Human Capital as the Main Determinant of Digital Divide: An Analysis of Technological Inequality in Countries Surveyed by the AsiaBarometer 2006

Kamila Kolpashnikova
The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo-to 113-0033 JAPAN

Abstract
This paper is focused on the analysis of digital divide within countries and cities surveyed in the AsiaBarometer 2006 database, namely, China, Hong Kong, Japan, Korea, Singapore, Taiwan, and Vietnam. The research constructs a model based on the data from the database, which consists of nine input variables, including fixed lines, mobile phones, household income, education level, English proficiency, geographical region, urbanization, and population size. Those variables are regressed against one dependent variable which represents an index of Internet and mobile use. The OLS multivariate regression shows that the most important determinants of ICT usage are education level and English proficiency. In contradiction with previous works and findings, within the data of this database, income appeared not to be a significant determinant of digital divide. This indicates the genuine and ever-fluctuating nature of digital inequality and its inconsistency in connection with other types of inequality.

Keywords: digital divide, technological inequality, human capital, ICTs, South-East Asia

1. Introduction
The fascination with what Alvin Toffler has called “that great, growling engine of change,” technology, starts to cool down, because it has become apparent that even technology does not change the inherent differences among and within countries. The new technological difference emerged to exacerbate the gap between people, which is referred to as digital inequality, or divide.

However, as Sen and Foster (1997) have pointed out, before there is a research on the issue of equality or inequality, the question “[in]equality of what?” should be answered.

There is a variety of inequalities. Jan van Dijk in his paper “Digital Divide Research, Achievements and Shortcomings” (2006) brings 5 different kinds of inequality: technological (inequality in “technological opportunities”); immaterial (inequality of “life chances, freedom”); material (inequality of “capital (economic, social, cultural), resources”); social (inequality in “positions, power, participation”); educational (inequality of “capabilities, skills”).

The technological inequality, defined as the technological opportunities, is represented by info-tech-infrastructure discrepancies. Those discrepancies are defined by the availability of the infrastructure to the population of a given country or a social group. The infrastructure that is usually relevant in the research of digital divide is computers and the Internet. In other words, this type of inequality is defined by, as Kling (1998) has put it, in the availability of “computers of adequate speed and equipped with appropriate software for a given activity,” and also by the availability of the access to the Internet, which corresponds with the definition given by van Dijk (2005). In the research of digital inequality, there is also a distinction between access and usage. The primary divide is in the access to the technologies, but with increase of diffusion rates, the divide is more visible in the usage patterns.

The immaterial inequality is a very difficult inequality to assess, it is represented in life chances and levels of freedom. Democracy and political systems in general can be regarded as indicators of such inequality. For example, Guillen and Suarez (2001) found that digital inequality is connected significantly with favorable conditions for entrepreneurship and investment, or Beilock and Dimitrova (2003) determine the openness of a society as an important determinant of digital divide. Both predictability of policymaking and openness of society may be regarded as the immaterial inequality.

The material inequality is perhaps the most apparent of all inequalities. It is commonly identified by income disparities. Within this research direction, income is considered by far the major determinant of digital divide. For example, Quibria et al. (2002) find strong relationship between technology use and income. Dasgupta et al. (2001) come to the same results and proclaim the income as the most important component of the digital divide: the digital divide “reflects a long-standing gap in per-capita availability of mainline telecom services.” Income is also one of the variables to explain the digital divide in the works of Fairlie (2002), Novak and Hoffman (1998).

The social inequality is the inequality in “position, power, and participation” (van Dijk, 2006) that is usually attributed to different social groups, such as, within same age, gender, race, etc. In the connection with digital divide,
the social inequality is usually analyzed within the frames of individual country, region, or group. For example, Lin (1998) suggests that personal computer adoption heavily depends on age. However, she also concluded that the best predictor is the ownership of other information and communication technologies (ICTs), followed by income and age.

The educational inequality may be represented in the two aspects: formal education itself and skills (training). In the context of digital inequality, those skills may include software literacy, hardware literacy (in whole called IT literacy - “the ability to use IT for a range of purposes” (Servon, 2002, p.7)), and language (Brooks et al., 2005), as a necessary skill for maximizing the utility of using the Internet.

As it can be seen from previous paragraphs, there can be drawn a number of parallels between different kinds of inequality.

This research concentrates on digital inequality of contry-level, and tries to estimate the current relationship between Internet usage with other kinds of inequality, employing the data of the Asia Barometer 2006 on seven South-East Asian countries and cities, namely (in alphabetical order), China, Hong Kong, Japan, Korea, Singapore, Taiwan, and Vietnam.

