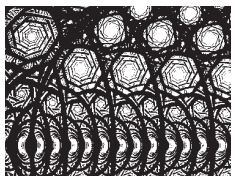

FACTORS THAT IMPACT INTERNET USE AND ARE SENSITIVE TO INCOME: CROSS-COUNTRY EMPIRICAL EVIDENCE

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This paper examines information and communication technology (ICT) and socioeconomic indicators associated with Internet use based on income level across countries. Although some literature deals with cross-country indicators of Internet use, no known study quantitatively examines which indicators are superior or how they differ across countries with different income level. We extract factors with the most important indicators and evaluate their impact on Internet use for four income groups: low, lower middle, upper middle, and high. The results show that Internet use can be stimulated by educated people, available computers, telecommunications connections and increasing income per capita. However, prices of telecommunications services, international trade, investment, population density, unemployment rate or GDP growth rate do not affect Internet use.

Keywords: technology gap, developing countries, digital divide, Internet access, information and communication technology

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INTRODUCTION

The technological innovations of the late 1990s were characterized by two new mediums of communication: the Internet and wireless technology. Productivity and economic growth are increasingly dependent upon the application of science and

technology as well as upon the quality of information and management in the process of production, consumption, distribution, and trade (Castells, 2000). The transformation of virtually every industry in today's world according to the imperatives of the information economy is undeniable (Taylor, 2001; Aronson, 2001). Equally undeniable is the critical role of the computer and the Internet in allowing these changes to take place. The ability to competitively design, manufacture, market, and distribute products internationally depends on modern telecommunications with executives, designers, managers, and salespeople around the world who are consulting, collaborating, communicating, and sharing information via computer-mediated networks (Kamel, 2005; Močnik, 2005, 2002; Roy, 2005; Warschauer, 2004; Castells, 2000).

The United Nations has officially accepted that the introduction and use of information and communication technology (ICT) and information management must become an integral element of priority efforts to promote and secure sustainable development for all (Bava, 2004; Filip, 2004; Guimardes, 2004; Hilliard, 2002; Aronson, 2001; Taylor, 2001; Singer and Roy, 1993). An ever-increasing body of literature suggests that the "networking revolution is creating new digital opportunities for developing countries, which can significantly benefit from investments in modern ICT infrastructure in a pro-competitive regulatory environment" (WB, 2006; Taylor, 2001; Aronson, 2001; McConnell, 1996; Rodrigues and Wilson, 2000). It is argued that ICT will be the main engine of economic growth over the next 20 years (IBRD, 2007; Roy, 2005; Kamel, 2005; Mwesige, 2004). ICT is also regarded as a valuable tool to promote education, healthcare, social change, and, ultimately, national development (WB, 2007; Guimardes, 2004).

The World Bank report (2006) provides an overview of ICT sector growth as it relates to the general economic status of 144 economies. The report analyzes investment trends, ICT services, and the role of ICT in business. However, it does not determine which indicators are more important than others. However, to compare key factors for stimulating Internet use, further manipulation of data is required. In our study, we determine important factors and their size of impact on Internet use as related to each country's development level.

This paper examines the frequency of Internet use in different countries in terms of ICT and socioeconomic factors. On top of fundamental problems of basic survival, nutrition, and illiteracy (WB, 2007; Von Braun and Torero, 2006a; Roy, 2005; Bava, 2004; Filip, 2004; Servon, 2002; Norris, 2000), developing countries must have access to information in order to become integrated into the global economy. As evidence

indicates that the use of ICT can be highly beneficial to individuals and communities, we suggest that greater use of the Internet can result in improved education, regular price policy, greater investment in telecommunications, greater exports and imports, etc. This paper examines which variables are associated with Internet use across countries with different income levels and which variables can best explain these differences. Among the most influential variables, we calculate their impact on Internet use in general and in terms of income level. Empirical results show that different variables influence Internet use when different groups of countries are considered.

The paper is organized as follows. In the next section, we discuss how Internet use is connected to secure sustainable development. In section 3, we discuss the data used to estimate the association between Internet use and selected ICT and socioeconomic indicators. In section 4, we calculate factors across groups with the use of factor analysis. Section 5 deals with multiple regression models by which we estimate the impact of factors on Internet use according to the development level of a country and overall. The final section concludes the paper.

ECONOMIC DEVELOPMENT AND INTERNET USE

The Internet and ICT in general have brought fundamental changes throughout society. ICT has instrumented the shift from an industrial age to a network age (Dobransky and Hargittai, 2006; Freese et al., 2006; Castells, 2000). In developed countries, production, acquisition, and flow of knowledge drive the economy, and global information networks represent key infrastructure (Hargittai and Shafer, 2006; Taylor, 2001; Aronson, 2001; Singer and Roy, 1993). Telecommunication equipment, computers, and the Internet have become an indispensable part of the modern world. Worldwide economies are becoming increasingly dependent on Internet technologies. ICT contributes to developing knowledge, which is one of the most important assets in the 21st century economy.

