아태연구 제14권 제1호
2007년 5월 30일 pp.125~142

Determinants of National Informatization: A Cross-country Analysis

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Key words(중심용어): 국가정보화(national informatization), 다국가분석(cross-country analysis,), 패널데이터(panel data)

Summary

As the current manifestation of the ongoing sequence of technological revolutions, ICT can be seen as the key factor driving economic growth in the present-day industrial societies. This paper investigates the major factors of the information society measured by ICT-related expenditure per capita in GDP. Using the panel data on 50 countries during 1992-2001 periods, this article reviews what is known about the determinants of the ICT expenditure figures and takes it as a proxy measure for the informatization across countries. Models were estimated to explore determinants using a cross-country analysis. Consistent with previous literatures, the results show that per capita income and ICT-related infrastructures were two robust explanators. Moreover, human capital investment significantly contributes to the national informatization in developing world. Openness to foreign trade should also be an important determinant as if the statistical analysis performed in the paper did give any statistical support. Consequently, to be able to take actions to bridge the digital divide or to eradicate information poverty, overall results in the paper can be helpful for policy-makers to establish the promising policies concerning national informatization.

Ⅰ. Introduction

The information and communication technology (ICT) can powerfully influence individuals, societies and economies, and this effect is likely to grow over the foreseeable future. The interest in the global diffusion of ICTs has also been spurred by arguments that it may increase knowledge diffusion through improving communication efficiency and allow developing countries to leapfrog traditional methods of increasing productivity (Norris, 2001 Steinmueller, 2001). Although several studies have cast a skeptical eye upon the ICT-productivity story (Gordon, 2000), the preponderance of the literature attributes the improvement to the introduction of new technologies (Autor et al., 1998; Brynjolfsson and Hitt, 2003).

Many researchers raise the question: what contribute to national informatization in developing and developed countries? Oxley and Yeung (2001) investigated that Internet diffusion is directly impacted by network infrastructure. The extent of development within telephone, computer, and communication technologies were found directly correlated with Internet diffusion. Wolcott et al.(2001) noted that external conditions such as legal, economic, political, and social conditions that surround Internet users also affect the level of adoption in the country. Goodman et al. (1994) also indicated that there are three primary barriers to wider distribution of networking such as government policies including law and practices; technical impediments; local and cultural factors. However, the principal problem in analyzing the informatization is that, except in a few advanced economies, national income and product accounts do not provide detailed enough information about ICT investment and consumption. This lack of official data makes international comparisons difficult as they have to rely on alternative, private sources of data.

The prime objective of this study is to identify and measure the effects of the major determinants of informatization at the country level. Most previous studies have been limited in scope, either adopting a regional focus, or considering only a small set of variables. To date, the majority of cross-country work in this area has been limited to the OECD countries. Besides, a few factors have been identified as being important, such as differentials in income, human capital, regulatory effectiveness, and telecommunications infrastructure, but a definitive study is lacking. The components of informatization to be covered in the analysis include the income per capita and ICT-related infrastructure such as the Internet and telephone, and government policy. A simple statistical model is also estimated to identify the important determinants of ICT expenditures per capita in a panel of 50 developed and developing countries in the period 1992-2001.

The organization of the paper is as follows. The next section reviews literatures studies on information society. Section 3 explains the determinants of influencing the national informatization through literature review. Section 4 provides the details of both fixed and random effect model as well as the definition of data considered here. Section 5 explains the panel estimation results and discusses empirical evidence regarding the differential of national informatization between developed and developing countries. Some concluding remarks are made in the final section.

Ⅱ. The Literature Survey on Information Society

As a more recent technological innovation, there are a many examples of cross-country analyses concerning the determinants of the information society. Press et al.(1998) identified several determinants of Internet adoption, including the existing telecommunications infrastructure, personal computing and software, financial resources as well as human capital. Dasgupta et al. (2001) focus on theInternet to telephone mainlines ratio as a dependent variable. The growth rate in this variable over the sample period is related to initial values of the Internet to telephone mainlines ratio, the urban population, income per capita, an index of competition policy as well as some regional dummies. The result including a negative impact of income per capita are somewhat difficult to interpret for a number of reasons because the sample period is quite early, 1990-1997. Kiiski and Pohjola (2002) examined a more recent sample, 1995-2000, and used a more conventional measure of the Internet hosts per 1000 inhabitants. In a broad sample encompassing about sixty OECD and developing countries, the five year growth in this variable is related to income per capita, telephone access costs, and the average years of schooling. Pohjola (2003) studied observed investment in ICT in 49 countries over 1993-2000. He regresses ICT investment per capita on income per capita, the relative price of ICT equipment, human capital measures, the share of agriculture and openness to international trade. In addition to finding the typically high elasticity of ICT investment with respect to income, he also detects a major role for human

