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The Role of Income Inequality in a Multivariate Cross-National Analysis of the Digital Divide

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This article is subject to the following research question: Is the role of income inequality in comparison to other factors an element that influences the digital divide? Eleven variables providing data on 126 countries are analyzed using multivariate regression to identify which of them influence Internet usage to what extent. The used data on 126 countries refer to the year 2005. The results show that income inequality measured by the Gini coefficient is an important influencing factor besides per capita income, the degree of urbanization, and the level of democratization. The results question reductionistic digital divide approaches that analyze information inequality via focusing on a single variable (such as technology or markets). Access to ICTs is shaped by the interaction of socioeconomic, political, cultural, social, and technological factors. These results cast doubt on technological determinism, economic reductionism, and linear trend projection in the digital divide debate. Digital divide causes are complex.

Keywords: *digital divide; social inequality; multivariate regression analysis; social theory; international comparative assessment; global data; mathematical modeling; social policy*

The goal of the study at hand is to discuss and test the role of social inequality in the digital divide in comparison to other variables. It will be assessed which variables have the most important effects on the digital divide and which role social inequality plays in this respect. As a method multivariate regression analysis is used. The analysis is based on data (11 variables addressing economic, social, political, and cultural issues) on 126 countries collected in 2005.

The potential result of the research could be one of the following options:

> Social inequality has no significant influence on the level of the digital divide, other variables are exclusively determinant.
> Social inequality is one of several factors that influence the level of the digital divide in complex ways.
> Social inequality is the only important factor with significant effects on the digital divide.

First, a short overview of the concept of social inequality is given (Section 1). Then, a connection to the notion of the digital divide is established (Section 2). Next, the applied method for studying the influence of social inequality on the global digital divide is explained

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in a separate section (Section 3). Finally, the results are reported and conclusions are drawn (Section 4).

As an introduction to the research topic addressed in this article, it will be shown that social inequality is an important factor that influences contemporary society. Because social inequality needs to be studied by performing social policy research, it must also become an issue in digital divide research. Therefore, a justification for the topic of social inequality being addressed is first required.

Bob Sutcliffe (2004, cf. also 2003) gave an overview of six different approaches in world inequality studies:

> Intercountry distribution approaches study the distribution of income between countries. Treating all countries equally, for example, by comparing the average income (gross domestic product [GDP] per capita, purchasing power parity [PPP]) of the 10 richest countries to that of the 10 poorest, shows an increase in inequality. Population-weighted calculations of the Gini coefficient of the world show a long-term increase of inequality from 1820 to 1980 and a fall since 1980. Sutcliffe stressed that this decrease is due to the rapid economic growth of China. Treating developing and developed countries as two separate blocs, therefore, shows an overall decreasing Gini inequality for both developed and developing countries since 1950. Within developing countries, based on this rating, there has been an increase of inequality in Africa and Latin America and a decrease in Asia since 1980. Measured in terms of average income, the average income per head in the South as percentage of that in the North has been continuously declining since 1950.
>
> Global approaches treat the world as if it were one country. Calculations of global Gini coefficients (Bourguignon and Morrisson, Sutcliffe, Sala-i-Martin) have shown decreasing global inequality since 1980.
>
> Branko Milanovic (2002) did not calculate inequality based on GDP data that were adjusted by PPP as most other studies did, but his study was based on household income surveys from 91 countries. He calculated an increase in Gini inequality, from 62.5 to 66, for the period from 1988 to 1993.
>
> Another possibility of measurement is to analyze the ratios of extremes: The ratio of the income per capita of the 10 richest percentages compared to the 10 poorest percentages (90:10 ratio) of the world shows continuous increases in inequality since 1950, whereas the 80:20 ratio shows continuous decreases since 1975.
>
> Focusing on life expectancy measures shows increases in global life expectancy.
>
> The human development index is a multivariable index based on the GDP per capita (PPP), the life expectancy at birth, the adult literacy rate, and the combined enrolment ratio in primary, secondary, and tertiary education. According to Sutcliffe, it is designed in a way to show the increasing convergence between rich and poor countries.

Sutcliffe stressed the fact that one can prove either increasing inequality or increasing equality, depending on the variables and data sources that are used. Certain groups like the IMF (International Monetary Fund) would conduct "inequality denial" to avoid policy changes. Sutcliffe stressed the importance of the ratios of extreme incomes.

> Whether or not the integral measures show convergence, the ratios of extremes reveal rising polarization between the top and the bottom groups. . . . There is no sign at all that either the extreme impoverishment at the bottom or the extreme enrichment at the top of the world distribution are coming to an end. (Sutcliffe, 2004, p. 33)

> Inequality in the distribution of income in the world in the modern epoch as a whole is higher than in any previous period of world history; and it is greater than the inequality which exists in any single one of the world's component countries. . . . Unfortunately, we can be safe in the knowledge that an egalitarian world is not at hand. (Sutcliffe, 2003, p. 33)

Likewise David Harvey (2005) stressed that in the past decades the upper-income classes have increased their income share in countries like the United States or the United Kingdom due to specific policy frameworks that have resulted in "the restoration or reconstruction of the power of economic elites" (p. 19). Against positions that argue that purely market-oriented policies have in the past decade produced a decrease in world income inequality and in the number of poor and absolute poor people (those living on less than US$2 and US$1 a day, respectively) and an increase in the absolute number of people living in medium developing countries, Held and McGrew stressed that the