According to some authors (i.e., Hargittai, 2007; Dobransky and Hargittai, 2006; Freese et al., 2006; Servon, 2002; Steinmueller, 2001; Bava, 2004; Guimardes, 2004), ICT has the power to benefit or to hinder progress toward social and economic justice. In addition to altering commerce, education, government, and communications, ICT affects the construction of and response to social problems, such as poverty and inequality. Thus, the technology gap has received ongoing attention. Technology can bring education to people living far from good schools, promote organizing efforts in disadvan-

taged communities, and connect people to a wide range of opportunities; however, lack of access to ICT for certain segments of the population exacerbates existing power relations and patterns of inequality. Thus, living without fundamental ICT infrastructure means living on the wrong side of the digital divide, which means being disconnected from the information society (Hargittai, 2007; Von Braun and Torero, 2006a, 2006b; Servon, 2002; Warschauer, 2004).

Because many factors can limit Internet accessibility, we must determine the current level of Internet use across countries and the factors that have contributed most to this process. Much of the success of the Internet depends on affordable, near-universal access (Freese et al., 2006; Keogh and Wood, 2005; Rao, 2001).[1] Numerous projects such as Internet kiosks, cyber cafés, and multipurpose community telecenters have been launched in developing nations to offer ordinary people a chance to get online.[2] However, universal access to the Internet and other ICT infrastructure remains a major problem (Keogh and Wood, 2005; Rao, 2001; Minges, 2001; Rogers and Shukla, 2001). The Internet is still very much an elite phenomenon (Lee, 1999; Miller and Slater, 2001). In the next section, we discuss the data for our empirical investigation.

DATA

For empirical research, we use data from World Development Indicators, United Nations Statistics, and United Nations Conference on Trade and Development (see Data Appendix). In this section, we present 31 data sets for 182 countries divided into low, middle, and high income groups. The low income group consists of countries with $875 or less GNI p.c.; the lower middle group, countries with $876 to $3,465 GNI p.c.; the upper middle group, countries with $3,466 to $10,725 GNI p.c.; and the high income group, countries with $10,726 or more GNI p.c. Such a division is made because independent T-tests reveal that all data are statistically different across four income groups. Therefore, we hypothesize that the development level (expressed by GNI) of a country may be an important determinant of these relationships. A total of 182 countries are included in the sample; we substitute the group mean of the variable of a certain income class for missing data.

Because the extent of Internet use depends on many factors, the analysis includes the group of ICT variables and six groups of socioeconomic variables – economic, investment, international trade, structural, educational, and population distribution – which we assume are considerably related to Internet use.

ICT Variables

ICT variables include: main telephone lines, fixed-line and mobile phone subscribers,[3] fixed-line and mobile phone monthly subscription costs, costs of a three-minute fixed-line and mobile call, personal computers, and Internet hosts. These variables are used to measure ICT diffusion, which is crucial to connectivity (Chaudhuri et al., 2005; Koski and Kretschmer, 2005; World Bank Report, 2007). It is expected that the higher the value of ICT variables, the greater the number of Internet users. In contrast, it is expected that the higher the costs, the smaller the number of Internet users. This hypothesis is supported by previous research (Chaudhuri et al., 2005, NTIA 1999).

Economic Variables

The World Bank Report (2007) as well as reports by the NTIA (1995, 1998, 1999, 2000, 2002) show that the wealth of a country influences the demand for the Internet. Therefore, we hypothesize that the higher the level of wealth (i.e. GNI), the higher the number of Internet users.

Investment Variables

We also examine the association between investment and Internet use. New technologies diffuse more rapidly where countries are open to investment (Perkins and Neumayer, 2004). Furthermore, the Internet requires a relatively large capital investment. The higher the investment in necessary infrastructure, the more Internet users that a country will have (e.g. Keller, 2004). For example, in China, the absolute poor population dropped from 250 million in 1978 to 26.1 million in 2004, largely because of strong investment and effective adoption of technologies (Zeng and Wang, 2007). Investment in telecommunications, gross capital formation, and foreign direct investment are assumed as a proxy for measuring the diffusion of technology. Hall and Jones (1997) suggest that technology transfer and diffusion contribute to an individual country's inventions and innovations, which in turn impact Internet use.

International Trade Variables

We evaluate the impact of international trade, which often leads to international technology diffusion (Perkins and Neumayer, 2004). International trade variables are represented as imports and exports of goods, services, and telecommunication equipment as well as high-technology exports. All of these factors are expected to accelerate the number of Internet users.