The next section of this paper will concentrate on the analysis of the previous research of digital divide. The third section will be devoted to the methodology, followed by results section. The problems met while conducting this research will be stated in the Limitations. The summary of main findings and their discussion will be brought in the end, within the Conclusions section.

2. Research Background

There exist two frameworks in which researchers deal with the phenomenon of digital divide--conceptual and empirical.

2.1 Conceptual Framework

The researches within the conceptual framework deal with definition and characteristics of digital divide and have several main directions. These directions explain the approaches to defining digital divide.

The main two approaches are from the research level—on the levels of global and social digital divides. The global divide reflects the differences between countries or regions of the world. Most of the researches on digital divide fall into this category (Norris, 2001; van Dijk, 2006, Warschauer, 2004; DiMaggio and Hargittai, 2001; Quibria et al., 2002; Dasgupta et al., 2001). The social divide researches, on the other hand, are the ones that are concerned with the gap between social groups within a country (Fairlie, 2002; Novak and Hoffman, 1998, etc.). This classification into global and social divides may be further extended by including additional individual level. This level is rarely used in research, but echoes, for example, in the work of Barzilai-Nahon et al. (2004) “Measuring Gaps in Cyberspace: Constructing a comprehensive digital divide index.”

Norris (2001, p.4) mentions also democratic digital divide, that is, “the difference between those who do, and do not, use the panoply of digital resources to engage, mobilize, and participate in public life.” This gives us another idea of the possible classification of digital divide research. There are three main dimensions of social activities (Stanfield, 2000, p.149) -- politics, economics and culture. The democratic digital divide can be classified according to those three dimensions, that is, the divide between people in connection with political, economic or cultural aspects. For example, political divide research can employ political indicators as political democracy (Crenshaw and Robison, 2006).

Another type of classification of digital divide is separation between “optimists” and “pessimists.” These two method types are also called the “disappearing digital divide approach” and the “emerging digital differentiation approach” (Peter and Valkenburg, 2006, p.296).

As one of the representatives of the optimists' wing, Negroponte (1998) concludes that the characteristics of the Internet will help the poor states to catch up quickly. On the other hand, the pessimists, such as Wilson and Rodriguez (2000), think that the digital divide between rich and developing countries is growing.

The ambivalence of the views on the issue may be explained by the fact that ICTs taken individually diffuse, however, in broader sense, inequality may persist due to unavailability and expensiveness of newly introduced technologies to poorer countries, regions, or groups of people.

2.2 Definition of Digital Divide

The concept of digital divide is usually limited to computers (or sometimes, internet hosts) and the Internet (as in van Dijk, 2005). This limitation can be justified by two immediate needs: to narrow down the definition and to emphasize the importance of those two components in the digital inequality.

Although some of the researchers of digital divide define it as the gap in the access only to the Internet (Castells, 2002), software and adequate hardware, which in general could be referred to as “computers,” are also the significant factor of technological advantage. However, the usage of multidimensional form of digital divide definition complicates its measurement. In these cases, the researchers commonly use indices of digital divide. It is necessary to note that software is an important indicator because it is one of the important tools of skill-upgrade and according to some researchers “helps students to learn the most” [among other types of computer knowledge].
(Tien and Fu, 2008); but it is also a very difficult indicator to assess, for there is no extensive data to work with.

2.3 Empirical Framework

The practical (empirical) framework represents a number of indices in the reports of international entities on the issues that deal with the ICTs and econometric models to assess the digital divide.

2.4 Indices

On the international level, there are global digital divide indices, such as Digital Divide Index (DDI) of Orbibcom (Sciadas, 2002) and Digital Divide Index (DDIX, and later DIDIX) of Empirica, Digital Opportunity Index (DOI) and ICT Opportunity Index (ICT-OI), introduced by International Telecommunication Union (World Information Society Report 2007).

Digital Opportunity Index (DOI)

“The Digital Opportunity Index has been designed to as a tool for tracking progress in bridging the digital divide and the implementation of the outcomes of the World Summit on the Information Society (WSIS)” (ITU and UNCTAD, 2007, p. 35). It consists of 11 indicators divided into 3 groups, which are represented in the following Figure 1.:}

![Figure 1. The Digital Opportunity Index](source)


It can be summarized that the indicators of DOI index are focused on: mobiles, Internet, computers and fixed lines, with an emphasis on different types of Internet access.

