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2008

A Global Model of Technological Utilization Based on Governmental, Business Investment, Social, and Economic Factors

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A GLOBAL MODEL OF TECHNOLOGICAL UTILIZATION BASED ON GOVERNMENTAL, BUSINESS INVESTMENT, SOCIAL, AND ECONOMIC FACTORS

Un modèle global d'utilisation des outils technologiques basé sur des facteurs gouvernementaux, d'investissement, sociaux et économiques

Research-in-Progress

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Abstract

This paper presents a model of governmental support and openness, business and technology investment, and socio-economic factors that influence technological utilization for 110 countries. The conceptual framework is based on prior research showing that these factors impact the usage of technology and vice versa. Structural equation modeling is applied to conceptualize and test the model. This model uses latent and observable variables and the application tests five hypotheses for the overall model and relationships between its factors. Data are recent and from the World Bank and World Economic Forum. The findings indicate a critical pathway of influences between the factors of government support and openness, socio-economic level, and technology utilization. The paper suggests policy steps for national governments of developed and developing nations especially for policy clusters of government emphasis on ICT, openness, and strengthening of R&D and technology investment.

Keywords: Global digital divide, socioeconomic factors, technological utilization, government investment, openness, structural equation modeling

Résumé

Ce papier présente un modèle des facteurs gouvernementaux, socio-économiques, et d'investissements qui affectent l'utilisation des technologies dans 110 pays. Une modélisation d'équations structurelles est appliquée pour conceptualiser et tester le modèle. Les résultats indiquent un chemin critique d'influence entre les facteurs de soutien et d'ouverture gouvernementaux, le niveau socio-économique, et l'utilisation des technologies. Le papier suggère les étapes d'une politique pour les gouvernements de pays développés et en développement, notamment dans les politiques de cluster, de soutien gouvernemental aux TIC, d'ouverture, et de renforcement de l'investissement en R&D et en technologie.

Introduction

Over the past decades technological development has been reshaping the material basis of our society and economy in an ever-increasing pace. Especially the rapid development and diffusion of the new information technologies have altered the process of production, raised productivity, and improved living standards in many countries around the world. This transformation is taking place on a global basis. Yet, this revolution is likely still in its beginning stages and its effects are not yet well understood and predictable.

One issue, which frequently surfaces, is the question of how these sweeping changes will affect the fabric of our lives. As Wilhem (2004) puts it: "Technology is not the problem—it's the use of technology that can empower or control, unite or divide. Moreover we need to recover the ideas of social justice and fairness that have been lost in the rush to make things faster and cheaper." Will the revolutionary advances of the information and communication technology (ICT) widen the "digital divide" and increase the gap of inequality in technology, which already is prevalent throughout societies or will we be able to direct these forces to work more equitably for the benefit of everyone? This is the daunting challenge the global economy face. The recent technological innovations and their impact on economic performance, especially in industrial countries, seem not only to affect the way we live and work but they also seem to determine the course of action in our society. For example, the rate of diffusion of one of the most recent prevalent technology, the Internet has been very much dependent on social institutional systems rather than "the outcome of the operation of technological [and market] advances only" (Zhao 2007, p. 29). Technology alone does not determine society and neither can society script the activities of technological innovation; technological change and innovation depend on many complex patterns of interaction, including individual inventiveness and entrepreneurship (Castells 1996, p. 5).

This paper has the objective to better understand the relationships of governmental, business and technology investment, and socioeconomic factors with information technology utilization. Its implications refer to how government, business, and citizenry might be involved with and support the utilization of IT. It raises relevant questions that may help policy makers and experts to identify and address potential and already developing social and economic problems based on the recent changes and it may help to increase the social dialogue and regional partnership among countries, employers, workers, governments, and civil society regarding the advances in technology.