Structural Variables

We expect that Internet use also depends on the structure of the economy. It is assumed that services (see Data Appendix) that employ more educated people contribute to greater Internet use.

Educational Variables

Education is another important variable for Internet use (Chaudhuri et al., 2005). The NTIA (1995, 1998, 1999, 2000, 2002) finds that the Internet is less attractive to people with limited education, because they have problems reading comprehensive text. Chaudhuri, Flamm, and Horrigan (2005) argue that people with higher levels of skill in navigating information technology use the Internet more frequently. Educational variables in this study include adult literacy rate, secondary and tertiary enrollment, and school life expectancy. We assume that these variables increase Internet use.

Population Distribution Variables

Because of the novelty of the Internet, younger people are presumably more inclined to access the Web (Chaudhuri et al., 2005; NTIA, 2002). NTIA finds peak usage between the ages 26 and 55. We examine the population density and the degree of urbanization as related to Internet use. For population distribution, the following variables are used: urban and rural population, population under age 15, population age 60 and above, the number of people per square kilometer, and total unemployment rate. The population under age 15 and over age 60 are expected to use the Internet less frequently because of smaller income and less computer literacy. Because urban areas offer Internet access at lower costs (Koski and Kretschmer, 2005), more Internet users are expected in these locations. We also expect the unemployment rate to negatively impact Internet use.

FACTOR ANALYSIS

In this section, we calculate factors because of high correlations between independent variables that prevent us to calculate their direct impact on Internet use. Factors across groups are calculated from independent variables that have correlations with Internet users higher than 0.3. In all cases, Kaiser--Meyer-Olkin (KMO) statistics are greater than 0.7 (De Vaus, 2002). By rotating the component matrices in Table 1, we extract five factors with eigenvalues of more than one for the low income group, three factors for the lower middle group, two factors for the upper middle group, four factors for the high income group, and four factors for the overall sample. Independent variables included in each factor are designated in italics.

➲ TABLE 1
Extracted factors (F) across groups

Independent variables included in factors	Low income group F1	F2	F3	F4	F5	Lower middle F1	F2	F3	Upper middle F1	F2	High income F1	F2	F3	F4	Overall F1	F2	F3	F4
Main telephone lines	*0,789*	0,223	0,285	0,109	0,081	*0,693*	0,499	0,151	*0,610*	0,511	*0,714*	0,118	0,278	0,419	0,556	*0,684*	0,315	0,140
Personal computers	0,291	0,164	0,289	0,139	*0,785*	-0,013	*0,884*	0,000	0,419	*0,735*	*0,720*	0,114	0,393	0,207	0,365	*0,805*	0,307	0,174
School life expectancy	*0,746*	0,062	-0,038	0,250	0,020	*0,635*	0,388	0,038	*0,710*	0,269	0,215	0,308	*0,744*	0,431	*0,817*	0,315	0,236	0,168
Population under 15 years	*-0,813*	-0,094	-0,298	-0,127	0,114	*-0,913*	-0,061	-0,088	*-0,857*	-0,289	-0,289	-0,431	-0,047	*-0,693*	*-0,836*	-0,282	-0,274	-0,086
Population age 60 and over	*0,665*	0,228	0,180	0,014	-0,419	*0,909*	-0,025	0,045	*0,891*	0,303	0,403	0,334	0,190	*0,743*	*0,735*	0,460	0,200	-0,118
Fixed and mobile phone subscribers	0,365	0,302	0,353	-0,021	*-0,436*	*0,535*	0,523	0,239	*0,583*	0,553	0,243	*0,517*	0,448	0,484	0,581	*0,600*	0,416	0,182
Tertiary gross enrollment	*0,787*	0,220	-0,004	0,009	0,407	*0,762*	-0,063	0,266	*0,826*	0,046	0,030	-0,103	0,561	*0,711*	*0,776*	0,361	0,269	0,061
Gross national income per capita	0,288	0,254	*0,811*	-0,163	0,057	0,161	*0,837*	0,184			*0,832*	0,345	0,127	-0,120	0,293	*0,758*	0,403	0,226
Secondary gross enrollment	*0,896*	0,155	0,051	0,138	0,111	*0,729*	0,244	0,041			0,095	0,283	*0,799*	0,088	*0,824*	0,218	0,219	0,293
Literacy rate	*0,785*	-0,132	-0,076	0,267	0,033				*0,794*	0,124	-0,047	*0,661*	-0,012	0,371	*0,820*	-0,002	0,170	0,323
Urban population	0,117	*0,963*	0,066	0,096	0,022	0,132	0,122	*0,980*							*0,534*	0,189	0,463	0,455
Rural population	-0,117	*-0,963*	-0,066	-0,097	-0,022	-0,132	-0,122	*-0,980*							*-0,534*	-0,189	-0,463	-0,455
Services	-0,083	-0,082	*0,809*	0,200	0,079						0,177	*0,877*	0,172	0,028	*0,516*	0,377	0,249	0,021
Internet hosts									*0,624*	0,470	0,434	-0,103	*0,754*	0,062	0,217	*0,820*	0,048	0,021
Imports of goods and services	0,204	0,205	-0,106	*0,855*	0,177				-0,028	*0,870*								
Exports of goods and services	0,487	0,413	-0,086	*0,523*	0,126										0,195	0,152	0,040	*0,823*
Fixed-line monthly subscription costs											*0,739*	0,090	0,061	0,308	0,035	0,461	*0,512*	0,175
Investments in telecommunications															0,255	0,103	*0,776*	-0,221
Telecommunication equipment export															0,260	0,258	*0,635*	0,292
Telecommunication equipment import															0,267	0,152	*0,791*	0,041
Foreign direct investment															0,397	0,132	*0,664*	0,170
High technology exports															0,093	0,329	*0,517*	0,128
Gross capital formation	0,214	-0,053	0,365	*0,697*	-0,091													
Industry											-0,396	*-0,819*	-0,167	-0,125				
KMO	0,740								0,793		0,735				0,925			
% of Variance	39,6	11,8	10,4	8,7	6,7	45,5	16,5	14,1	58,4	11,4	48,4	12,2	9,9	7,1	55,2	7,6	6,6	5,0

