez, 2005; Hargittai, 1999), it is not included in our scheme of defining variables. One of the main reason for this is that educational level, as well as employment and age, is usually closely related to income level (e.g., Norris, 2001), therefore, the effect of income actually has largely been mediated by the factors specified above. On the other hand, as Norris (2001) found, once a certain level of Internet development is achieved, economic development is not necessarily essential to Internet use.

While *access* can be unambiguously operationalized that whether or not one is able to use the Internet, the operational definition for Internet *use* is much more complex and tricky. For example, as a multidimensional concept, Internet use can be defined either by the amount of online time, the frequency of use, or the websites or applications one uses. According to Zhu and He (2002), at least two dimensions, i.e., time and activities need to be considered in the operationalization of Internet use. In addition, when they elaborate the concept of usage gap,Van Dijk and Hacker (2003) apply the dimension of whether using the Internet for work and education, or out of the motivation of entertainment. In the current study, we will basically examine four aspects of Internet use, i.e., the time Internet users spend on the Internet, and three most popular Internet activities in terms of information acquisition, email use and online games playing. They are measured in the following ways.

1) Time: the time that users spend on the Internet was coded as light and heavy, segmented by the median of the weekly time. Heavy time was adopted in each demographic group.

2) Information acquisition, email use and online games playing: respondents were asked whether or not they participate in these online activities. A dummy code was assigned for each of them respectively.

Data of Analysis

The data for current study was drawn from the Macao Internet Project which is one of the partners of the World Internet Project. We conducted six random sampling telephone surveys from 2002 to 2007 in Macao. Each survey was conducted in every December, except the one in January in 2002, using a computer-assisted telephone interviewing (CATI) system. All surveys targeted at regular residents aged between 6 and 84 years old, except that the 2002 survey targeted at those between 18 and 74, who speak Chinese (including Cantonese, Mandarin and other dialects) and live in Macao with a residential telephone line. Calculated by the Response Rate Formulae 3 (RR3) of the American Association for Public Opinion Research (AAPOR),[4] the response rates are 40.2%, 46.2%, 45.3%, 36.2%, 46.4%, and 36.6% respectively. The sample size varies between 1002 and 2070. At the 95% confidence level, the sampling errors of the whole sample are ±3.16%, ±2.2%, ±2.5%, ±2.3%, ±2.4% and ±2.3% respectively. All sample data are weighted based on two demographic variables, i.e., gender and age.

Findings

We have illustrated in the previous section that digital divide involves both access divide and usage divide in the study of ICT divide, the Internet divide in particular. To answer our research questions "*RQ1: What is the relationship between access divide and usage divide over time in Macao?"*, and "*RQ2: Does usage divide evolve differently from access divide?"*, we start with the computation of a series of Gini coefficients to measure the magnitude of these divides based on the probability sample data between 2002 and 2007 in Macao. The results are shown in Table 1. For the purpose of reference, the Internet penetration rates are also listed.

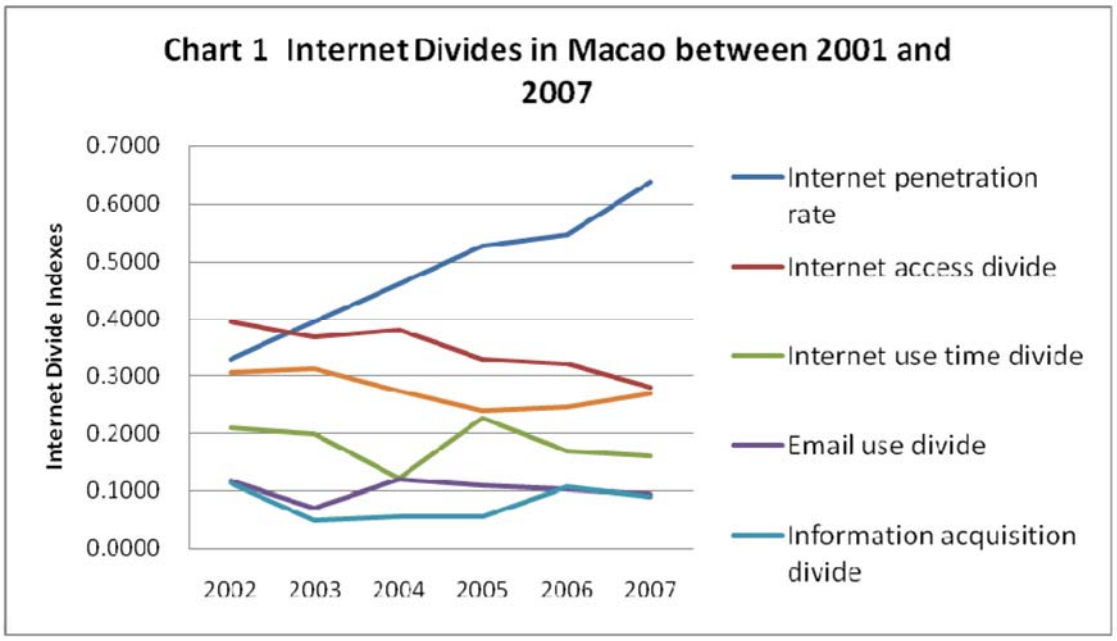
[4] See http://www.aapor.org/default.asp?page=survey_methods/standards_and_best_practices/standard_definitions#response