Background

The rapid development of new technologies in the information age is a source of problems for the old socioeconomic structures "…until society and social institutions are able to match perfectly with them" (OECD 1998, p. 126). "If there is technological advance without social advance, there is, almost automatically, an increase in human misery" (Harrington 1987, p. 960). Fortunately, the advances in technology and the risks associated with its applications can be shaped by social and political choices. Society through government intervention and policy changes can stall or accelerate the process of technological change. There is sufficient evidence from the literature that both government intervention and private sectors involvement are crucial in alleviating the digital divide (Robison et al., 1995; Quibria et al., 2004; Wallsten, 2005; Raven, 2007; Ono, 2007; Guillen and Suarez, 2005; James, 2008; Author, 2008). James (2008) rejects the view that digital divide will be alleviated without government intervention. In a comparative study between China and India, Raven (2007, p. 91) argues that even though both countries had access to the information technology at about the same time, each has taken a different path which dramatically involves both government and business contributions; as he puts it: "These approaches are based on a number of factors, including government initiatives and focus, infrastructure building, experience and understanding of business operations, and culture, among others."

Hypotheses

The present study seeks to answer the following hypotheses.

Hypothesis 1.

Is an overall model that includes the factors of investment in business and technology; government support, legal framework and societal openness; socioeconomic level; and technology utilization, significant in modeling the observed endogenous variables?

The conceptual model of the four factors, seen in Figure 1, is hypothesized to apply for the overall sample and subsamples of developed and developing nations. Hypotheses 2-5 include support for the relationships shown between pairs of factors.

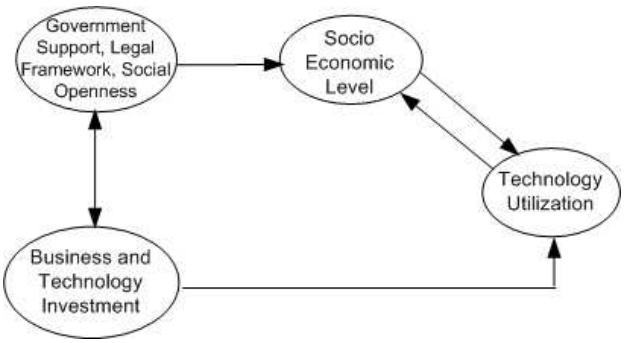

Figure 1. Conceptual Model of Technology Utilization

Several studies have included all the factors of this model, although they were not formulated with pathways and did not utilize structured equation modeling methodology (Robison et al., 1995; Sharma and Gupta, 2003; Dutta, 2007; Author, 2008). The justification for Hypothesis 1 is from prior literature that supports the overall conceptual correspondence of the factors. The theoretical justification of individual links occurs under Hypotheses 2-5.

Robison and Crenshaw (1995) applied 3-step regression methodology to a sample of countries in the early 1990s to identify influences on internet capacity, defined as the number of internet hosts per capita. Modernization theory of development underpins the study. Findings show significant influence of development level and political freedom on internet capacity, while education broadly conditions other variables in the model. Teledensity is validated as a significant proximate determinant, and would be considered part of the present INVBT. The other conceptual model factors are present. Sharma and Gupta (2003) developed a conceptual study that contains variables for all of the factors in the present model, although they are arranged differently. The relevant outcome variable is "digital divide," which is accompanied by 11 other social and economic outcomes such as marginalization and impact on taxes. A difference from the present model is that variables associated with the current INVBT factor influence GSLO-like variables but they do not covary. The INVBT-like variables are termed "global environment," while the SOCLEV-like "human systems" and "social/cultural" factors are present but not grouped together. Author (2008) analyzed the impacts of 13 independent variables on ICT usage, expenditure, and infrastructure. The independent variables were not grouped, but if categorized to the present model, would be evenly divided between GSLO, INVBT, and SOCLEV. Results indicate that for developed nations, variables in the INVBT factor were most significant in influencing TECUTIL, while for developing nations, the pathway from GSLO to SOCLEV to TECUTIL is supported. Since regression was utilized, the present model's pathways could not be statistically validated but only inferred. In sum, these three studies include the hypothesized model's factors, and some of the pathways are justified.

Hypothesis 2.

Do the factors of investment in business and technology (INVBT) and government support, legal framework, and societal openness (GSLO) significantly co-vary with each other? This applies for the overall sample and two subsamples.