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

From Table 1, we can see that only seven variables are common across all groups: main telephone lines, personal computers, school life expectancy, population under 15 years and over 60 years, fixed and mobile phone subscribers, and tertiary enrollment. Surprisingly, investment in telecommunications, telecommunication equipment imports and exports, foreign direct investment, and high technology exports are only for the overall group.

We can see that in five factors for the low income group, 16 variables are included. Three factors for the lower middle income group include 11 variables. Two factors for the upper middle group represent 10 variables. Four factors for the high income group include 14 variables and 21 variables are represented by four factors for the overall sample.

From the value of KMO and the cumulative percentages of variance explained by the factors (Table 1), we see that calculated factors explain more than 70 percent of cumulative variance of Internet use in all cases. However, the percentage of variance by factors across groups varies. For common variables included in all factors, we calculate partial regression coefficients across groups and find that these variables impact Internet use in varying degrees (Table 2).

TABLE 2
Partial regression beta coefficients* for common variables included in factors

Common independent variables	Income group: Low income	Lower middle	Upper middle	High	Overall
Main telephone line	0.671	0.796	0.701	0.740	0.933
	(0.439)	(0.626)	(0.474)	(0.532)	(0.870)
	N = 49	N = 48	N = 30	N = 33	N = 160
Personal computers	0.658	0.345	0.862	0.852	0.970
	(0.421)	(0.101)	(0.734)	(0.716)	(0.940)
	N = 48	N = 50	N = 30	N = 33	N = 155
School life expectancy	0.421	0.443	0.588	0.688	0.707
	(0.159)	(0.179)	(0.322)	(0.456)	(0.496)
	N = 49	N = 50	N = 30	N = 33	N = 161
Population under 15 years	-0.530	-0.475	-0.775	-0.594	-0.739
	(0.265)	(0.210)	(0.586)	(0.332)	(0.543)
	N = 49	N = 50	N = 30	N = 33	N = 158
Population 60 years and over	0.407	0.388	0.766	0.656	0.791
	(0.148)	(0.133)	(0.572)	(0.412)	(0.623)
	N = 48	N = 50	N = 30	N = 33	N = 159
Fixed and mobile phone subscribers	0.509	0.715	0.690	0.757	0.926
	(0.243)	(0.501)	(0.457)	(0.560)	(0.856)
	N = 48	N = 50	N = 30	N = 33	N = 160
Tertiary enrollment	0.558	0.354	0.528	0.565	0.775
	(0.296)	(0.107)	(0.253)	(0.297)	(0.598)
	N = 49	N = 50	N = 30	N = 33	N = 159

*All beta coefficients are significant at $p<0.01$; in parentheses is Adjusted R^2;
Dependent variable: Internet users.

In Table 2, we can see the size of impact of common variables on Internet use across groups. For example, personal computer use has a greater impact on the number of Internet users in the high income group than in the lower middle income group. In addition, main telephone lines explain 44 percent of variability of Internet use for the low income group, 53 percent for the high income group, and 87 percent for the overall group. Fixed and mobile phone subscriptions account for 24 percent of the variability of Internet use for the low income group and 86 percent for the overall group. For five variables, betas and adjusted R^2 are the highest for the overall sample. Therefore, to estimate the impact of factors on Internet use, we conduct five multiple regressions separately in the next section.