DDI and ICT – Opportunity Index (ICT-OI)

“The ICT Opportunity Index is the result of merger of two well-known projects, ITU’s Digital Access Index (DAI) and Orbibcom’s Digital Divide Index (DDI)” (Ibid., p. 119). DDI project was held by Canada based companies, Orbibcom and the Canadian International Development Agency (CIDA) in 2002-2003. Both DDI and ICT-OI consist of 2 groups of indicators: Info-Density and Info-Use. While Info-Density reflects productive capacity, Info-Use reflects consumption. These two groups are divided into 4 sub-groups: Networks, Skills, and Uptake, Intensity, correspondingly.

![Figure 2. The ICT Opportunity Index](source)


The indicators, additionally to the technological infrastructure (main telephone lines, mobiles, Internet, computers and TVs), draw attention to the literacy component of digital divide and introduce literacy and enrolment rates.

DIDIX

The DIDIX is an index introduced by Empirica. Empirica is a German “internationally active research and consulting firm concentrating on concept development, the application and development of new information and communication technology and the information society” (Empirica, 2009). Among its clients are the European Commission and the Eurostat. The index is based on survey and uses classification of results based on gender, age, income and education. The index is divided into four “risk groups” according to that classification.

In the Figure 3, DIDIX – a digital divide index is presented. In the lest column, the groups of the social strata under research are brought. On the right side, the three dimensions (three indicators) of digital divide are shown with their respective weights.

![Figure 3. The Digital Divide Index (DIDIX)](source)
2.5 Model Framework

Separately stands another empirical research direction—econometric modelling of digital divide. This sections focuses on four examples of such modelling.

In Dasgupta et al. (2001), authors introduce a model of estimating growth of Internet intensity, depending on the impact of urbanization, income, and government policy.

\[
\log N_t = \log N_{t-1} + \beta_0 + \beta_1 \log Y_{t-1} + \beta_2 \log U_{t-1} + \beta_3 \log C_{t-1} + \theta R_{it} + \varepsilon_t
\]

where \( N_t \) = Internet subscribers/telephone mainlines

\( U_{it} \) = Size of urban population

\( Y_{it} \) = Income per capita

\( C_{it} \) = Index of competition policy

\( R_{it} \) = Vector of regional dummy variables (Sub-Saharan Africa, Middle East/North Africa, Asia, Latin America).

This research of Dasgupta et al. stresses the importance of policy differences and income in digital divide.

Another paper by Dewan et al. (2005) “Across the Digital Divide: A Cross-Country Multi-Technology Analysis of the Determinants of IT Penetration” provides a model, in which digital divide (IT penetration - \( IT_t \)) is estimated through several indicators, such as, main telephone lines (MAINit), monthly telephone subscription cost (TELit), average cost of local call (CALLit), size of urban population (URBANit), GDP per capita (GDPtr), average years of schooling (SCHit), and size of goods in the economy (TRADEit) (\( \varepsilon_t \) is an error term). The model is
given on p. 420 (Dewan et al., 2005):

\[
IT_t = \beta_0 + \beta_1 MAINit + \beta_2 TELit + \beta_3 CALLit + \beta_4 URBANit + \beta_5 GDPtr + \beta_6 SCHit + \beta_7 TRADEit + \text{(year dummies)} + \varepsilon_t
\]

Dewan et al. suggest that income is the main determinant of information technology penetration.

Crenshaw and Robinson (2006) adopted the following model to “explore the relationship between growth in Internet hosts” and a number of independent variables (p. 195) (NB.Y stand for internet hosts):

\[
\text{Log}(Y_{it}) = \beta_0 + \beta_1 (\text{log of internet hosts} 1995) + \beta_2 (\text{log of gross domestic product per capita}) + \beta_3 (\text{log of tertiary education}) + \beta_4 (\text{log of liberal democracy}) + \beta_5 (\text{log of property rights}) + \beta_6 (\text{log of local cost of 3-minute call}) + \beta_7 (X_{it}) + \varepsilon_t.
\]

This research found that “foreign investment, major urban agglomerations, manufacturing exports, nongovernmental organization presence, and tourism as well as democratic openness, property rights, and income” are the best predictors of Internet diffusion.