Simon (2004) developed a conceptual model that technical and societal critical success factors were necessary for adopting E-Commerce in developing nations. Technical CSFs were physical infrastructure and communications infrastructure, while societal ones were intellectual property rights, legal issues, standards, education, change management, business and government awareness, taxes, privacy/consumer protection, and the political-economic

environment. Simon emphasized that technical CSFs, similar to the present GSLO factor, and societal CFSs corresponding to the present INVBT factor have a synergy that leads to the success of E-Commerce (Simon, 2004).

A regression study of adoption rates for six technologies in 18 Asian nations at varied development levels (Quibria, 2003) recognized the importance of income and education in ICT adoption, while business and government policies could further it by investing in infrastructure and encouraging the rule of law, property rights, and freedom for individuals. Robison and Crenshaw (2002) identified a one-way relationship from GSLO to INVBT, but not in the other direction. Particularly, they point out that more societal openness in poorer, developing nations encourages a greater prevalence of transnational corporations, which in turn attract telecommunications infrastructure and allow enhanced communications with core developed nations.

Hypothesis 3.

Does government support, legal framework, and societal openness (GSLO) significantly influence socioeconomic level (SOCLEV)? This applies for the overall sample and two subsamples.

Case studies of Estonia (Dutta, 2007) and Egypt (Warschauer, 2003) provide support for Hypothesis 3 for mid-level and developing countries. In 1991, when Estonia became independent from the former Soviet Union, successive governments emphasized development off information technologies and the internet. The government introduced a series of programs starting in the mid to late 1990s aimed at creating openness in the society, including constitutional rights of internet access for all citizens, a portal linked to all government websites, and open access to draft legislative bills and amendments. The Tiger Leap program sought for all school children to have Internet access and skills and the "Look @ the World" program which aimed to provide training on the internet as well as open access to reach 90 percent of the citizens. During the period, the country achieved remarkable advances in per capita income and education level of technology, although some challenges remain including deficits in ICT workforce, maintenance of top government leadership interest, and stimulating the export industry in technology (Dutta, 2007). The case demonstrates long term support for the model's pathway of GSLO to SOCLEV.

In a 3-year participant observation case study of educational technology for Egpyt, Warschauer (2003) analyzed and critiqued the Egyptian government's attempt to stimulate technology skills levels by setting up multimedia centers in government schools and computer labs in secondary schools, and developing educational software, satellite educational television programming, and a videoconferencing training system. The government sought to expand openness to information, stimulate technological learning, and in turn increase technology levels. "Solving Egypt's educational problems requires not so much a provision of equipment, but rather a mobilization of social forces to work for an improved and equitable educational system" (Warschauer, 2003). Although the government program had many problems, its intent relative to the present model was to strengthen the pathway GSLO impacting SOCLEV. Baliomoune-Lutz (2003), in a regression study of 47 developing nations, examined the influences on ICT diffusion of government trade policies, freedom indicators, per capita income, and education. Government trade policies and income were influential on ICT, while freedom indicators had moderate impact. Government policies on trade and freedom were associated with higher incomes. In short, the influence of GSLO on SOCLEV finds moderate support, especially for developing countries.

Hypothesis 4.

Does socioeconomic level (SOCLEV) significantly influence technology utilization (TECUTIL)? This applies for the overall sample and two subsamples.

The two-way interactions between SOCLEV and TECUTIL are supported by a number of studies, especially for SOCLEV impacting TECUTIL (Danowitz et al., 1995; Quibria et al., 2003; Korupp and Szydlik, 2005; Dasgupta et al., 2005; Chinn and Fairlie, 2005). In a study of internet diffusion five North African nations, Danowitz et al. (2005) identified the key barriers as low income growth, limited social and economic integration in the region, an unabsorbed labor surplus, and inability to develop the necessary level of consumption. Quibria et al.'s study (2003) of ICT in 18 Asian nations, discussed under Hypothesis 2, also confirmed the effect of income per capita on per capita adoption of five technologies and a moderate effect of education. In a national, longitudinal study of German households, Korupp and Szydlik (2005) found that computer and internet use were influenced positively by income and male gender and negatively by living in a single household. In the families pointed out that computer and internet use is often driven by children, leading to generational and age effects. Although based on the household unit of analysis, the findings point to both a pathway from SOCLEV to TECUTIL, and also a pathway in the opposite direction, particularly mediated by technology being available to children. In a study that examined panel

data to determine variables influencing diffusion of mobile phone use during the 1990s, Dasgupta et al. (2005) identified the most important variables as per capita income, change in per capita income, urban population, and to a lesser extent a governance index. The income and urban variables support Hypothesis 4. Chinn and Fairlie (2007) examined differences in internet and personal computer penetration for 161 countries from 1999-2001, using regression and gap analysis. Significant variables were income per capita, followed by years of schooling, illiteracy, dependency ratios, urbanization, infrastructure, and regulatory quality. In summary, the model's link of SOCLEV to TECUTIL is supported, with income and education being especially important contributors.