MULTIPLE REGRESSIONS WITH FACTORS

All factors that are used as independent variables in multiple regression models are uncorrelated. To estimate the separate impacts of factors on Internet use across groups, we exert stepwise multiple regressions across groups, represented by equation (1):

$$Y_{ki} = a_{k0} + b_{jk}F_{jk\,i} + \varepsilon_{ki} \quad (1)$$

where Y_{ki} is the estimated average Internet users per 1000 people for *k-th* group ($k = 1, \ldots, 5$, 1 = low, 2 = lower middle, 3 = upper middle, 4 = high, 5 = overall); a_{k0} is the constant of the *k-th* group; b_{jk} is the multiple regression coefficient of the *j-th* factor ($j = 1, \ldots 5$, j = 5 for k = 1, j = 3 for k = 2, j = 2 for k = 3, j = 4 for k = 4, j = 4 for k = 5) of the *k-th* group of i countries ($i = 1, \ldots, N$, N = 49 for k = 1, N = 50 for k = 2, N = 30 for k = 3, N = 33 for k = 4, N = 164 for k = 5); ε_{ki} is the *k-th* group error of *i* countries.

The model for the low income countries includes five factors, one of which is dropped from analysis. The factors that have the strongest and most significant impact on Internet use are main telephone lines, tertiary and secondary enrollment, school life expectancy, the division of population according to age, and literacy rate. These factors explain nearly 29 percent of the variability. Services and GNI p.c. account for 12 percent; urban and rural population, 11 percent; and personal computers and fixed and mobile phone subscribers, 5 percent. All factors are significant at 0.01 (except factor 5, which is significant at 0.05). The imports and exports of goods and services as well as gross capital formation do not contribute to the explanation of the variance. For the overall model, 53 percent of variability of Internet use is explained at 0.01 significance level.

Tables 3 to 7 present the results of stepwise multiple regressions.

➲ TABLE 3
A Stepwise Multiple Regression for the Low Income Group: Dependent Variable Internet Users[a]

	Model 1	Model 2	Model 3	Model 4
FACTOR 1	0.534*			
FACTOR 1		0.530*		
FACTOR 3		0.354*		
FACTOR 1			0.524*	
FACTOR 3			0.365*	
FACTOR 2			0.332*	
FACTOR 1				0.525*
FACTOR 3				0.346*
FACTOR 2				0.330*
FACTOR 5				0.226*
Change in R^2	0.285*	0.125*	0.110*	0.051**
R^2	0.285	0.410	0.520	0.571
Adjusted R^2	0.270	0.384	0.488	0.532
F	18.724*	15.983*	16.262*	14.662*

[a] Regression coefficients are reported as betas (standardized regression coefficients). N=49, *p<0.01, **p< 0.05.

➲ TABLE 4
Stepwise Multiple Regression for the Lower Middle Income Group: Dependent Variable Internet Users[a]

	Model 1	Model 2	Model 3
FACTOR 2	0.469*		
FACTOR 2		0.505*	
FACTOR 1		0.479*	
FACTOR 2			0.508*
FACTOR 1			0.485*
FACTOR 3			0.246**
Change in R^2	0.220*	0.228*	0.060**
R^2	0.220	0.448	0.508
Adjusted R^2	0.203	0.424	0.476
F	13.501*	19.039*	15.825*

[a] Regression coefficients are reported as betas (standardized regression coefficients). N=50, *p<0.01, **p<0.05.

For the lower middle income group, personal computers and GNI p.c. explain 22 percent of Internet use variability. Main telephone lines, school life expectancy, the division of population according to age, fixed and mobile phone subscribers, and tertiary and secondary enrollment explain 23 percent of the variance. Urban and rural population explain 6 percent of the variance. Factors 1 and 2 are significant at 0.01, while factor 3 is significant at 0.05. With the model, 48 percent of variability of Internet use is explained at 0.01 significance level.

➲ TABLE 5
Stepwise Multiple Regression for the Upper Middle Income Group: Dependent Variable Internet Users[a]

	Model 1	Model 2
FACTOR 2	0.649*	
FACTOR 2		0.649*
FACTOR 1		0.645*
Change in R^2	0.421*	0.416*
R^2	0.421	0.837
Adjusted R^2	0.400	0.825
F	20.356*	69.349*

[a] Regression coefficients are reported as betas (standardized regression coefficients). N=30, *p<0.01.

For the upper middle income group, personal computers and imports of goods and services explain 42 percent of the variance. Main telephone lines, Internet hosts, school life expectancy, the division of population according to age, fixed and mobile phone subscribers, literacy rate, and tertiary enrollment explains less than 42 percent. Both factors are significant at 0.01. The whole model explains 83 percent of the variance.