Table 1 Internet Divides in Macao between 2001 and 2007

	2002	2003	2004	2005	2006	2007
Internet penetration rate	32.9%	39.5%	46.2%	52.7%	54.8%	63.9%
Internet access divide	0.3941	0.3675	0.3796	0.3282	0.3200	0.2795
Internet use time divide	0.2081	0.1990	0.1215	0.2262	0.1684	0.1606
Email usage divide	0.1187	0.0712	0.1209	0.1102	0.1037	0.0959
Information acquisition divide	0.1132	0.0496	0.0559	0.0554	0.1061	0.0900
Online games playing divide	0.3073	0.3128	0.2752	0.2399	0.2471	0.2704

According to its definition, the bigger a Gini coefficient is, the larger the divide or inequality. From Table 1, among all types of divides, it is found that the Internet access divide is the largest one while information acquisition is the least. The greatest inequality is found in online games playing among the four usage divides. It is understandably that there are less variances of searching information among Internet user than those of playing online games. In addition, a closer examination on the Internet access divide shows that the divide drops from 0.3941 in 2002 to 0.2795 in 2007 whereas no clear pattern is found among the four Internet usage divides. It seems that such findings tell us the different characteristics between Internet access divide and Internet usage divide. A non statistically significant test of bivariate correlation analysis between Internet access divide and any of the four Internet usage divides also confirms the independent relationship between the two types of divide. It is also worthy of noting that a strong negative correlation (r=-.946) between Interne access divide and Internet penetration rate, indicating that more people using the Internet certainly helps to reduce inequality of Internet access, but this is not the case for Internet usage divide.

To better illustrate the scenario of Internet divides over time, we compare them in Chart 1 which shows the continuous declining pattern over years except a slight rise in 2004. As for the Internet usage divides, a fluctuant pattern is depicted. With this result, it can be preliminarily concluded that while access divide might relatively be easily predictable, usage divides are somehow much more elusory due to one of the facts that functionalities and applications of the Internet are continually updated. In other words, access divides and usage divides do evolve in different patterns.



Discussion and Conclusion

This study begin with the review of digital divide related studies and debates, which, in Norris' (2001, p.4) words, remained "conceptually over-simplified and theoretically underdeveloped". More specifically, we focus on the methods researchers have been using for the purpose of quantifying the magnitude of digital divide, and found that so far most of such efforts have been quite preliminary, characterized by the descriptive approach in nature. We then justify the necessity of using a standard measure of distribution inequality, i.e., Gini coefficient, in the studies of digital divide. During the process, we also elaborate a defining framework through which, various definitions of digital divide can be organized under the same umbrella. Three key constitutive components of this framework are levels of analysis, inequality types and types of ICT involved.

With these theoretical and methodological preparations, we attempt to explore the dynamic nature of digital divide by investigating the Internet access divide and usage divide in Macao over time. We empirically investigated the "dynamic disequilibria" (Chakraborty & Bosman, 2005, p. 397) of digital divide and found no relationship between Internet access divide and usage divide. We also confirmed from our findings that access divides and usage divides evolve in different patterns over time. The findings might

indicate that the Internet access divide and Internet usage divide are not parallel in terms of the magnitude of divide. In addition, the evolutive pattern of Internet access divide, in some sense, might mirror the socio-economic status as Arquette (2002) found that the digital divide parallels the gap in economic and human development.

Last but not least, it is suggested that future investigation on access divide or usage should be connected with broader social and cultural context. Previous studies have revealed that ICTs access and usage are related to factors such as cosmopolitanism (Guillen & Suarez, 2005), size of urban population, telecommunication policy, physical communication infrastructure , rule of law, credit card use, political freedom, etc. (Dewan et a., 2005).