Hypothesis 5.

Does the factor, investment in business and technology (INVBT) significantly influence technology utilization (TECUTIL)? This applies for the overall sample and two subsamples.

In Simon's conceptual study (2004) of critical success factors (CSFs) for e-commerce adoption, three of the ten factors he identified as CSFs were communication infrastructure, business and government awareness, and taxes. They fit in with the present model's factor of INVBT. The study by Chinn and Fairley (2007) also identified telecommunications infrastructure as significant for internet and pc use. In the present model, it would be associated with technological readiness for INVBT. Author (2008) in a regression study of IT prevalence and expenditures for 71 developed and developing nations, found the greatest influence was scientific and technical journal articles, followed by foreign direct investment. For developing nations, FDI was most significant. These factors are important components of INVBT and justify the link in Hypothesis 5.

Methodology

This research is based on structural equation modeling (SEM), which is an integrated modeling approach that utilizes factor analytic methods to form factors based on observed endogenous variables (Byrne, 2001). SEM analyzes the group of observed variables and the relationships of their latent factors, to estimate model fit. In the present case, confirmatory SEM is utilized, in which prior knowledge is applied to formulate a conceptual model of factors and the structural model, i.e. their hypothesized causal connections (Blunch, 2008). The latent factors must be defined operationally, i.e. variables are assigned to the factors (Byrne, 2001; Blunch, 2008). The measurement model describes relations between the observed variables and latent factors. SEM computes the latent factors and fits the model to data for the observed variables by adjusting the specified relationships between the factors in order to estimate how closely the covariances of the observed variables fit those of the theoretical model (Bollen and Long, 1993; Byrne, 2001; Blunch, 2008). For SEM, the present study utilized AMOS software (Arbuckle, 2007).

SEM methodology is applied to test the five hypotheses that the level of information technology in a country can be modeled by the latent factors, Investment in business and technology (INVBT), Government support, legal framework, and societal openness (GSLO), Socioeconomic level (SOCLEV), and Technology utilization (TECUTIL). Each latent variable (factor) is measured by five or six observed endogenous variables. The variables specific justifications are not included due to space limitations.

- Investment in business and technology (INVBT) is measured by Technological readiness (TECHREDY), University-industry research collaboration (UNIVINDCOL), Venture capital availability (VENCAPAV), Financial Market Sophistication (FINMRKTS), Foreign direct investment (LFDIPC, measured per capita as a log), and Level of scientific research (SCIENRES).
- Government support, legal framework, and societal openness (GSLO) is measured by Government prioritization of ICT (GPRIORIT), Number of Procedures Required to Start a Business (NPROCSB), Freedom of the Press (FRDMPRSS), Laws relating to ICT (ICTLAWS), and Intellectual property protection (INTLPROP).
- Socioeconomic level (SOCLEV) is measured by QEDUSYS (Quality of the education system), GENRPED (Gross enrollment ratio, Primary education), PFEMLAB (Percent females age 15-64 in the labor force), LGNIPC (Log of gross national income per capita), and dependency ratio (DEPRTO). The latter is defined as the ratio of children plus elderly divided by the working age population.
- Technology utilization (TECUTIL) is measured by Internet users per 100 population (INTUSERS), Internet servers per million population (INTSERAS), Mobile phone subscribers per 1,000 (MOBPHSUB), Personal computers per 100 (PERSCOMP), and Log of internet hosts per 10,000 (LINTHOST).

Descriptive statistics for the dependent variables for TECUTIL are given in Table 1. There are wide divergences in technological utilization between developed and developing nations, as well as differences in coefficients of variation, with developed nations having somewhat higher CVs.