> Actual trends (. . .) denote a real increase in both global inequality and world poverty. (. . .) Global wealth or assets are even more unequally distributed. Estimates indicate that the richest 10 per cent of the world's population own 85 per cent of the world's wealth—a GINI of 0.89—compared to most countries, where the richest 10 per cent in most economies own 50 per cent of total wealth—a GINI of 0.7, with only a few above 0,8. (. . .) In 1960, the income of the richest 20 per cent of the world's people stood at about thirty times that of the poorest 20 per cent; by 1997 the corresponding figure was seventy-four. (Held & McGrew, 2007, pp. 130-131)

It is estimated that between 1969 and 1999 the average real pay of CEOs of big corporations rose 11 times whereas that of production workers remained unchanged (Sutcliffe, 2003, p. 3). The richest 1% of the world (50 million) receives as much as the bottom 57% (2.7 billion). The top 10% of the U.S. population (25 million people) receives an income equal to the poorest 43% of the world (2 billion). Furthermore, 75% of the world population receive only 25% of the world income (all data for 1993, by Milanovic, 2002).

In challenging neoclassical views, one particularly prominent view of the past years has been the one by Nobel laureate Amartya Sen (1999), who argued to consider poverty and freedom not only in terms of income, but to take them as capabilities and deprivation of capabilities "of persons to lead the kind of lives they value" (p. 18). This view is important as it stresses that a good life is not simply obtained by money, but additionally requires premises such as health care, education, political participation, gender equality, and so on. The problem with Sen's view is that by shifting the attention away from poverty in terms of lack of money, he also shifts the attention away from issues that concern income distribution. It is left out that freedom is not just individual, but relational and based on the overall distribution of resources (that enable individual capacities). Sen is so much preoccupied with individual capabilities that he does not see that these capabilities can be limited by unequal distribution of resources, of which money certainly is not the only one, but in the current capitalist system a very important one. Sen (1999) gave an analysis in which all resources are equally important; for example, he argued:

> A person who is disabled may have a larger basket of primary goods and yet have less chance to lead a normal life (or to pursue his or her objectives) than an able-bodied person with a

> smaller basket of primary goods. Similarly, an older person or a person more prone to illness can be more disadvantaged in a generally accepted sense even with a larger bundle of primary goods. (p. 74)

A disabled or old and ill person who is starving and does not have any material resources will probably die; the lack of economic resources might intensify the negative consequences of the disablement and the illness because in a capitalistic environment support and treatment for the disabled cost money, and the rich (in terms of money) can afford better support and treatment. Socioeconomic deprivation intensifies all other problems, whereas other problems do not automatically intensify material scarcity. This example intends to show that distribution of economic resources is not the only aspect of equality, but the foundational one. The danger that underlies Sen's argument is that it can be interpreted as the position that one can be free and happy without control of economic resources, an assumption that supports the continued existence of socioeconomic inequality. He does not focus on the dialectic of opulence and poverty (Cameron, 2000). To stress his position that all capabilities are equally relevant, Sen argued in another example that South Africa (2005 GNP per capita: US$11,110, PPP; life expectancy at birth: 50.8 years), Namibia (GNP per capita: US$7,586, PPP, life expectancy: 51.6 years) or Brazil (GNP per capita: US$8,402, PPP; life expectancy: 71.7 years) have a higher per capita GNP than Sri Lanka (GNP per capita: US$4,595, PPP; life expectancy: 71.6 years) or China (GNP per capita: US$6,757, PPP; life expectancy: 72.5 years), but a lower life expectancy (Sen, 1999, p. 6, data based on UNHDR, 2007). This example creates the impression that *life expectancy* is an independent variable, but Sen did not mention that in China and Sri Lanka income distribution (Gini: 46.9 and 40.2) is more equal than in the other countries mentioned previously (Gini South Africa: 57.8, Namibia: 74.3, Brazil: 57) and that hence socioeconomic issues might have influence on noneconomic issues like life expectancy and, therefore, play a central role (data from UNHDR, 2007). Brazil and South Africa are "symbols of inequality" (Sutcliffe, 2003, p. 30). To shift the attention from the "overemphasis on income poverty and income inequality" (Sen, 1999, p. 108) to "the more inclusive idea of capability deprivation" (Sen, 1999, p. 20) plays down the central importance of socioeconomic issues in capitalist society.

> But if existing property rights regimes disenfranchise the have-nots, then what property rights does economic democracy deliver? How does one argue for the superiority of one property rights regime over another? Just as conservatives sidestep this question by favoring existing property rights regimes, Sen sidesteps the basic philosophical question by simply favoring an expansion of property rights for the poor (Hahnel, 2005, p. 49).

In digital-divide research, Robin Mansell and colleagues, who tend to argue that a dual strategy is best for solving the problem of the digital divide in developing countries on a global level, have promoted Sen's capabilities approach. This dual strategy is focusing on one hand on opening markets for capital investment to provide infrastructures and simultaneously advancing human capacities by public education endeavors on the other (Credé & Mansell, 1998; Mansell & Wehn, 1998). As shown in the works of Sen, there is a strong focus on individual capacity strengthening. Scientific and professional skills, tacit knowledge, social capabilities, language skills, participatory skills, facilitating skills, and control skills are considered as a central premise for solving the problem of the digital divide; for

example, it is argued that "coordinated ICT investment strategies can produce economic returns and social benefits" (Credé & Mansell, 1998). Just like in the works of Sen, there is hardly any focus on social inequality and class relations and the fact that, as shown by the data provided above, during the past decades, economic development has not benefited all, but for many it has resulted in social inequality that they confront in their daily lives.