References

Arquette, T. J. (2001). Assessing the digital divide: Empirical analysis of a meta-analytic framework for assessing the current state of information and communication system development. Unpublished draft dated on Sepember 15, 2001, Department of Communication Studies, Northwestern University

Arquette, T. J. (2002). Social discourse, scientific method, and the digital divide: Using the Information intelligence quotient (IIQ) to generate a multi-layered empirical analysis of digital division, Working Paper, Northwestern University.

Chakraborty, J. & Bosman, M. M. (2005). Measuring the digital divide in the United States: Race, income, and personal computer ownership. *The Professional Geographer, 57* (3), 395-410.

Corrocher, N. & Ordanini, A. (2002). Measuring the digital divide: A framework for the analysis of cross-country differences. *Journal of Information Technology, 17*, 9-19.

Dewan, S. & Riggins, F. J. (2005). The digital divide: Current and future research directions. *Journal of the Association for Information Systems, 6* (12), 298-336.

Dewan, S., Ganley, D., & Kraemer, K. L. (2005) Across the digital divide: A cross-country multi-technology analysis of the determinants of IT penetration. *Journal of the Association for Information Systems, 6* (12), 409-432.

Eamon, M. K. (2004). Digital divide in computer access and use between poor and non-poor youth. *Journal of Sociology and Social Welfare, XXXI*(2), 91-112.

Guillen, M. F. & Suarez, S. L. (2005). Explaining the global digital divide: Economic, political and sociological drivers of cross-national Internet use. *Social Forces, 84*(2), 681-708.

Hargittai, E. (1999). Weaving the western web: Explaining differences in Internet connectivity among OECD countries. *Telecommunications Policy, 23* (10/11), 701-718.

Hawkins, S. (2005). Beyond the digital divide: Issues of access and economics. *The Canadian Journal of Information and Library Science, 29* (2), 171-189.

Jin, J. & Xiong, C. (2002). Digital divide in terms of National Informatization Quotient: The perspective of Mainland China. Paper presented on *International Conference on The Digital Divide: Technology and Politics in the Information Age,* 22-23 August 2002, Hong Kong.

Joseph, R. (2001). Understanding the digital divide. *Prometheus, 19*(4), 333-336.

Kauffman, R. J. & Techatassanasoontorn, A. A. (2005). International diffusion of digital mobile technology: A coupled-hazard state-based approach. *Information Technology and Management, 6* (2), 253-292.

Kiiski, S. & Pohjola, M. (2002). Cross-country diffusion of the Internet. *Information Economics and Policy, 14* (2), 297-310.

Lindsay, B. & Poindexter, M. T. (2003). The Internet: Creating equity through continuous education or perpetuating a digital divide? *Comparative Education Review, 47* (1), 112-122.

Norris, D. T. & Conceicao, S. (2004). Narrowing the digital divide in low-income, urban communities. *New Directions for Adult and Continuing Education, 101*, 69-81.

Norris, P. (2001). *Digital divide: Civic engagement, information poverty, and the Internet worldwide*. New York, NY: Cambridge University Press.

Paterson, A. (2004). (Book review) Technology and Social Inclusion: Rethinking the digital divide by Mark Warschauer. Knowledge, *Technology, & Policy, 16*(4), 122-125.

Quibria, M. G., Ahmed, S. N., Tschang, T., & Reyes-Macasaquit, M. L. (2003). Digital divide: Determinants and policies with special reference to Asia. *Journal of Asian Economics, 13* (6), 811-825.

Sciada, G. (2005). Infostates across countries and over time: Conceptualization, modeling, and measurements of the digital divide. *Information Technology for Development, 11*(3), 299-304.

Servon, L. (2002). Four myths about the digital divide. *Planning Theory & Practice*, 222-227.

Van Dijk, J. & Hacker, K. (2003). The digital divide as a complex and dynamic phenomenon. *The Information Society, 19*, 315-326.

Van Dijk, Jan (1999). *The network society: Social aspects of new media*. Thousand Oaks, CA: Sage.

Venkatesh, V. & Shih, C. F. (2005). An investigation of theories of diffusion in the global context: A comparative study of the U.S., Sweden and India. Working paper, The Paul Merage School of Business, University of California, Irvine, CA.

Wong, P. K. (2002). ICT production and diffusion in Asia: Digital dividends or digital divide? *Information Economics and Policy, 142*(2), 167-187.

Zhu, J. H. & Zhou, H. (2002). Perceived characteristics, perceived needs, and perceived popularity: Adoption and use of the Internet in China. *Communication Research, 29* (4), 466-495.