Another research by Wunnava and Leiter (2008) tests the model of relationship between Internet Penetration Rate and several “determinants of inter-country Internet diffusion rates” (p. 8):

\[
\text{INTERNET}_t = \beta_0 + \beta_1 \text{lnGDP}_t + \beta_2 \text{INFRA}_t + \beta_3 \text{TERTENROL}_t + \beta_4 \text{URBANPOP}_t + \beta_5 \text{ENGLISH}_t + \beta_6 \text{GINI}_t + \beta_7 \text{FREEDOM}_t + \varepsilon_t
\]

where

\( \text{GDP} \) = GDP per capita measured at PPP,

\( \text{INFRA} \) = “telecommunications and infrastructure variable, which is calculated by taking the minimum of the telephone and PC penetration rate” (p. 8, Ibid.),

\( \text{TERTENROL} \) = gross tertiary enrollment,

\( \text{URBANPOP} \) = urban population,

\( \text{ENGLISH} \) = variable of whether country’s official language is English or it is not,

\( \text{GINI} \) = Gini Income Inequality Index,

\( \text{FREEDOM} \) = Freedomhouse's Freedom Index.

This researched showed that GDP, telephone and PC penetration rates, English proficiency, Freedom Index were the main determinants of Internet penetration rates, with Gini Index and tertiary enrollment playing also a more or less significant role. This frameworks leaves out the urbanization as a determinant of Internet use.

Several commonalities may be drawn out of these four researches. They all suggest that income is an important determinant, political matters are also considered important. The views on urbanization differ, while Dasgupta, et al. (2001) and Wunnava and Leiter (2008) do not find a connection with digital divide, Crenshaw and Robinson (2006) emphasize the importance of urban agglomerations.

3. Research Methodology

The present work was conducted based on the model which was constructed in accordance with the previous literature on the determinants of digital divide and available recent data, which was not yet used in the digital inequality research.
3.1 Data

All data was extracted from the Asia Barometer 2006, a project “carried out on the Grants-in-Aid for Scientific Research of the Japanese Ministry of Education, Culture, Sports, Science and Technology, 2005-2008 with the project identification number 17002002, which covers seven societies in East and Southeast Asia. Fieldwork is conducted by Nippon Research Center, Ltd., a Gallup International Association member in Japan, and its partners in each country/area. AsiaBarometer is a registered trademark of Professor Takashi Inoguchi, Chuo University, Japan, Director of the AsiaBarometer Project. In 2006, 7 countries and major cities were surveyed: China, Hong Kong (China), Japan, Republic of Korea, Singapore, Taiwan (China), and Vietnam” (AsiaBarometer.org).

“The Asia Barometer 2006 survey covers such topics as: quality of Life, governance, democratic consolidation/regression, social virtues, happiness, international alignments, new middle class, religiosity, mass media, identity, and globalization” (AsiaBarometer.org).

The number of respondents was 2000 for China, 1000 for Hong Kong, 1003 for Japan, 1023 for Korea, 1006 for Taiwan, 1000 for Vietnam.

Sampling method for Asia Barometer 2006 was “multistage stratified random sampling and quota sampling” (AsiaBarometer.org) and it employed face-to-face interviews as the survey method.

The questionnaire consists of 50 main questions (Q1-Q50), some containing sub-questions within themselves, and 9 questions of personal character (F1-F9).

3.2 Model

The research employs OLS method for the following model:

$$II = \beta_0 + \beta_1 Fixed\_Lines + \beta_2 Mobile\_Phones + \beta_3 Gender + \beta_4 English\_Ability + \beta_5 Educational\_Level + \beta_6 Region + \beta_7 Urban + \beta_8 Population\_Size + \beta_9 lnIncome + \epsilon$$

The model consists of nine available variables, including two variables of infrastructure (fixed lines and mobile phones), one income variable, one education variable and three variables concerning the residency (geography, urbanization, and population size). The latter, particularly urbanization and population size data, are not available for all the countries.

“II (Internet Index)” is the arithmetic average of three variables that are considered as indicators of Internet usage from the database, namely, concerning viewing Internet web pages, reading/writing e-mails, and reading/writing messages on mobile phones. The three variables are corresponding sub-questions of the question Q2 “Please indicate how frequent you use the Internet and mobile phones” from the Asia Barometer Questionnaire 2006. The first, question was “How often do you view Internet web pages by computers?”, the second “How often do you read or write e-mails by computers?”, and the third “How often do you read or write messages by mobile phones?”. The answers contained six options: “almost everyday (=1),” “several times a week (=2),” “several times a month (=3),” “seldom (=4),” “never (=5),” and “don't know (=9).” DK (“don't know”) answers were omitted within the regression analysis.

“Fixed_Lines” is a variable on the basis of the 4th sub-question “Fixed-line phone” of the question Q1 “Which of the following public utilities does your household have the use of?”. The answers consisted of two options: yes (= 1) and no (= 0).