capital and a negative impact of agriculture's importance in the economy.
Non-economic factors can be critical for the adoption of new technologies. However, studies have also shown that government policies can be important in the early stages of Internet adoption (Bazar and Boalch, 1997; Lin, 1993). They found the predictability of policymaking to be a significant determinant. Unfortunately, their measure of policy predictability was highly correlated with another determinant, a Democracy Index. Furthermore, Atkin et al. (1998) found that demographic factors have more impact on Internet adoption than communication needs for early adopters, and Lin (1998) found that age is a major predictor of computer adoption.
In Table 1 the 50 countries for which data exist are classified into two groups, high income and low income countries. Sweden, Denmark, United Kingdom and United states are at the top of the ranking whereas India, Indonesia, Philippines and South Africa are at the bottom in the level of the informatization. Disparities in ICT expenditures ratios in GDP per capita are quite large, ranging from 2.2 per cent in Romania to 14.4 per cent in Netherlands. Two developing countries, Colombia and Czech Republic, stand out from the rest with expenditure shares of 12.0 and 9.5 per cent, respectively. These countries have spent a larger share of their national income on ICT than, for example, Finland and Germany.

Table 1. Average share of ICT expenditures per capita

High Income Countries	**Code**	**%[a]**	**Index[b]**	**Low Income Countries**	**Code**	**%[a]**	**Index[b]**
	AU			Argentina	AR	4.0	21
	S			Brazil	G	8.3	16
	AU			Bulgaria	BR	3.8	25
	T			Chile	A	8.1	34
	BE			China	BG	5.7	15
	L			Colombia	R	12.	14
	CA			Czech Rep.	CH	0	44
	N			Egypt	L	9.5	-
	DN			Hungary	CH	2.5	36
	K			India	N	8.9	6
	FI			Indonesia	CO	3.9	6
	N			Malaysia	L	2.2	22
	FR	10.		Mexico	CZ	6.6	14
	A	7		Philippines	E	3.2	10
Australia	DE	7.2	79	Poland	EG	4.2	27
Austria	U	8.1	73	Romania	Y	5.9	29
Belgium	GR	8.7	76	Russian Fed.	HU	2.2	19
Canada	C	9.3	89	Slovak Rep.	N	3.3	34
Denmark	HK	7.7	96	South Africa	IN	7.5	10
Finland	G	9.1	79	Thailand	D	9.2	13
France	IS	7.9	58	Turkey	ID	3.7	21
Germany	L	6.1	76	Venezuela	N	3.6	12
Greece	IR	8.7	31	Vietnam	MY	4.0	-
Hong Kong	L	7.4	83		S	6.7	
Iceland	IS	7.3	91		ME		
Ireland	R	5.7	72		X		
Israel	IT	9.6	62		PH		
Italy	A	7.4	47		L		
Japan	JP	9.3	76		PO		
Korea, Rep.	N	14.	89		L		
Netherlands	KO	4	86		RO		
New Zealand	R	7.2	65		M		
Norway	NL	6.5	86		RU		
Portugal	D	9.9	40		S		
Singapore	NZ	4.7	80		SV		
Slovenia	L	4.7	-		K		
Spain	NO	5.1	46		ZA		
Sweden	R	11.	96		F		
Switzerland	PR	3	94		TH		
United Kingdom	T	10.	95		A		
United States	SG	2	95		TU		
	P	9.7			R		
	SV	7.9			VE		
	N				N		
	ES				VN		

Ⅲ. Factors Influencing the National Informatization

1. Income

Informatization can be diversely defined. This paper considers the share of ICT expenditures in GDP per capita as a proxy for the national informatization. While there is no consensus, several factors have been identified in previous literature. The most common of these is per capita income. Previous studies have shown that countries whose people are better off economically tend to have higher Internet penetration (Arnum and Conti, 1998; Hargittai, 1999). Maherzi (1997) showed that richer countries have more telecommunications networks and higher media penetration overall. Within and among wealthier nations, previous studies have demonstrated a strong and positive relationship between GDP and Internet user rates. That higher GDP induces higher informatization seems reasonable for as an individual's income grows, she or he is able to afford additional goods and services, including Internet access.