Given the fact that social inequality seems to be a central issue concerning contemporary society, its relation to the digital divide will be discussed in the following section.

Social Inequality and Digital Divides

During the past couple of years, more and more scholars have argued that the digital divide is not a technological problem, but a social problem and the consequence of underlying societal inequalities. Furthermore, it has been stressed that the digital divide concerns not only the availability of computers, but also the required skills for using it and what users do with computers. Jan van Dijk (2005) distinguished between motivational, material, skills, and usage access to new media. Mossberger, Tolbert, and Stansbury (2003) distinguished between access, skills, economic opportunity, and democratic divide. Wilson (2006) described eight aspects of the digital divide: physical access, financial access, cognitive access, design access, content access, production access, institutional access, and political access. Warschauer (2003) distinguished access as falling under physical, digital, human, and social resources categories. The different forms of access can be considered as layered, with material access at the bottom, which means that each type is necessary, but is not sufficient precondition for the next. If one has no access to computers and the Internet in physical terms, then it will not make sense and it will not be possible to develop specific skills and usage experiences.

Van Dijk (2005) argued that access is dependent on personal factors (age, gender, ethnicity, intelligence, personality, health, and ability) and the availability of temporal, material, mental, social, and cultural resources. The latter's availability would be shaped by structural positions in labor, education, household, and nation. Norris (2001) identified a global, a social (income), and a democratic divide. Castells (2001) saw income, education, ethnicity, age, family status, and ability as determining access factors. Wilson (2006) saw the six demographic variables of gender, geography, income, education, occupation, and ethnicity as influencing access. DiMaggio, Hargittai, Celeste, and Shafer (2007) listed eight categories of stratification: region and place, employment status, income, education, ethnicity, age, gender, and family structure.

Given the broadening of the digital divide concept, it is feasible to argue that social inequality is a factor that should be accounted for in digital-divide research. This assumption is supported by research undertaken by Jeffrey James (2007a, 2007b, 2008), who argued for a redefinition of the digital-divide concept, so that differences between individuals are taken into consideration. As one important factor, the "inequality of Internet use within, rather than between countries" (James, 2007b) should be taken into account. The problem is that only few countries have provided data that link Internet usage to income levels (James, 2007b).

Hardly any theoretical foundations exist to explain the digital divide (Vehovar, Sicherl, Hüsing, & Dolnicar, 2006). Recent works by the author of this article attempted to provide

a social theory for studying phenomena concerning the relationship of Internet and society (Fuchs, 2006, 2007, 2008). It can be used as a basis for the study of digital divides.

Society can be conceived as consisting of interconnected subsystems that are not independent and based on one specific function they fulfill, but are open, communicatively interconnected, and networked. The following subsystems of a model of society can be conceived: ecological, technological, economic, political, and cultural subsystems (Fuchs, 2008). Why exactly these systems? To survive, humans have to appropriate and change nature (ecology) with the help of technologies so that they can produce resources for distribution and consumption (economy), which enable them to make collective decisions (polity), form values, and acquire skills (culture). If one conceives the economy as being created by humans that act on nature by using technology to achieve specific goals, then the core of this model consists of three systems (economy, polity, culture). This distinction can also be found in other contemporary sociological theories: Giddens (1984, pp. 28-34) distinguishes between economic institutions, political institutions, and symbolic orders/modes of discourse as the three types of institutions in society. (cf. Fuchs, 2003b). Bourdieu (1986) spoke of economic, political, and cultural capital as the three types of structures in society. (cf. Fuchs, 2003a). Habermas (1984) distinguished between the lifeworld, the economic system, and the political system. Human agents and social structures that are produced by human agents and condition the agents' practices shape each of the subsystems of society. Each subsystem is defined and permanently re-created by a reflexive loop that productively interconnects human agents and their practices with social structures. (Fuchs 2003a, 2003b, 2008).

Technologies enable and constrain human practices, and their main dimensions are as follows: the material access to them (in modern society mainly with the help of money as technologies are sold as commodities), the capability to use them, the capability to use them in such ways that oneself and others can benefit, and embedding institutions. The digital divide refers to unequal patterns of material access to, usage capabilities of, and benefits from computer-based information and communication technologies that are caused by certain stratification processes that produce classes of winners and losers of the information society, and of participation in institutions governing information and communication technologies (ICTs) and society. Material access refers to the availability of hardware, software, applications, networks, and the usability of ICT devices and applications. Usage access and skills access refer to the capabilities needed for operating ICT hardware and applications, for producing meaningful online content, and for engaging in online communication and cooperation. Benefit access refers to ICT usage that benefits the individual and advances a good society for all. Institutional access refers to the participation of citizens in institutions that govern the Internet and ICTs, and to the empowerment of citizens by ICTs to participate in political information, communication, and decision-making processes. Stratification patterns are on one hand social hierarchies such as age, family status, ability, gender, ethnicity, origin, language, and geography (urban/rural). These categories have resulted in different types of the social divide. On the other hand, unequal patterns of material access, usage capabilities, benefits, and participation concerning ICTs are also due to the asymmetric distribution of economic (money, property), political (power, social relationships), and cultural capital (skills). Hence, there is also an economic divide, a political divide, and a cultural divide. In modern society, structures take on the form of capital that is accumulated and unevenly distributed, so that different social classes and class fractions with a different (high,

