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The Influence of Educational, Social, and Economic Factors on the International Digital Divide, as Measured by IT Usage and Expenditure

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ABSTRACT

The objective of this paper is to examine, for a sample of nations, the extent of influence of educational, social, and economic factors on five dependent variables: per capita prevalence of three technologies (pcs, internet host units, and mobile phones), ICT expenditure as percent of GDP, and ICT infrastructure quality. International data on 56 countries are drawn from the *Global Information Technology Report* (Dutta et al., 2002-2003) and the *World Development Indicators 2003* (World Bank, 2003). Utilizing the unit of analysis of the nation-state, linear regression analyses are conducted to test the paper's three research questions.

INTRODUCTION

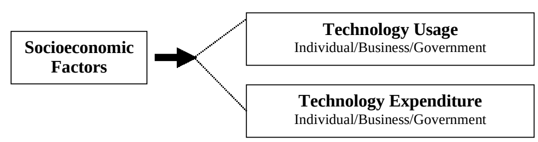
The rapidly increasing disparity in the utilization and expenditure of technology is apparent worldwide. This is commonly referred to as the "Digital Divide," i.e. that society has major divisions in intensity of IT utilization and application. In a recent annual report on the global digital divide, the World Economic Forum indicated that 88 percent of all internet users are from industrialized countries that comprise only 15 percent of the world's population. Brazil has the fastest worldwide rate of growth in computer and Internet usage, but only 13 percent of its population owns a computer and 5 percent has access to the Internet. According to the same report: "More than 80 percent of people in the world have never heard a dial tone, let alone sent an e-mail or downloaded information from the World Wide Web" (World Economic Forum, 2002). Despite much talk about the power of IT to transform the economic development process, relatively little research has been performed in a global context on how IT is being used in developing countries, what barriers exist to the diffusion and adoption of IT in different world regions and cultures, and what lessons can be learned to support leaders and policy makers in reducing or overcoming the international digital divide.

METHODOLOGY

The framework for the study is based on the model developed by the World Economic Forum in collaboration with the Center for International Development (CID) at the Harvard University and published in the *Global Information Technology Report* (GITR, 2002-2003).

Our research framework is depicted in Figure 1 below. The right side of this model, the usage of ICT and their sub-components is adopted from the Networked Readiness Index Framework of the GITR from Figure 1 above. Data for the *Global Competitiveness Report* (Dutta et al., 2003) were downloadable from over 4,000 surveys in 82 countries that include well over 100 questions.

Figure 1. Framework for the socioeconomic factors



We explore the association of several socioeconomic factors on some of the sub-components of this model used by GITR in 82 countries. Our unit of analysis is the nation-state and data are collected from *GITR* (2002-2003) and the *World Development Indicators 2003* from the World Bank. The nation-state as a unit of analysis has the weakness of aggregating the many different levels of technology within a single nation-state. However, this is addressed by interpreting the effects as national ones, i.e. national factors result in national expenditures and usages. Another problem might be that macro units miss the variety of human situations of inequality and the question of the differing capabilities of people to overcome them (Sen, 1995). However, the intent of this paper is to measure, interpret, and assess the larger effects that influence nations as a whole, rather than focusing on individual diversity.

VARIABLES USED IN THIS STUDY

Variables were chosen to support the framework in Figure 1 based on prior studies, including Sharma and Gupta (2003), Simon (2004), Florida (2002, 2005), and Azari and Pick (2004, 2005). Since the data sources had some missing data, this choice of variables reduced the size of the sample of nations with complete data to 56 for regression analysis.

Dependent Variables

- Personal computers per 1,000 people
- Internet host users per 1,000 people
- Mobile phones per 1,000 people
- Information and communications technology expenditure per capita
- Index of overall ICT infrastructure quality

Independent Variables

- Gross National Produce (GNP) in $billions per capita
- Foreign Direct Investment in $ millions per capita
- Availability of scientists and engineers
- Public spending on education (percent of GNP)
- Primary pupil teacher ratio (pupils per teacher)
- Secondary school enrollment (net enrollment ratio in percent)
- Percentage of expenditure in education
- Quality of math and science education
- Quality of local IT training programs
- Government prioritization of ICT
- Percent of females in the labor force
- Gini Index
- Commercial energy use per capita

RESEARCH QUESTIONS

1. What are the most important socioeconomic factors that influence average per capita national technology usage for personal computers, internet hosts, and mobile phones?
2. What are the most important socioeconomic factors that influence average per capita national technology expenditure for information and communications technology?
3. What are the most important socioeconomic factors that influence ICT infrastructure quality?