➲ TABLE 6
Stepwise Multiple Regression for the High Income Group: Dependent Variable Internet Users[a]

	Model 1	Model 2	Model 3	Model 4
FACTOR 1	0.583*			
FACTOR 1		0.583*		
FACTOR 3		0.531*		
FACTOR 1			0.583*	
FACTOR 3			0.531*	
FACTOR 4			0.407*	
FACTOR 1				0.583*
FACTOR 3				0.531*
FACTOR 4				0.407*
FACTOR 2				0.179*
Change in R^2	0.340*	0.282*	0.166*	0.032**
R^2	0.340	0.622	0.788	0.820
Adjusted R^2	0.319	0.597	0.766	0.794
F	15.977*	24.719*	35.979*	31.911*

[a] Regression coefficients are reported as betas (standardized regression coefficients). N=33, *p<0.01, **p< 0.05.

For the high income group, main telephone lines, personal computers, GNI p.c., and fixed-line monthly subscription costs explains 34 percent of the variance. Internet hosts, school life expectancy, and secondary enrollment explain 28 percent, while population according to age and tertiary enrollment ex-

plain 17 percent. Services and industry, fixed and mobile phone subscribers, and literacy rate explains only 3 percent of the variance. Factors 1, 3, and 4 are significant at 0.01, while factor 2 is significant at 0.05. With the model, 79 percent of variability of Internet use is explained at the 0.01 significance level.

➲ TABLE 7
Stepwise Multiple Regression for the Overall Group: Dependent Variable Internet Users[a]

	Model 1	Model 2	Model 3	Model 4
FACTOR 2	0.780*			
FACTOR 2		0.780*		
FACTOR 1		0.467*		
FACTOR 2			0.780*	
FACTOR 1			0.467*	
FACTOR 3			0.314*	
FACTOR 2				0.780*
FACTOR 1				0.467*
FACTOR 3				0.314*
FACTOR 4				0.132*
Change in R^2	0.608*	0.218*	0.098*	0.018*
R^2	0.608	0.826	0.924	0.941
Adjusted R^2	0.605	0.823	0.923	0.940
F	250.988*	381.224*	648.319*	639.677*

[a] Regression coefficients are reported as betas (standardized regression coefficients). N=33, *p < 0.01.

For the overall group, main telephone lines, personal computers, Internet hosts, fixed and mobile phone subscribers, and GNI p.c. explain 61 percent of the variance. School life expectancy, the division of population according to age, the share of urban and rural population, literacy rate, tertiary, and secondary enrollment explain 22 percent of the variance. Fixed--line monthly subscription costs, investment in telecommunications, telecommunication equipment imports and exports, high technology exports, and foreign direct investment explain almost 10 percent. Exports of goods and services explain less than 2 percent of the variance. All factors are significant at 0.01. The model explains 94 percent of the variability of Internet use at the 0.01 significance level.

In summary, we can see that using separate models shows the impact of factors across groups. Interestingly, there is no association between prices and Internet use, except for fixed-line monthly subscription costs for the high income group (see Table 1). Mobile phone monthly subscription costs and the costs of a three-minute mobile and fixed-line call were not included in any base from which factors were calculated,

because their relationships with Internet use were too weak (less than 0.3). Thus, our empirical research does not confirm the results of previous studies that find cost to be an important determinant of ICT use (i.e. Chaudhuri et al., 2005; NTIA, 2000). Moreover, population density, total unemployment rate, and GDP growth rate were not important factors. Imports of goods and services seem to impact Internet use only for the low and upper middle income groups. For the low income group only, the exports of goods and services and gross capital formation are also influential variables. Our study also does not support previous research that exposes international trade or investment as important (i.e. Keller, 2004; Perkins and Neumayer, 2004).

The results for the overall group are uncertain because of aggregated data. Certain income groups represent a much more viable base for analysis. Our results show that the relationships between variables differ across countries. The keys to stimulate Internet use are education, available personal computers, telecommunication connections, and increasing income per capita.

For the low and lower middle income groups, the variance is rather small compared to other groups. This implies that in less developed countries, there are numerous other important variables that contribute to Internet use, i.e. the social infrastructure of the economy. However, this surpasses the scope of this study.

CONCLUSION AND POLICY IMPLICATIONS

In the paper, we have examined what variables are associated with Internet use in terms of national income level. In order to assess the impact of different indicators that are related to Internet use, we calculate factors across four income groups: low, lower middle, upper middle, and high. Sixteen of 30 variables explain Internet use for the low income group; 11 variables for the lower middle income group; 10 variables for the upper middle group; 14 variables for the high income group; and 21 variables for the overall sample. Only seven variables are common across all groups: main telephone lines, personal computers, school life expectancy, population under 15 years and over 60 years, fixed and mobile phone subscribers, and tertiary enrollment. The impact of each factor on Internet use varies significantly across groups.