Table 1. Descriptive Statistics for Dependent Variables

		Means			Coefficient of Variation*		
Dependent Variables	Abbreviation	Entire Sample	Developed Nations**	Developing Nations***	Entire Sample	Developed Nations*	Developing Nations**
Number of Internet Users (millions)	INTUSERS	23.4	37.7	9.3	103.8	177.5	77.9
Internet Servers per million population	INTSERAS	110.0	212.3	3.9	50.8	79.4	68.8
Mobile Phone Subscribers per 1,000 population	MOBPHSUB	553.1	814.7	263.8	147.2	350.2	110.2
Internet Hosts per 10,000 population	PERSCOMP	411.7	683.7	144.0	43.3	72.3	16.1
Log of Personal Computers per 100 population****	LINTHOST	19.6	32.3	6.6	87.3	136.4	47.4

* Note coefficient of variation equals 100 times the mean divided by the standard deviation

** Gross national income per capita greater than or equal to $3,400

*** Gross national income per capita less than $3,400

****The table shows the raw values.

The SEM measurement model is shown in Figure 2.

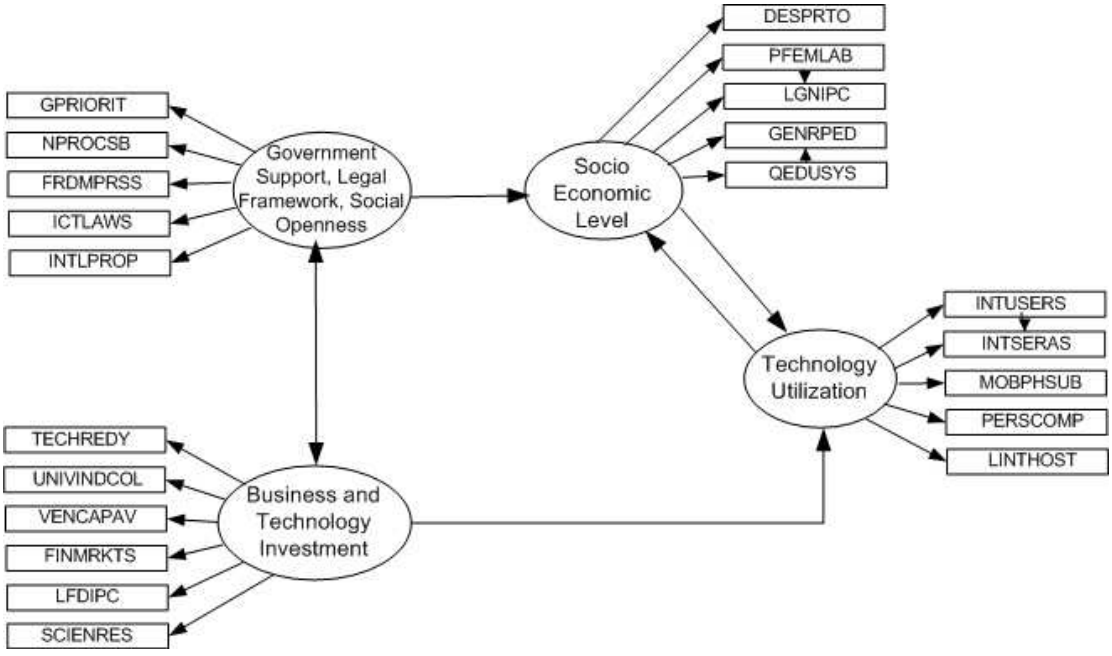

Figure 2. Structured Measurement Model of Technology Utilization, with Observed Endogenous Variables (note: error terms not shown for endogenous variables)

The measurement model's data are collected from the *Global Competitiveness Report* of the World Economic Forum (Dutta et al. 2007) and the *World Development Indicators 2007* (World Bank, 2007).