“Mobile_Phones” is a variable on the basis of the 5th sub-question “Mobile phone” of the question Q1 “Which of the following public utilities does your household have the use of?”. As with the “Fixed_Lines,” the answers consisted of two options: yes (= 1) and no (= 0).

“Gender” is a variable on the basis of the question F1 “Please indicate your gender.” The answers consisted of two options: male (= 1) and female (= 2).

“English_Ability” is a variable on the basis of the question F4 “How well do you speak English?”. The answers consisted of five options: “not at all (=1),” “very little (=2),” “I can speak it well enough to get by in daily life (=3),” “I can speak English fluently (=4),” and “don't know (=9).” DK answers were omitted within the regression analysis.

“Educational_Level” is a variable on the basis of the question F3 “What is the highest level of education you have completed?”. The answers consisted of six options: “no formal education (=1),” “elementary school/junior high school/middle school (=2),” “high school (=3),” “professional school/technical school (=4),” “university/graduate school (=5),” and “don't know (=9).” DK answers were omitted within the regression analysis.

“Region” is a variable on the basis of data that was compiled by interviewers depending on where the respondent resided. The options differ for each country/city. The answers for China are “Eastern (=1),” “Central (=2),” and “Western (=3).” The answers for Hong Kong are “Hong Kong Island (=1),” “Kowloon Peninsula (=2),” and “New Territories (=3).” The answers for Japan are “Hokkaido/Tohoku (=1),” “Kanto (=2),” “Chubu (=3),” “Kinki (=4),” “Chugoku/Shikoku (=5),” and “Kyushu (=6).” The answers for Korea are “Seoul Metropolitan Area (=1),” “Middle Area (=2),” “South-West Area,” and “South-East Area.” The answers for Singapore are “Northern (=1),” “Eastern (=2),” “Southern (=3),” “Western (=4),” and “Central (=5).” The answers for Taiwan are “Northern (=1),” “Western (=2),” and
“Southern (=3).” The answers for Vietnam are “Northern (=1),” “Central (=2),” “Northern (=3),” and “Mekong Delta (=4).”

“Urban” is a variable on the basis of data that was compiled by interviewers depending on where the respondent resided. The answers consisted of two options: “urban (=1)” and “rural (=2).” This data is available only for three cities: Hong Kong, Singapore, and Taiwan. However, for Hong Kong and Singapore all respondents were identified as “urban,” which can be explained by the fact that Hang Kong and Singapore are cities, while Taiwan is a little bigger region (island).

“Population Size” is a variable on the basis of data that was compiled by interviewers depending on where the respondent resided. The options differ for each country/city and are available for 5 countries: China, Japan, Korea, Singapore, and Vietnam. The answers for China are “Population 3 million or more (=1),” “Population 1-3 million (=2),” “Population 0.5 – 1 million (=3),” “Population less than 0.5 million (=4),” and “Country (=5).” The answers for Japan are “Government-Designated Cities (=1),” “Population 1000000 or more (=2),” “Population less than 1000000 (=3),” and “Towns and Towns (4).” The answers for Korea are “Large city (=1),” “Small and Medium City (=2),” and “Eup/Myon (=3).” Eup and Myons are towns (administrative entities) in Korea. The answers for Singapore are “Population 9000000 or more (=1)” and “Population less than 9000000.” The answers for Vietnam is a list of different cities of the country: “Ha Noi (=1),” “Thai Nguyen (=2),” “Da Nang (=3),” “Hue (=4),” “HCMC (=5),” “Vung Tau (=6),” “Can Tho (=7),” and “My Tho (=8).”

“lnIncome” a logged income variable on the basis of the question F8 “What was the total gross annual income of your household last year?”. The explanation of why the income variables were logged is brought in the following section (Results). The options differ for each country/city. On most of the countries data is based on yearly income, except Singapore and Taiwan, where monthly income was asked. Each questionnaire contained the answer “Don’t know (=99)” for people who found it difficult to calculate their income, as well. Income data seems to be the most inconsistently composed within the Asia Barometer survey. The answers for China consist of 20 different levels, starting with less than RMB200000 (USD2926) increasing by RMB100000 (USD1463) each step till RMB2000000 (USD29260) a year. The answers for Hong Kong consist of 20 different levels, starting with less than HKD500000 (USD6435) increasing by HKD200000 each step till HKD1500000, by HKD300000 each further step till HKD3000000, by HKD500000 further four steps till HKD5000000, by HKD1000000 till HKD8000000, and by HKD2000000 till HKD 1 million, with the last level (=20) for HKD1 million (USD128700) or more a year. The answers for Japan consist of 20 different levels, starting with less than JPY2 million (USD22227) increasing by JPY1 million (USD11114) each step till JPY20 million (USD222272) or more a year. The answers for Korea consist of 20 different levels, starting with less than KRW20 million (USD17384) increasing by KRW10 million (USD8692) each step till KRW200 million (USD173837) or more a year. The answers for Singapore consist of 12 different levels, starting with “no income (=1),” followed by less than SGD1000 (USD708) increasing by SGD1000 (USD708) each step till SGD10000 (USD7083) or more a month. The answers for Taiwan consist of 20 different levels, starting with less than TWD300000 (USD935) increasing by TWD100000 each step till TWD500000, by TWD50000 each further step till TWD100000, by TWD200000 one step till TWD150000, by TWD500000 one step till TWD200000, with the last level (=20) for TWD200000 (USD6232) or more a month. The answers for Vietnam consist of 16 different levels, starting with less than VND12 million (USD642) increasing by VND12 million each step till VND180 million (USD9626) or more a year.