Empirical results show that there is no association between prices and Internet use, except for fixed-line monthly subscription costs for the high income group. Imports of goods and services seem to impact Internet use only for the low and upper middle income groups. Exports of goods and services

and gross capital formation are influential variables only for the low income group, and their impact is rather small. Thus, our study does not support previous research that international trade and investment variables are important for Internet use.

Moreover, our results show that indicators of Internet use across countries differ in terms of impact and specification. This finding is important for ICT policy measures adapted to certain countries. Using secondary data, our analysis is limited on available statistics from WB, UN, and UNCTAD and therefore dependent on their reliability.

Another policy implication that emerges from this study is that population density, unemployment rate, GDP growth rate, mobile phone subscriber costs, and cost of a three-minute fixed-line and mobile phone call do not influence Internet use. Investment in telecommunications, telecommunication equipment exports and imports, foreign direct investment, and high technology exports seem to have a slight impact on Internet use for the overall sample but no impact when countries are analyzed according to income groups. Education is among the most influential variables that stimulate Internet use but it is not the cause for Internet use, nor is Internet use the one that causes education.[4]

For improving the development level, it is therefore necessary to bring technology to less developed countries. However, for effective use of technology proper public policy in cooperation with concerted efforts by the private for-profit and non-profit sectors must be adopted.

Our empirical results clarify the impact of ICT in relation to economic development. Bringing forward the right policy measures across countries will attenuate the technology lag, which can help to bring developing countries into the global economy. In future work, we plan to examine indicators of Internet use using country-specific data.

DATA APPENDIX

Internet users: the number of Internet users per 1000 citizens; 2004 data from the World Development Indicators (WDI)

Main telephone lines: per 1000 people; 2003 UNCTAD data

Fixed-line and mobile phone subscribers: per 1000 people 2004 WDI data

Mobile phone and fixed-line monthly subscription costs: cover the rental line but not terminal equipment; in some cases, the rental charge includes an allowance for free or reduced rate calls; if there are different charges for different exchange areas, the

largest urban area is used; both expressed in dollars were logarithmized; 2002 mobile data and 2003 fixed-line data from UNCTAD

Cost of a three-minute mobile and fixed-line call: refer to peak hours; expressed in dollars; 2003 UNCTAD data

Personal computers: per 1000 people; 2003 UNCTAD data

Internet hosts: per 100,000 people; based on the country code in the host address; may not correspond to the actual physical location; 2003 UNCTAD data

GNI p.c.: calculated using the World Bank Atlas method[5]; 2004 WDI data

GDP growth: annual percentage growth rate of GDP; 2004 WDI data

Investment in telecommunications: expenditure associated with acquiring telecommunication equipment infrastructure, including supporting land and buildings as well as intellectual and non-tangible property such as computer software; also includes expenditures on initial installations and additions to existing installations; expressed in millions of dollars were logarithmized; 2003 UNCTAD data

Gross capital formation: additions to the fixed assets of the economy plus net changes in the level of inventories; expressed in percentages of GDP, 2004 WDI data

Foreign direct investment: net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor; calculated as the sum of equity capital, reinvestment of earnings, other long-term capital, and short--term capital as shown in the balance of payments; expressed in millions of dollars were logarithmized; 2004 WDI data

Services: the share of GDP that is created by services corresponding to ISIC divisions 50–99; 2004 WDI data

Industry: the share of GDP that is created by industry corresponding to ISIC divisions 10–45; 2004 WDI data

Imports of goods and services: the value of all goods and market services received from the rest of the world; expressed in percentages of GDP; 2004 WDI data

Exports of goods and services: the value of all goods and market services provided to the rest of the world; expressed in percentages of GDP; 2004 WDI data

Telecommunication equipment imports and exports: expressed in millions of dollars; 2002 UNCTAD data; aggregated from the following Standard International Trade Classification (SITC), Revision 3 sub-groups: (1) 764.1 Electrical apparatus for line telephony or line telegraphy; telephone sets; teleprinters; telephonic or telegraphics switching apparatus; other apparatus for carrier-current line systems; other telephonic or telegraphic apparatus; (2) 764.3 Transmission apparatus for radio--telephony, radio-telegraphy, radio broadcasting or television, whether or not incorporating reception apparatus or sound--recording or reproducing apparatus; transmission apparatus incorporating reception apparatus; (3) 762.81 Other radio-broadcast receivers; and (4) 764.91 Parts and accessories, suitable for use solely or principally with the apparatus of sub-group 764.1

High-technology exports: products with high R&D intensity such as computers, pharmaceuticals, scientific instruments, and electrical machinery; expressed in percentage of manufactured exports, 2004 WDI data