A number of pre-processing procedures were conducted on the data. Variables giving raw totals for the country were converted to per capita. Several variables with large variances, in particular LGNIPC, LFDIPC, and LINTHOST, were adjusted by the natural log. Since AMOS does not have a robust missing value feature, a limited number of variable values (less than 15) were imputed by substituting the average values for a group of similar countries in the sample. In the case of the huge foreign direct investment (FDI) for lightly populated Luxembourg, its FDI per capita was replaced with the average per capita value based on a subsample of similar European nations. This outlying irregularity arises because that country records FDI for many other major countries that have funds flowing through it. After preprocessing, the total sample size is 110. It is evenly divided into subsamples of 56 developing nations, defined as those with gross national income per capita (GNIPC) equal or greater than $3,400,

and 54 developed countries, i.e. those with GNIPC less than $3,400. The dividing point of $3,400 was determined by a 60:40 weighted average of the means for lower middle income and upper middle income countries in the dataset of the World Bank for 2005 (World Bank, 2007).

Fourteen of the 21 variables were selected based on prior research studies which were cited under the hypotheses and which were appropriate for inclusion in one of the model's factors. Due to space limitations, their full justifications are not included. SCIENRES (quality of scientific research institutions) is closely related to scientific publications, which was the leading variable explaining technology uses in a recent study (Author, 2008). Four of the six variables for the INVBT factor were not in prior research on digital divide and were selected on appropriateness for that factor as defined under Hypothesis 2. They are FINMRKTS, VENCAPAV, TECHREDY, and UNIVINDCO. They are in Likert-scale variables from (World Economic Forum, 2007, variables 1/02, 1/03, 5.05, and 1.01). The justifications for their inclusion in INVBT are: financial market sophistication and venture capital availability encourages investing; technological readiness strengthens the capability to invest in technology; collaboration between universities and industry was a policy implication noted in digital divide studies (Author, 2005, 2008). Two variables in the GSLO factor ICTLAWS and INTLPROP are likewise Likert-scale variables from the World Economic Forum, 2007 (variables 2.02 and 20.4). The justification for ICTLAWS is that laws related to ICT create a more open and democratic society, which is part of the concept of GSLO. INTLPROP, intellectual property protection, supports the legal framework for ICT. Detailed discussion of the variables and their definitions are available from the international agencies (World Bank, 2007; Dutta et al., 2007). The 21 variables were all measured in the years 2004-2006. Eleven of them are numeric from data series of international agencies, and seven are from surveys of the World Economic Forum (Dutta et al., 2007) and measured on a 7-point Likert scale.

Findings

The results for the overall sample indicate good support for the model, according to two of three indices (see Table 2). As seen in Figure 3, there is significant covariance between INVBT and GSLO. The values in parentheses in Figures 3 and 4 represent critical ratio, i.e. the ratio of standard error to the estimate. Part of the explanation is that a country that has a strong and fair legal framework, openness, clear procedures, and governmental interest in furthering ICT is also likely to have healthy internal and foreign investment, R&D, and government-university research collaboration. For an economically disadvantaged, struggling country progress on GSLO can be difficult Government strategic planners and leaders should consider of reducing control and red tape, adding freedoms and openness, which in turn help to stimulate educational advances, greater labor force participation including by women, and higher incomes, all of which contributes to enhanced technology utilization. Such policies have been recommended in prior conceptual and empirical studies (Sharma and Gupta, 2003; Author, 2008).

The importance of these openness factors in fostering technology investment and growth was noted for developing countries by Baliamoune-Lutz (2003). Guillen (2005) found that democratic regimes had associated growth of internet technologies and usage. In the model results, the influence of GSLO on SOCLEV and the influence of INVBT on TECUTIL are not significant. For the latter, the non-significant relationship is inverse. However, there is significant influence of SOCLEV on TECUTIL, although not in the reverse direction. The strong impact of socioeconomic factors corresponds has been noted by in many country-sample studies (Danowitz et al., 1995; Quibria et al. 2003, Korupp and Szydlik, 2005; Dasgupta et al. 2005, Chin and Fairlie, 2005), although not found in others (Baliamoune-Lutz 2003, Author, 2008). However, none of the cited studies utilized SEM methodology, which allows for enhanced model complexity. The single directionality is supported by Warshauer's case analysis of Egypt, which emphasized obstacles in the reverse direction. Starting programs with technological usage may lead to failed educational solutions. The single directionality of the link is contrary to a study of Germany (Korupp and Szydlk, 2005), which pointed to a reverse pathway of technological utilization especially from children in the household that influences SOCLEV.