4. Results and Discussions

4.1 Distribution Analysis of Income Variable

The results of the distribution of the variables skewness is given in the following Table 1. The two columns of the table are for skewness and kurtosis respectively. The numbers outside brackets are the statistics and in brackets —standard errors for skewness or kurtosis.

<table>
<thead>
<tr>
<th>Country</th>
<th>Skewness (st.er)</th>
<th>Kurtosis (st.er)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>2.83 (0.055)</td>
<td>10.78 (0.11)</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>0.21 (0.08)</td>
<td>-0.27 (0.16)</td>
</tr>
<tr>
<td>Japan</td>
<td>1.54 (0.089)</td>
<td>3.17 (0.178)</td>
</tr>
<tr>
<td>Korea</td>
<td>2.6 (0.078)</td>
<td>12.95 (0.155)</td>
</tr>
<tr>
<td>Singapore</td>
<td>0.96 (0.078)</td>
<td>0.46 (0.154)</td>
</tr>
<tr>
<td>Taiwan</td>
<td>0.43 (0.078)</td>
<td>-0.78 (0.156)</td>
</tr>
<tr>
<td>Vietnam</td>
<td>2.12 (0.077)</td>
<td>6.08 (0.155)</td>
</tr>
</tbody>
</table>

The results show considerable skewness in income data, especially, for China, Korea, and Vietnam.

For all countries, the statistics for skewness is not within the range of +/- twice the standard error of skewness.

There is only one city for which the value of kurtosis is within the range of +/- twice the standard error of kurtosis —Hong Kong. All other countries data, except Taiwan which appeared to be platykurtic, are leptokurtic.

The income variable, hence, was logged to avoid the excessive influence of outliers. For the logged functions the skewness and kurtosis statistics are brought on the Table 2.

Table 2 : Skewness and Kurtosis of Logged Income Distribution
As it is shown in the Table 3, skewness and kurtosis are lesser in the case of logged distributions, this explains the choice of logged function for income variable.

### 4.2 Regression

The results of regression analysis had shown the significance of Education level, English ability, and Mobile phones as the main determinants of the digital divide. On the other hand, some traditional determinants as fixed lines and income were not far as significant within the scope of this research.

The multiple regression was made using ordinary least squares method (SPSS).

The Internet Index (II) was taken as the dependent variable, and other nine variables—as regressors.

**Table 3 : Standardized Coefficients (Beta) for Independent Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>China</th>
<th>Hong Kong</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed-lines</td>
<td>0.026</td>
<td>-0.016</td>
<td>-0.008</td>
</tr>
<tr>
<td>Mobiles</td>
<td>-0.180***</td>
<td>-0.038</td>
<td>-0.213***</td>
</tr>
<tr>
<td>Gender</td>
<td>0.020</td>
<td>0.012</td>
<td>0.029</td>
</tr>
<tr>
<td>English</td>
<td>-0.200***</td>
<td>-0.228***</td>
<td>-0.193***</td>
</tr>
<tr>
<td>Education</td>
<td>-0.413***</td>
<td>-0.409***</td>
<td>-0.236***</td>
</tr>
<tr>
<td>Region</td>
<td>-0.004</td>
<td>-0.038</td>
<td>0.043</td>
</tr>
<tr>
<td>Urbanization</td>
<td>0.045**</td>
<td>0.019</td>
<td></td>
</tr>
<tr>
<td>log_Income</td>
<td>-0.126***</td>
<td>-0.115***</td>
<td>-0.090***</td>
</tr>
</tbody>
</table>