Adult literacy rate: percentage of individuals aged 15 and older who can read and write; 2004 WDI data

Tertiary enrollment: ratio of total tertiary gross enrollment, regardless of age, to the population of the age group that officially corresponds to the level of tertiary education; 2004 WDI data

Secondary enrollment: the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the secondary level of education; 2004 WDI data

School life expectancy: the total number of years of schooling that a child can expect to receive, assuming that the probability of his or her being enrolled in school at any age equals the current enrollment ratio for that age; 2004 UN Statistics data

Urban population: percentage of the total population; 2005 UN Statistics data

Rural population: the percentage of the total population; 2005 UN Statistics data

Population under 15 years: 2005 UN Statistics data

Population age 60 and over: 2005 UN Statistics data

The number of people per square kilometer: 2004 WDI data

Total unemployment rate: adults aged 15 and older who are currently without work, available for work, and are seeking work; based on the labor force, not the total population; 2004 UN Statistics data

NOTES

[1] In India, a country of one billion people, millions of citizens are connected to the Internet but lack electricity (Rao, 2001).

[2] Community technology centers (known as telecenters or community access points) have emerged at an increasing pace in the last several years. Telecenters are locally based nonprofit organizations that link community residents to ICT resources. They represent a particular type of government-sponsored facility, such as post offices, libraries, or schools, or even privately operated Internet cafés (Minges, 2001; WB, 2006).

[3] We also consider mobile phone subscribers, because mobile phones provide the only access to the Internet in some remote areas. Mwesige (2004) finds that the use of mobile phones is rising in developing countries. In Uganda, for example, the number of mobile phone subscribers is more than three times the number of the fixed line subscribers (ibid).

[4] We tested the causality between secondary/ tertiary enrollment and Internet use with Granger test of causality (Gujarati, 2004). The results, which are not included in the paper because of the space limit, show that variables are not causally related.

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Faktori koji utječu na upotrebu interneta te su osjetljivi na dohodak: međudržavna empirijska činjenica

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U članku istražujemo indikatore informacijsko komunikacijske tehnologije (ICT) i socioekonomske indikatore koji su vezani uz upotrebu interneta na osnovi ostvarenih prihoda u raznim državama. U literaturi se pojavljuju indikatori upotrebe interneta u raznim državama, dok istodobno ne poznajemo njezinu metodologiju ocjenjivanja. U radu su prikazani faktori s najvažnijim indikatorima i njihov utjecaj na upotrebu interneta za četiri osnovne grupe ostvarenih DBP-a po stanovniku: niski, niži srednji, viši srednji i visoki. Rezultati pokazuju da se upotreba interneta može stimulirati ako su ljudi bolje obrazovani te raspolažu računalom, telekomunikacijskim vezama i rastom DBP-a po stanovniku. Cijene telekomunikacijskih usluga, međunarodna trgovina, investicije, populacijska gustoća, stupanj nezaposlenosti ili stupanj rasta DBP-a ne utječu na upotrebu interneta.

Ključne riječi: tehnološki raskorak, države u razvoju, digitalna podjela, internetski pristup, informacijska i komunikacijska tehnologija

Einkommensbedingte Faktoren, die die Internetnutzung bestimmen: Internationale empirische Daten im Vergleich

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Im Artikel werden Indikatoren der Informations- und Kommunikationstechnologie (IuK) sowie sozioökonomische Indikatoren untersucht, die mit der weltweiten Internetnutzung und dem jeweils unterschiedlichen

Staatseinkommen in Zusammenhang stehen. Die Fachliteratur führt verschiedene Indikatoren der Internetnutzung an, doch die Methodologie zur Auswertung des Phänomens ist unbekannt. Die Autorin präsentiert die wichtigsten Indikatoren und ihren Einfluss auf die Internetnutzung in vier Hauptgruppen des BIP pro Kopf: Staaten mit niedrigem BIP, Staaten mit niedrigen und solche mit höheren Mittelwerten sowie Staaten mit hohem BIP. Die Ergebnisse zeigen, dass in Staaten, deren Bevölkerungen einen höheren Bildungsgrad besitzen, mit Computer und Internetanschluss ausgestattet sind und ein wachsendes BIP pro Kopf aufweisen, die Internetnutzung besser stimuliert werden kann. Der Preis für Dienstleistungen in der Telekommunikation, der internationale Handel, Investitionen, die Bevölkerungsdichte, die Arbeitslosenrate oder die BIP-Wachstumsrate haben dabei keinerlei Auswirkungen auf die Internetnutzung.

Schlüsselbegriffe: Technologische Engpässe, Entwicklungsstaaten, digitale Verteilung, Internetanschluss, Informations- und Kommunikationstechnologie