Table 1
Aspects and Dimensions of the Digital Divide

	Economic capital	Political Capital	Cultural Capital	Age	Family Status	Gender	Ability	Ethnicity	Origin	Language	Geography
Material access											
Usage and skills access											
Benefit access											
Institutional access											

medium, low) total amount of economic, political, and cultural capital are created (see Fuchs, 2008). The reason for gaps in access, usage/skills, benefit, and participation concerning ICTs is the multidimensional class structure of modern society that creates structural inequalities. People with high income, far-reaching and influential social relationships, good education and high skills are much more likely to have access to ICTs, to be capable of using them, to benefit from this usage, and to be supported in political participation by ICTs than people who are endowed with only a little amount of economic, political, or cultural capital. Table 1 summarizes aspects and dimensions of the digital divide.

Based on these theoretical foundations, two digital-divide studies have already been carried out (Fuchs & Horak, 2007, 2008). This article enhances and concretizes these works further.

Treating digital divides as complex issues means that, on one hand, different forms of access have to be distinguished and on the other hand that the factors that influence the existence and potential closing of digital divides should be considered as multiple and interconnected. To contribute to complex digital-divide research, the joint influence of multiple variables on physical Internet access will be evaluated with the help of international data on 126 countries. The employed method will be described in the next chapter.

Digital Divide Methodology

Vehovar et al. (2006) argued that digital divide studies are dominated by simple comparisons like bivariate analyses that are not sufficient and sometimes even misleading. They suggest to increase the usage of three complex methodologies: multivariate modeling, compound indexes, and time-distance studies. Today "bivariate methods often prevail in digital divide research" (Vehovar et al., 2006, p. 282). It would be overlooked that by "simultaneously examining several variables we may discover that they behave differently compared to bivariate analysis" (Vehovar et al., 2006, p. 287). The study of the article at hand is a contribution to the development of more complex methods for researching the digital divide. It takes up Vehovar's suggestion in the field of multivariate analysis. Similar to Vehovar, Jos De Haan (2004) called for multifaceted dynamic models of the digital divide that are based on multivariate analyses.

Multivariate analyses have already been applied in a number of digital divide studies. These studies fall within two categories: national and global research.

Mossberger et al. (2003) analyzed the influence of political affiliation, gender, education, age, ethnicity, and income on the level of ICT access in the United States using multivariate regression. Van Dijk (2005) reported the results of a multivariate analysis of surveys on Internet access conducted in the United States and the Netherlands and shows the importance of income as an influencing factor on physical access to computers. Korupp and Szydlik (2005) applied the same method to data from three waves of the German socioeconomic panel to determine the influence of human capital, family context, and social context on Internet and computer usage. Van Dijk (2005, chapter 4) found that material access in the United States and the Netherlands was most dependent on income, followed by education, age, and gender. Concerning occupational structure, managers and professionals had best access conditions, followed by technical, sales, support occupations; precision production, craft, and repair occupations; service workers; jobs in farming, forestry, and fishing; and operators, fabricators, and manual workers. Concerning households, families with school-age children had the highest access rates. Families without children and single households had the lowest figures. There was also a significant gap between urban and rural areas. Mossberger, Tolbert, Johns, and King (2006) used multivariate regression to show that less educated workers and lower-paid minorities experience a larger percentage of change in income due to ICT use in the United States. A methodologically comparable study was conducted to show the importance of ethnicity and region as stratifying factors in ICT access (Mossberger, Tolbert, & Gilbert, 2006). Martin and Robinson (2007) used multiple regressions for analyzing the development of the relation of Internet access and family income in the United States from 1997 to 2003.

Hargittai (1999) tested the influence of various factors on the number of Internet hosts in a country for 18 OECD countries. Norris (2001) analyzed the influence of economic, social, political, and regional development on old and new media adoption based on cross-national data by multivariate regression. Quibria, Ahmed, Tschang, and Reyes-Macasaquit (2003) analyzed how population size, GDP per capita, and education influence ICT adoption in Asian countries. Caca-Ferreruela and Alabau-Munoz (2004) analyzed data on 30 OECD countries to determine which factors influence broadband markets. Grigorovici, Constantin, Jayakar, Taylor, and Schement (2004) conducted a multivariate regression of World Bank and ITU data to show that ICT development is more influenced by capabilities of skills than by existing connectivity. Chinn and Robert (2004) used regression analysis based on data on 161 countries for determining the influence of 11 factors (4 technological, 3 demographic, 2 economic, 2 educational ones) on Internet penetration. Mariscal (2005) focused on the influence of GDP per capita, urbanization, and privatization on teledensity in a study on 85 countries. Crenshaw and Robison (2006) used longitudinal regression analysis to study the influences of a number of variables such as tourism level, foreign direct investment (FDI), manufacturing exports, urban agglomeration, NGO presence, GDP, property rights, democratic openness on Internet diffusion in 80 developing countries. Chon-Kyun Kim (2007) analyzed the relation of various factors on e-government performance based on data on 163 countries. The study is an international comparison and it uses multivariate regression with interval-scaled variables.