**R² with II**  

<table>
<thead>
<tr>
<th>Variable</th>
<th>Korea</th>
<th>Singapore</th>
<th>Taiwan</th>
<th>Vietnam</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.034.</td>
<td>0.007</td>
<td>-0.027</td>
<td>-0.034.</td>
</tr>
<tr>
<td></td>
<td>-0.126***</td>
<td>-0.072***</td>
<td>-0.066***</td>
<td>-0.293***</td>
</tr>
<tr>
<td></td>
<td>-0.017.</td>
<td>0.014.</td>
<td>0.001.</td>
<td>0.143***</td>
</tr>
<tr>
<td></td>
<td>-0.118***</td>
<td>-0.314***</td>
<td>-0.206***</td>
<td>-0.240***</td>
</tr>
<tr>
<td></td>
<td>-0.532***</td>
<td>-0.358***</td>
<td>-0.440***</td>
<td>-0.282***</td>
</tr>
<tr>
<td></td>
<td>0.026.</td>
<td>0.025.</td>
<td>0.048.</td>
<td>-0.004.</td>
</tr>
<tr>
<td></td>
<td>-0.019.</td>
<td>0.017.</td>
<td>0.022.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.087***</td>
<td>-0.183***</td>
<td>-0.062***</td>
<td>-0.052.</td>
</tr>
<tr>
<td></td>
<td>0.500.</td>
<td>0.532.</td>
<td>0.408.</td>
<td>0.442.</td>
</tr>
</tbody>
</table>

**Table 4 : Average Ranking of Independent Variables within Model**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed-lines</td>
<td>6.5 (7)</td>
</tr>
<tr>
<td>Mobiles</td>
<td>2.7 (3)</td>
</tr>
<tr>
<td>Gender</td>
<td>6.3 (6)</td>
</tr>
<tr>
<td>English</td>
<td>2.5 (2)</td>
</tr>
<tr>
<td>Education</td>
<td>1.2 (1)</td>
</tr>
<tr>
<td>Region</td>
<td>6.0 (5)</td>
</tr>
<tr>
<td>Urbanization</td>
<td>7.0 (9)</td>
</tr>
<tr>
<td>Population size</td>
<td>6.6 (8)</td>
</tr>
<tr>
<td>log_Income</td>
<td>3.8 (4)</td>
</tr>
</tbody>
</table>

To ease the summary of results through variables, the average rankings of each variable are taken to see which of them showed more strength within the Model. In the Table 4 those average rankings are brought to the table view. The number outside the brackets is the average ranking among countries, inside—the ranking of the average rankings within the nine input variables.

In this way it is easier to see that there can be found some similarities among countries. In all countries, the best predictor among independent variables was Education Level, except for Vietnam, where it was on the second place. However, in general, the Education Level variable, which has the significant explanation level in all countries, is the best predictor of digital inequality within this Model. Education had the biggest share (53%) in explaining Internet Index in Korea. This may have to do with the deregulation of telecommunication market in the country, together with a significant emphasis on the technology in the Korean educational policy.

The next best predictor was English Ability with significant levels in all countries. The English knowledge seemed to be more important in Singapore, almost matching in its explanation strength (31%) to education level (36%). Despite the fact that English is an official language of Singapore, the inequality in English ability seem to pose a barrier to the use of the Internet by Singaporeans.

The third in rank is Mobile Phones variable, which has a significant level in all countries except Hong Kong. The variable is most “heavy” in Vietnam (29%) and Japan (21%).

Contrary to previous findings, f.e. of Ono (2006) or of the digital divide model constructors mentioned in the background literature section of the present research, income appeared to be between the third to fifth places, and the fourth rank in average among independent variables to explain digital divide, nonetheless, it had a significant level except in Vietnam. The biggest share in the model this variable has in Singapore (18%), but in general less than 10% of explanation strength among all countries.

As it is shown in the Table 3, the model had a significant explanation strength in three out of seven countries (R² is equal or greater than 0.5)—China, Korea, and Singapore. In Hong Kong, Taiwan, and Vietnam is has lesser credibility with R² being between 0.4 and 0.49. However, in Japan this model does not seem to apply, as R² is only 0.24. Nevertheless, the main focus was not the model itself, but the nature of the relations of the determinants with the Internet Index.
Other five variables seemed to have very little to do with digital divide, including gender, and mostly were not significant (p > 0.05).

Gender showed everywhere negative correlation with Internet Index, except in Korea. This means that in general everywhere, but not in Korea, men are more prone to use Internet. However, the numbers are too small for this conclusion to be significant. This variable, on the other hand, has a significant level in Vietnam, probably, indicating persistent gender inequality within the country.