FINDINGS

Stepwise regression analysis was applied for the five dependent variables. With GNP excluded, the most significant and positive correlate, for all dependent variables, is quality of math and science education. The second most significant correlate for PCs per capita, internet hosts per capita, and ICT spending portion of GNP is scientists and engineers in R&D per capita. A close third in significance is availability of scientists and engineers for internet hosts per capita, mobile phones per capita, and ICT infrastructure quality. Also primary pupils per teacher is inversely significant for mobile phones per capita.

In summary, the associations of three variables are predominant: math/science education quality, scientists and engineers in R&D, and availability of scientists and engineers. Training, education, and presence of these professionals appear to be essential for technology worldwide. There may be reverse directional effects which are not investigated here. The findings regarding scientists and engineers correspond to the results of the previous publications for U.S. counties (Azari and Pick, 2005). A difference is that the U.S. findings also demonstrated the importance of ethnic composition and in some cases support services. The findings on education are consistent with other research at the national levels (Warschauer, 2003; Zhu and Wang, 2005).

DISCUSSION

The major results, when GNP is excluded, are that technology is stimulated by scientific and technical education, by scientific and engineering talent, and by scientists and engineers engaged in R&D. These will be discussed in terms of the national unit of analysis of this study.

At the level of regional, local, or metropolitan units within nations, research has shown that scientific and technical education contributes to technology (Florida, 2002; Azari and Pick, 2004, 2005). These studies indicate that the positive effects of education are not limited to technical students, but apply to general college attainment and to broad scientific education. In other words, communities and metropolitan areas benefit by having an educated population with an abundance of scientists, engineers, and other technical professionals. The contribution to higher levels of technology per capita are from the capability of communities to conduct R&D, to fill scientific and technical jobs, and to attract in-migration of scientific talent. An example of such a community is the Silicon Valley near San Jose in California.

In the current research, the quality of math and science education can influence nations in a somewhat analogous way. Nations foster creativity including in technology through forming educated segments of the population referred to by Florida (2005b) as the “creative class,” which he defines as employees in science, engineering, health care, business law, architecture and design, entertainment, and the arts. This class is estimated at 40 million in the U.S. and 125 million worldwide (Florida, 2005). Besides the U.S., nations with high percentages of “creative class” are Ireland, Belgium, Australia, Netherlands, New Zealand, Estonia, the U.K., Canada, Finland, and Iceland. These nations can compete better economically in technology and other creative industries. Analogous to the rationale for communities, nations with high quality of scientific education attract foreign students and talented immigrants who add to the level of technology (Florida, 2005). Florida carries this argument further, suggesting that governments and businesses can be proactive in seeking talented students and top-skilled immigrants, examples being Australia and Ireland.

The results for availability of scientists and engineers and for scientists and engineers in R&D per capita also follow the above arguments for localities and regions. If there is a strong pool of scientific talent, then a nation’s industry and universities can be more creative and productive, leading to greater prevalence of technology and its infrastructure, and a stronger economy in general.

POLICY IMPLICATIONS

The paper suggests policy that can be taken by the countries and their governments to foster effective use of technology and reduce the digital divide. Steps recommended for national governments to foster greater national levels of technology are to emphasize high quality of education at all levels and especially in math and science; upgrade skills; improve basic infrastructure to support educational outcomes; invest in poverty reduction, health, and infrastructure, which allows educational gains to be better realized; attract scientific talent both domestically and internationally; reduce the gender divide; and encourage societal openness and tolerance. Educational advance is especially crucial in developing nations, where educational investments directed towards technology have not always been successful (Warschauer, 2003). We reason that the presence of a scientifically educated population, with a creative science/engineering workforce performing more R&D contributes to higher levels of technology utilization and infrastructure.

The first two points on national policies to improve educational access and infrastructures in the tertiary sector with a focus on digital literacy and creativity are especially important and are strongly supported by the paper’s findings. More developed nations have struggle with finding the budget and political support to broadly advance higher education. This becomes a question of national leadership in giving high priority to educational improvement programs and providing the necessary resources, expertise, and national educational leadership to succeed. In developing nations, the problems are more critical and difficult (James, 2004, 2005). When literacy itself is a national challenge such as in some African, Asian, and Latin American nations, digital literacy and creativity may not receive as much attention or funding. Those nations may be better to focus funding for digital literacy and creativity in certain regions and metropolitan areas, as a stimulus to the nation. The successes of the state of Kerala in India is an example. Another approach, recommended by Florida (2005) is to stimulate education is to form international consortia with the goal of advancing digital literacy worldwide.

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