These studies, which were conducted either at the national or global level, have one thing in common; that is, little attention was given to income inequality. The specific qualities of the study at hand are:

Multivariate analyses on Internet usage rates are carried out based on a number of variables.
The study uses comparative data on 126 countries. It aims to find general global patterns.
The study is specifically interested in the role of income distribution.
The study uses a theoretical model that allows using inequality measures systematically.

The goal of the conducted multivariate regression was to obtain a linear equation that estimates the number of Internet users per 1,000 people for all countries, based on various economic, political, cultural, and social variables. Most of the data were obtained from *Human Development Report 2007/2008*, which reports data for the year 2005. Other data for the same year were included too (sources are indicated in the following table). Table 2 gives an overview of which data were gathered and entered into SPSS 13. Specific attention in the analysis will be given to social inequality. The study is limited to the influences on physical Internet access, as this access is materially essential and the one on which most cross-national data is available.

The dependent variable "Internet access" was measured by Internet access per 1,000 inhabitants in a country. Data was taken from the *Human Development Report* 2007/2008 (UNHDR, 2007), which bases its figures on the World Bank's World Development Indicators (WDI). World Development Indicators Internet usage data in turn are based on the International Telecommunication Union's (ITU) World Telecommunication Indicators (WTI), whose Internet usage data are based on national surveys or estimations of the number of Internet users in a country. An alternative index, also provided by the ITU, is the number of Internet subscribers (regular or broadband). But, as this number tends to be smaller because there are people who are not subscribers but only users, for a more detailed coverage, the *number of Internet users* per 1,000 inhabitants was selected as dependent variable. An advantage of using this indicator is that it is available for almost all countries, which allows to use a large number of countries and data for this mathematical model. Another advantage is that the ITU data are relative and internationally comparative. The dependent variable represents physical access, which means that issues such as usage access and benefit access were neglected in this analysis. On one hand, this poses potential for future research, and on the other hand, the focus on physical access might be a good entry for a rather novel stream of research because data on it is relatively standardized and easily available (which is not the case for other dimensions of ICT access) and physical access can be considered as the material foundation of access: If people do not have access to computers, computer networks, hardware, and software, they will not be able to develop any usage capacities and benefits. The first is a necessary but not a sufficient condition for the second.

The United Nation's statistical database serves as main data source for the study at hand as it provides data on all 177 countries which are included in the *Human Development Report*. Table 2 shows a respectable number of variables on which comparable international data were gathered. However, it would have been interesting to include some additional variables: In the economic realm, it would be interesting to include data on hourly real wages, wage shares, and industry concentration ratios to assess if a relative fall in wages and a highly concentrated economy have negative effects on Internet adoption. For real wages, no comparable data are available. The ILO only provides nonstandardized data in national currencies for only 80 countries. Concerning wage shares, data on 27 European countries and some non-European ones are available in the Annual-Macro Economic Database (AMECO). For concentration ratios, no national and internationally comparable data are available. To

Table 2
Aspects and Dimensions of the Digital Divide in the Conducted Study

	Economic Capital	Political Capital	Cultural Capital	Age	Family Status	Gender	Ability and Health	Ethnicity	Origin	Language	Geography
Material access	GDP per capita US$ PPP, GDP growth rate 1990-2004, Gini index, share of richest 10% to poorest 10%, share of richest 20% to poorest 20%, unemployment rate, services in % of total employment, share of wealth held by richest/ poorest 10/20 %	Democracy index (fair elections and pluralism, functioning of government, political participation, political culture, civil liberties), average voter turnout in all national elections since 1945 (IDEA: Institute for Democracy and Electoral Assistance)	Adult literacy rate, combined gross enrolment ratio for primary, secondary and tertiary education	Life expectancy at birth, population under the age of 15, population over 65	Birth rate per 1,000 (UN Common Database), fertility rate (UN Common Database), average household size only until 1994	Gender-related development index (GDI: literacy, education, income), gender empowerment measure (GEM: women in parliament, income, job positions)	Life expectancy at birth, disabled persons per 1,000 (UNO statistics from 1990, too old for reliable inclusion)	Migration stock (UN Common Database)	Migration stock (UN Common Database)		Urban population as % of total population
Usage and skills access											
Benefit access											
Institutional Access											

Note: GDP = gross domestic product; GDI = gross domestic income; PPP = purchasing power parity.

obtain reliable results, comparable data from more than 100 countries are required. Therefore, the three interesting economic variables could not be included. Unfortunately, there is a strong neoclassical predominance in macroeconomic data collection. Concerning the political realm, it would be interesting to include data on civil society to avoid a purely institutional view of politics. However, no such data is available to a significant extent. The most interesting variable is the Civil Society Index (civilsocietyindex.org), which so far only covers 50 countries; this is not enough for obtaining significant results.