Table 2. Goodness of Fit for Models Tested					
			Goodness of Fit Indices		
	N	Chi^2 (p, DF)	Chi^2/DF	RMSEA	PNFI
Desired Levels*			≤ 3.0	≤ 0.1	≥ 0.6
SEM Overall	110	465.09 (0.000, 182)	2.55	0.119	0.711
SEM Overall, with SOCLEV excluded	110	221.70 (0.000, 101)	2.19	0.105	0.786
SEM Developed Nations	54	321.6 (0.000, 185)	1.74	0.116	0.649
SEM Developing Nations	56	452.4 (0.000, 184)	2.46	0.166	0.498

DF = degrees of freedom. RMSEA = root mean square error of approximation, PNFI = parsimononious normed fit index
*Carmines and McIver, 1981; Arbuckle, 2007.

To examine the robustness of the SOCLEV factor, a second model was tested that is similar to the overall model, but excluding the SOCLEV factor and its observed variables. Results of this 3-factor model are similar to the overall model in the strong covariance between INVBT and GSLO and non-significant influence on INVBT on TECUTIL. However, the influence of GSLO is also non-significant on TECUTIL. The overall SEM goodness of fit is significant and similar to the full model. Since this model is overall weaker in its factor relationships, it reinforces that SOCLEV is important to include.

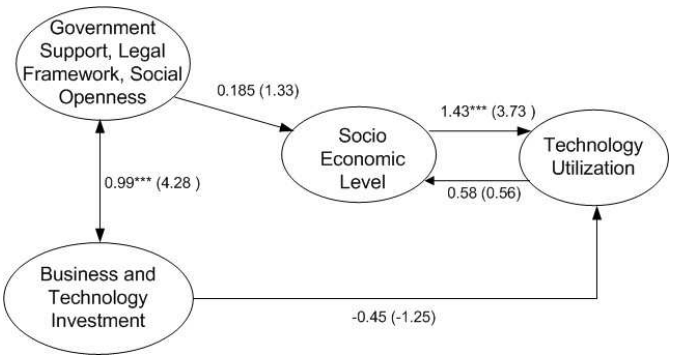

Figure 3. Standardized estimates from Non-recursive Structured Equation Model, Overall Sample

Potential differences of developed and developing nation subsamples were tested by introducing two more models, for developed and developing country subsamples. The purpose of doing this was to analyze whether the 4-factor model is supported for these sets of countries that differ considerable economically, socially, and technologically. Prior studies of developing nations (Dasgupta et al., 1998; Wallsten, 2005; Raven et al., 2008), developed nations (Ono and Zavodny 2007), and both types (Zhao et al., 2007; Author, 2008) had noted a number of differences, such as greater importance of R&D as a correlate of technology in developed nations (Author, 2008) and uncertainty avoidance as an inhibitor in developing counties (Zhao et al., 2007).

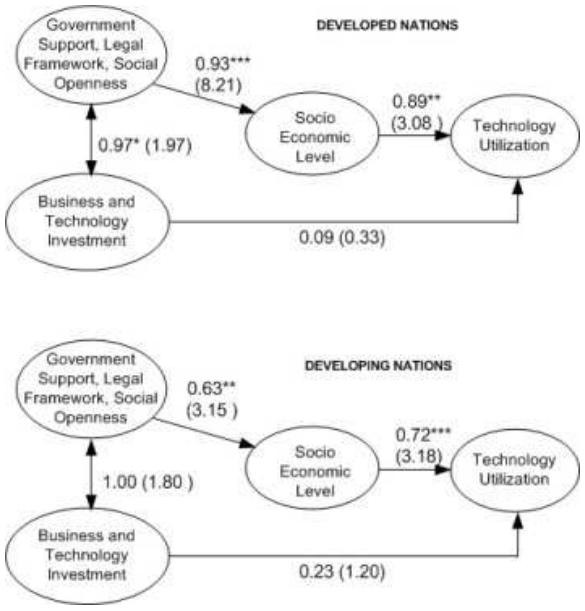

Figure 4. Standardized estimates from Structured Equation Models, Developed and Developing Nations