Fixed lines, once a very good predictor of digital divide, appear to lose their upper hand. This is probably because the technology of fixed lines was diffused in all seven countries, if compared to different more modern technologies, such as mobile phones. Moreover, the world trends of fixed lines show that this technology is being more and more abandoned and replaced by mobile phones instead.

All spatial variables, that is, Region, Urbanization and Population Size, showed no significant explanation ability within this model, in contrast with Crenshaw and Robinson (2006).

5. Limitations

It is notable that income did not appear as the main determinant of the digital divide. Beside the conclusion used herewith, the reason may lie in the fact that data on income was collected without considering the average income in the country/city. In the most of income distributions, responds tended to concentrate at the lower parts of income range. This may be explained by the supposition of interviewers that usually in households there are at least two people whose income should be considered and the tendency to increase the expectancy of household income when compiling the questionnaires. However, the means of household income did not appear to be much higher than the country's per-capita average. One of the possible explanations could be that women of most households did not hold a job at the time.

The results of spatial data was also hard to interpret. If the data was arranged in the order of (perceived or otherwise measured) development, the results may have shown some significance.

6. Conclusions

The present research's main finding was that among the target countries and cities—China, Hong Kong, Japan, Korea, Singapore, Taiwan, and Vietnam—education level proved to be the best explanatory variable of digital divide. Moreover, two of the top variables were the ones concerned with the quality of human capital, rather than infrastructure.

The transition from income inequality as the main contributor to differences in ICT usage to educational inequality suggests that the digital inequality in itself might not necessarily reflect only the financial gap between people. Moreover, considering the speed of ICTs' diffusion, it is safe to state that within the seven countries of the present research income is no longer the main determinant of Internet and mobile usage.

This finding goes in accordance with the augural vision of DiMaggio and Hargittai (2001), who “hypothesize[d] that, in the long run, education will be a strong predictor of the use of the Internet for the enhancement of human capital, the development of social capital, and political participation.”

However, in OECD's Information Technology Outlook 2008, it is stated that the discrepancies between people of some OECD countries with different types of education level have almost disappeared. This indicates that with time the diffusion of technologies reaches the state when it is distributed evenly despite income or education. Hence, the digital inequality has a very fluctuating nature and is not a mere reflection of income and educational inequalities, because it shows individual distinctions compared to them.

The same may be stated in regards to the other infrastructural technologies. The Internet usage depends on the infrastructure, but, because the latter may be already evenly diffused, it does not obligatorily mirror infrastructure's distribution. While having more in common with individual technologies at a moment (like here with mobiles), Internet usage has ceased to depend on other ICTs, to which it used to correlate strongly before (fixed lines).

The significant variable of infrastructure within the seven countries was mobile phones. It was especially apparent in Vietnam, perhaps, because the services are not yet evenly diffused along the country. Indeed, Vietnam has the lowest mobile penetration rates within the countries in question. Another nation with a “heavy weight” on mobiles is Japan, which was predictable, for many of the Japanese prefer to access Internet from their portable phones.

The most puzzling result is probably the dominance, albeit insignificant, of women in Internet use in Korea. It is very difficult to find explanation for this phenomenon without its further and better analysis. This contradicts the finding of Ono (2006) who states that in “South Korea, women are less likely to use... the Internet than men.” The short difference of a decade and a whole new generation of Internet users may have really changed the gender of an average Internet user in Korea.

The gender variable in general was on significant level only in Vietnam, indicating the persistent gender inequality in the country. Despite the stereotype, however, the other six Asian countries showed very little gender
inequality in ICT usage, which gives hope for levelling of gender-related ICT use differences in the region.

Therefore, despite the major opinion that digital inequality solely reflects innate social differences within countries, it proved that it has its own character, together with its own speed of diffusion, and that it may depend on different types of inequalities at different points of time. This dependence continuously changes or sometimes halts altogether, urging researchers to follow its progress at all times.

7. Acknowledgements

The author wants to thank the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT) for the scholarship to study in the University of Tokyo that made this research possible.

The author is also very thankful to Professor Shigeto Sonoda of the University of Tokyo for providing data of AsiaBarometer database and valuable comments on the preliminary stage of this paper.

References


7. Acknowledgements

The author wants to thank the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT) for the scholarship to study in the University of Tokyo that made this research possible.

The author is also very thankful to Professor Shigeto Sonoda of the University of Tokyo for providing data of AsiaBarometer database and valuable comments on the preliminary stage of this paper.

References