To avoid errors in multivariate regression analysis, one has to avoid a strong degree of multicollinearity. To guarantee this quality, bivariate correlations between all variables shown in Table 1 were conducted and all variables that showed high correlations were eliminated ($r > .80$; Berry & Feldman, 1985, p. 43). For example, it is obvious that the Gini coefficient will correlate highly with the other income distribution measures on which data are available. Or that there are high correlations between the adult literacy rate and the educational enrolment rate, and between the share of people aged less than 15, the share of people aged more than 65, the fertility rate, and the birth rate. There was also a high correlation between the gender indexes and other variables due to the fact that these indexes are based on other variables such as education and GDP. Therefore, gender variables were not included. The unemployment variable was not included in the analysis as for many developing countries no data were available. Finally, only those variables were included in the multivariate correlation that showed coefficients of less than .8 when bivariately correlated with all other included variables. These were 11 interval-scaled variables: voter turnout (political), democracy index (political), GDP per capita (economic), growth of GDP per capita (economic), share of services in total employment (economic), Gini coefficient (economic), adult literacy rate (cultural), share of migrant stock (social), share of urban population (social), life expectancy (social), and age under 15 (social). Another condition that should be fulfilled to avoid high multicollinearity is that tolerance ($1\text{-}R^2$) is more than 0.1 and the variance inflator factor (VIF) less than 10 (Ho, 2006, p. 249) when regressions between predictors are performed. Conducting such regressions with SPSS showed that all of our predictors fulfilled these conditions for tolerance and VIFs.

A first estimation was obtained by conducting casewise, excluding multivariate regression using the enter method with the help of SPSS 13 ($N = 99$, see Table 3). $R^2 = .814$, so the model can account for 81.4% of differences in variance. $F(11, 88) = 35.003$, significance = 0.000, showed a good ability of the model for predicting the outcomes. The collinearity statistics in the table show that there were no significant interactions between the variables. One can observe that the factors that have the highest influence on the Internet access in this model are GDP per capita, the Gini coefficient, the degree of urbanization, and the level of democratization.

Via stepwise regression, the same model was optimized and the resulting model then was again run separately to obtain a better fit by including a larger number of cases through variable reduction. The results are reported and interpreted in the next section.

Results and Interpretation

Table 4 shows the model that was obtained using stepwise multivariate regression. It is based on 126 cases.

Table 3
Model Number 1

	Coefficients Unstandardized		Standardized Coefficients			Statistics Collinearity	
	B	*SE*	β	*t*	Significance	Tolerance	VIF
(Constant)	–28,850	201,497		–0.143	.886		
Democracy index 2007	20,161	10,106	.162	1,995	.049	.319	3,132
GDP per capita	0.010	0.002	.539	5,176	.000	.195	5,123
Gini index	–3,711	1,491	–.171	–2,488	.015	.449	2,227
Urban pop in %	1,935	0.880	.189	2,198	.031	.285	3,503
Life expectancy at birth	0.568	1,948	.025	0.292	.771	.293	3,410
Adult literacy rate	–0.812	1,256	–.056	–0.646	.520	.286	3,496
Migrants stock	1,074	1,596	.038	0.673	.503	.649	1,542
Voter turnout since 1945	0.446	0.836	.031	0.534	.595	.633	1,579
% of people aged under 15	0.443	2,367	.020	0.187	.852	.191	5,224
Average GDP growth 1990-2005 in %	–0.122	7,031	–.001	–0.017	.986	.862	1,160
% of s % of service jobs in total employment	1,152	.022	0.235	.815	.245	4,077	0.271

Note: GDP = gross domestic product.
A dependent variable: Internet users per 1,000 inhabitants, $R^2 = 0.814$, $N = 99$, $p < .001$.

Table 4
Model Number 2

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	*SE*	β	*t*	Significance	Tolerance	VIF
(Constant)	28,452	48,446		0.587	.558		
Democracy index 2007	12,329	5,897	.118	2,091	.039	.440	2,274
Gini	–3,113	0.920	–.143	–3,384	.001	.782	1,279
GDP per capita	0.012	0.001	.629	9,079	.000	.290	3,446
share of urban population in %	1,621	0.495	.170	3,272	.001	.514	1,945

Note: GDP = gross domestic product.
A dependent variable: Internet users per 1,000 inhabitants, $R^2 = 0.831$, adjusted $R^2 = 82.6$, $N = 126$, $p < .001$.

The Durbin–Watson test showed a value of 1.792, which means that the errors of prediction are independent. The model accounts for 83.1% (R^2, Adjusted $R^2 = 82.6\%$) of the variation in Internet use. It is significant: $F(4, 121) = 149{,}189$ ($p < .001$). This shows a highly significant good ability of the model to predict the resulting variable. All predictor variables make significant contributions to the prediction of the resulting variable at levels of $p < .05$. For this model, the following are significant predictors of Internet usage in a country: GDP per capita, $t(126) = 9.079$, $p < .05$; the Gini coefficient, $t(1{,}256) = –3.384$, $p < .05$; the

urbanization rate, $t(126) = 3.272$, $p < .05$; and the democracy index, $t(126) = 2.091$, $p < .05$. The collinearity statistics (tolerance > 0.1 and VIF < 10 for all variables) show that the predictor variables are not strongly correlated with each other (no multicollinearity).