The results for the subsamples are consistent with the overall model and in addition the pathway from GSLO to SOCLEV to TECUTIL is seen to be stronger. The overall goodness of fit for the submodels is somewhat stronger than for the overall model (see Table 2). INVBT and GSLO co-vary significantly for the developed nation subsample, while the strong pathway just mentioned is highly statistically significant for both. As with the overall model, the direct effect of INVBT on TECUTIL remains non-significant and slightly positive. Prior studies have shown that scientific research and creative activities are associated with technology adoption and use in developed nations (Florida, 2005, Author, 2008). However, those studies were qualitative or restricted in model scope, so the present use of broader SEM that includes the factors of SOCLEV and GSLO co-varying with INVBT, may realize the impacts of INVBT on technology utilization more indirectly.

The lower values for the covariances of INVBT and GSLO in the two subsamples versus the overall sample might relate to instability in the SEM test under smaller sample sizes. However, this model disjunction may point to further research to try to discern and identify variables that may account better for its causation in the subsamples. In spite of this disjunction, the pathway of GSLO to SOCLEV to TECUTIL is completely significant and overall stronger than for developed nations. The links in this pathway have been pointed to for developing countries (Robison et al., 1995; Sharma and Gupta, 2003; Baliamoune-Lutz, 2005; Dutta, 2007; Author, 2008). It has the important policy implication that a national government start its efforts to improve ICT utilization by encouraging openness, press freedom, and the legal system, while giving programmatic priority to ICT (Baliamoune-Lutz, 2005; Dutta, 2007). The better results on this pathway for developing nations corresponds to findings of much greater impact from governmental prioritization of IT (Author, 2007) and from openness and advances in the legal system (Dutta, 2007). In a developing nation, the federal government can take proactive steps to stimulate a conducive social and legal environment for ICT (Dutta, 2007; Author, 2007).

One limitation of this study is inconsistency and constraints in the data, especially for developing nations, which limits sample size. An implication for the present research is that the subsample sizes are small for SEM analysis, although the goodness of fit tests remain significant. Larger sample size would lead to greater stability in SEM testing. Another limitation is the complexity of patterns of interaction for modeling global technological utilization, so no model can capture all the dimensions. Since SEM has not been previously applied to model the global digital divide, the conceptual framework was limited mostly on results of prior multivariate regression studies.

Conclusion

This paper analyzed the relationships of government support and openness, business and technology investment, and socioeconomic factors on technological usage of 110 countries. Results indicate a strong pathway of influence from the government framework to socioeconomic level and in turn on technological utilization, which is even stronger for separate samples of developed and developing nations. The direct influence of business and technology investment on technology utilization is consistently weak. The findings are consistent with prior literature studies, although SEM analysis has rarely been applied to the study of the "global digital divide," largely due to lack of large country samples until recently.

Returning to the paper's research questions, the findings indicate the following:
Research Question 1. It is supported for all models examined, since the overall goodness of fit is demonstrated.
Research Question 2. Covariance of GSLO and INVBT is supported by the overall and developed nation models, but not for developing nations.
Research Question 3. The influence of GSLO on SOCLEV is supported only for the developed and developing country subsamples.
Research Question 4. The influence of SOCLEV on TECUTIL is supported only for the developed and developing country subsamples.
Research Question 5. There is no significance direct impact of INVBT on TECUTIL.

There are fundamental policy implications, especially for the developing world. For government planners, the research suggests longer-term steps to stimulate government prioritization of ICT, openness of society, democracy, and a stable legal structure. There are perhaps higher-level reasons to take these steps such as to better the human condition, but technology is a beneficiary. This research points to a pathway through the intermediate factor of improving social and economic conditions. China in recent years might exemplify this pathway, which is clearly not in process and not completed, but we can point to the loosening in historical tight autocratic control and the cracking open of some freedoms as a stimulus to economic growth, with technological level as a beneficiary. The present study implies the need for future research to address the links between technological change and socioeconomic factors, available resources, the role of government, multicultural content, behavior of population, corporate social responsibility, the building of communities, and social group compositions. Establishment of a comprehensive dialogue between different stakeholders in national and other communities -- government, businesses, educational, institutions, citizens -- can foster a unified approach to pathways such as appear in this research study, with their potential benefits.

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