These results show that the Internet usage rate of a country for the year 2005 can be estimated by the equation:

$$Y = 0.012 \times \text{GDP per capita} - 3.113 \times \text{Gini} + 1.612 \times \text{urban population share} + 12.329 \times \text{democracy index} + 28.452$$

Interpreting the standardized Beta coefficients shows that economic performance is the most important influencing factor, followed by urbanization, equality, and democracy. GDP per capita has 3.7 times the influence of urbanization, 4.4 times the one of income distribution, and 5.3 times the influence of democracy. This result shows that the argument of access as only being determined by capital investment and economic growth does not prove true. There are other factors that have significant influence. Urbanized regions are more advantaged than rural areas when it comes to ICT access. Therefore, given a large degree of rural areas, which is the case in many developing countries, there is a negative influence on ICT access. In urban areas, it is easier to establish ICT access and a service-based economy. Societies that are predominantly agricultural normally are largely rural in character. The level of democracy of a country also plays a crucial role concerning influence. As a composite index, it reflects besides government factors such as fairness, freedom of elections, civil liberties, also the degrees of dynamicity and civil society participation of the political system. A rather closed political system that limits opposition and exerts censorship is unlikely to support mass Internet usage. Income distribution is an important factor that influences Internet access. GDP is not the only important factor. The results of the conducted analysis show that per capita income is nonetheless an important factor because building, maintaining, and using the Internet and other ICTs requires money in capitalist systems. But if the income is distributed very asymmetrically, that is, if there is a strongly dominant class character, then important parts of society that cannot afford access will be excluded.

The leading countries in Internet access in 2005—Iceland (869 persons/1,000), Sweden (764/1,000), the Netherlands (739/1,000), Norway (735/1,000)—not only have a large GDP per capita, a high degree of urbanization, and top-ranked democracy levels, but also very low Gini values (25.0, 25.0, 30.9, 25.8). On comparing these countries to the United States, it appears that the United States (Internet usage 630/1,000) have a larger GDP per capita than all of these countries, but also a much higher Gini value (40.8), and a slightly lower democracy index. Another example is Hong Kong (Internet usage 508/1,000), which has a GDP per capita that is higher than the one of Sweden and the Netherlands, but a high income inequality (Gini = 43.4), which results in drawbacks in Internet usage. If, like in the case of the United States, all factors except income distribution that we assume to rise to Gini = 50 would remain the same, then the estimated user rate would fall from 637 to 608 users per 1,000 inhabitants, which is a fall by 4.8%. Assuming equal conditions for Hong Kong, the user rate would fall from 548 to 527 (–4.0%). In poor countries, a rise in inequality has dramatic effects. So for example, in a country like Vietnam, which has a low GDP per capita (2100 US$ PPP, USA: 41,890 US$ PPP) and medium levels of democracy index and urbanization, an increase of inequality from Gini = 33.4 to 50 would result in an almost 50% reduction of the countries Internet users from an estimated 106 per 1,000 to 54 per 1,000.

Based on the data by the UNO that has been used for this estimation, in 2005, there were 971.5 million Internet users in the world. The estimation provided by my model gave a total number of 1,031.7 million. Based on the results, it was determined what would happen if the income inequality in all countries increased by 30% (Gini_New = Gini × 1.3) and all other parameters remained the same. For example, for the United States, this would mean a rise of its Gini value from 40.8 to 53.04, which is comparable to the distribution that can be found in a country like Ecuador today (53.6). The new estimation of the number of the worldwide Internet users now was 811.7 millions. This means, if inequality in all countries increases by 30%, the number of Internet users would fall by 220 million, which is a percentage share of 21.3% of all estimated Internet users; that is, 30% more inequality produces 20% less Internet users.

Norris (2001) argued that once countries have enough affluence, Internet access will follow along with connectivity. The problem would be that for many countries affordability would not be possible due to social inequality. Van Dijk concluded from a statistical analysis of data on the U.S. and the Netherlands for the years 1985-2000, that physical access between upper- and lower-income classes was deepening. A similar result was obtained by the same method by DiMaggio et al. (2007, p. 553) when analyzing the relation of family income and Internet usage in the United States from 1994 until 2001. Van Dijk (2005) said the following:

> [The argument] that the digital divide is shrinking, as the lowest categorical values are expanding at a higher rate than the highest values, is misleading. . . . When a developing country increases its Internet access rate from 0.1% to 2% while a developed country climbs from 20% to 40%, the expansion rate of the developing country is 10 times as high as that of the developed country. However, it is much more telling in this case that the point change of the developed country is much larger: Many more new Internet users have been added. (p. 50)

Applying these arguments on a global level means that it is unlikely that the digital divide will be closed as long as there is a high degree of global inequality and high degrees of national inequality in many countries.

In an influential strategy article by the World Bank (2005), based on linear trend projection it is argued, "Developing countries are catching up with the rich world in terms of access, with far higher growth rates in the developing world than in OECD countries" (World Bank, 2005, p. 1). But as a proof only single countries or regions are cited, no proof is given as to why this should be considered a general trend for all developing countries. As main indicators teledensity, ownership of a mobile, and access to a fixed-line phone are cited. These are data that do not tell whether individuals are financially able to make significant regular use of these devices. The causes of closing the digital divide would be technological and economic: "Driving the worldwide trend towards infrastructure rollout is the availability of new technology and falling prices, combined with considerable investment spent with greater efficiency" (World Bank, 2005, p. 4). To foster the further closing of the digital divide, the introduction of "the private, competitive provision of telecommunication services" (p. 10), that is, privatization of the telecommunications sector, to "attract greater private competitive financing," is suggested. Benjamin Compaine (2001a) has argued that ICT market development based on Moore's law decreases the costs of ICT access. As a result, the digital divide would be "less a crisis than a temporary and normal process" (p. 326). "Self-evident forces of declining cost, natural acculturation and growing availability are so

far moving quickly in the direction of widespread adoption" (Compaine, 2001b, p. 345). Therefore, the digital divide would not be that much of a problem. An argument against linear projection of access growth is that people who have adopted technology do not automatically continue to use it forever. They might, for example, not be able to pay monthly connection fees due to economic hardship. Peter Golding (2000) argued against the assumption that the diffusion of technologies runs inevitably from affluent to poorer groups that during Fordism this was due to rapid economic growth and diminishing inequality, which would not be the case today. That such a pattern could be observed in the case of television would not imply that it is also the case for the Internet and the PC because other than television, "ICT goods require recurrent investment" (Golding, 2000, p. 174). Govindan Parayil (2005, p. 45) holds against the technological determinist assumption of universal diffusion that the transition toward computerized information societies in developing countries would increase productivity levels and hence increased international competitiveness of the West, which would allow them to "increase their share of global wealth vis-à-vis the poor countries and regions that were left out of the information revolution." Result would be a self-reinforcing cycle that deepens the gap. Jeffrey James (2008) characterizes approaches that are based on linear trend projection of "digital divide complacency." He argued that these accounts are naïve because they neglect that linear trend projection would not be possible in the case of ICTs as these would require high skills and literacy to be established in developing countries; innovation capacities and scientific knowledge would be concentrated in the developed world so that economic advantages would accumulate (James, 2007a, 2008).

In this article, the influence of various economic, political, and cultural variables on physical Internet access was tested by multivariate regression based on cross-national data. Special attention was given to variables of social inequality. The result was that for the year 2005 data, GDP per capita exerted the most important but not the only influence. Social inequality measured by the Gini coefficient, the level of democracy, and the degree of urbanization of a country were also found to be important influencing factors. The results show that complex models of the digital divide are needed that do not reduce the causes and potential solutions to single variables or realms of society (such as markets or technological development). An interaction of socioeconomic, political, cultural, social, and technological factors shapes access to ICTs. These results cast doubt on technological determinism, economic reductionism, and linear trend projection in the digital divide debate. The digital divide is neither an economic nor a technological issue; it is a complex societal issue with complex causes that are rooted in the stratified character of contemporary society. There must be an economic foundation of ICT access, a certain level of overall wealth and material production, to enable widespread ICT access. Producing economic wealth can be based on different models of production. Various factors such as income inequality pose significant downward pressure on universal ICT access. In this context, public access models and common interest policy measures could be important for achieving universal access.

One contemporary influential policy perspective on the digital divide is what Mariscal (2005, p. 434) termed as *market economy perspective*, which suggests as follows:

> The most effective universal policies are simply to foster economic growth and implement sound regulatory policies [that advance liberalization, privatization, and competition in the telecommunication sector] in order to increase the supply of telecommunications services.

Table 5
Measurements of World Wide Inequality

	1980	1988	1990	1993	1998	2000	2003
Gini coefficient (Sutcliffe, 2007)	0.66		0.65			0.62	0.63
10/10 ratio (Sutcliffe, 2007)	78.86		64.21			57.41	64.41
5/5 ratio (Sutcliffe, 2007)	120.75		101.02			116.41	130.46
1/1 ratio (Sutcliffe, 2007)	216.17		275.73			414.57	564.27
Gini coefficient (Milanovic, 2007a, 2007b)		0.62[b]		0.65[b]	0.64[b]		0.70[a]

a. Milanovic (2007a).
b. Milanovic (2007b).

This perspective has been interpreted as strategy of "big bang" reforms. (Samarajiva & Gamage, 2008, p. 111, cf. also Samarajiva, 2000). The rather strict focus on GDP growth is questioned by the results provided by the study at hand, which shows that social, political, and cultural issues have to be considered when devising policy strategies for solving the digital divide. The implication is that an economic reductionistic strategy will fail for establishing global universal Internet access.

Table 5 shows a number of measures of global inequality. Without going into further detail, it can be observed that global inequality has remained at high levels. Sutcliffe's (2007) Gini calculation for the global level can be considered as an example. A value that is higher than 0.60 indicates severe global inequality. Compared to the national level, such high inequality is similar to the one in Brazil, South Africa, Botswana, Bolivia, Namibia, Lesotho, Central Africa, and Sierra Leone.

> While the ratio of national income per head of the richest to the poorest country is 104 to 1 (Luxembourg to Sierra Leone), the ratio of the average salary of CEOs of large U.S. corporations to that of an average U.S. worker is 245 to 1. The exploding riches of this small class gives them the means to exercise vast influence on the policies of the U.S. and other governments, which themselves have a major impact on the world's inequalities. (Sutcliffe, 2007, p. 69)

Given the fact of exploding global inequality, is it really likely that the global digital divide will be solved by economic accumulation and technological development as many stakeholders seem to believe?

In relation to the research task formulated at the beginning of this article, it can be said that the overall finding that income inequality is one of several factors that influence the level of the digital divide in complex ways is a sign for the need of complex models of the digital divide.

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