2. Internet and Telephone

Similarly, Bazar and Boalch (1997) postulated that the presence of adequate infrastructure, such as telecommunications, is crucial for adoption of the Internet in developing countries. Particularly, a positive correlation between infrastructure and Internet penetration was demonstrated by Arnum and Conti (1998). For example, the Internet is one of the fastest growing communication technologies. It has been adopted at an unprecedented pace. The number of Internet users worldwide reached 377.7 million in September 2000. The significance of the Internet globally is likely to increase, yet there is paucity in literature on what factors affect Internet adoption at the country level. Early studies on Internet use in the United States showed a typology consistent with diffusion of innovations theory and Rogers'characterization of innovators (Rogers, 1995). While most works on ICT development have been on OECD countries, there is a small, but growing literature about developing nations. Mendoza and Alvarez (1997) showed that Internet users tend to have higher income levels and to connect to the Internet from work or educational institution.

A technical problem is that, as might be expected, there are high correlations among personal computer (PC), Internet and GDP. Because multicollinearity can influence the magnitudes and variances of parameter estimates for the affected explanatory variables, this is why PC is deleted in the explanatory variables.

3. Human Resources

Human capital is directly associated with the innovative of a nation. Nedovic-Budic et al. (1996) found that lack of technical expertise and trainingprograms for both system administration and end users in less developed countries is an inhibitor to the Internet diffusions process. The impacts of human capital are more controversial. Lee (2001) finds that the level of secondary education is important for the adoption of both main lines and mobile telephone technology. He also comes up with evidence for the strong role of secondary and tertiary education in explaining the differences across countries in the number of Internet hosts per capita. However, neither Hargittai (1999) nor Norris (2001) obtains any statistical support for education. Kiiski and Pohjola (2002) noted that the poor statistical performance of education in their analysis of OECD countries may reflect the low variability of the schooling variable in the sample rather than the lack of impact of education on Internet penetration.

4. Openness

The regulatory regime of a country affects the acceptance and deployment of new technology such as the Internet. Generally, the government adopting a positive attitude towards Internet technology may engage in restructuring the domestic economy and adaptive policies to encourage diffusion. For example, in some less developed countries, governments have played a major role in Internet development through initiating and funding the Internet and internet-related technologies. On the other hand, developing countries can also be impacted by reluctant governments that can actually impede the diffusion.

5. ICT Investment

Shih et al. (2002) regress the share of IT hardware and systems investment in GDP on a number of explanatory variables in 44 countries in 1985-1999.

The factors driving IT investment turn out to be different for developed and developing countries. For example, while controlling for GDP per capita, they find that human capital and telecommunication infrastructure matter for the adoption of IT in developing countries only. Caselli and Coleman (2001) examine a dataset encompassing up to 89 countries over the years 1970-90, focusing on the computer imports/worker ratio, as a proxy measure for the investment in ICT. In attempting to explain the variation in this variable, they rely upon a large set of variables, including income per worker, investment per worker, structural descriptors, human capital, imports and exports from and to the OECD.

6. Urbanization

The percent of the population living in urban areas also provides a negative contribution in the decompositions. Most regions have substantially more rural populations than the United States resulting in an advantaged geographical distribution in terms of computer use. The computer penetration rate gaps with the United States would be from 6.1 to 13.7 percent higher if these regions had a similar percentage of the population living in urban areas. The two exceptions are Europe and Central Asia, and Latin America and the Caribbean, which have comparably sized urban populations.

7. Electric Power Consumption

Regional differences in electric power consumption also contribute to the ICT-related infrastructure. As World Bank data (2003), this factor explains 6.8 percent of the gap between Europe and Central Asia and the United States and from 15.1 to 17.8 percent of the gaps between other regions and the United States. Undoubtedly, countries in which relatively few people have access to reliable electricity provide limited opportunities for the use of personal computers. In this sense, it is possible that the use of per capita electric power consumption understates the true contribution of access to electricity to the regional gaps in informatization.

8. Other Factors

Irrelevancy to this study, more recently, focus has switched to policy related variables. Wallsten (2003) examines a developing country sample of 45 countries in 2001. He relates Internet users and Internet hosts to the standard variables as well as measures of regulatory regime characteristics, including agency independence, transparency, and discretion. Price regulation is also examined. One problem in interpretation arises from the use of PCs per capita variable as a control variable. The inclusion of this variable raises the possibility of simultaneity bias among other things. The regulatory regime of a country affects the acceptance and deployment of new technology such as the Internet. Generally, the government adopting a positive attitude towards Internet technology may engage in restructuring the domestic economy and adaptive policies to encourage diffusion. For example, in some developing countries, governments have played a major role in Internet development through initiating and funding the ICTs.

Ⅳ. Model and Data

1. Model Specification

The simple statistical model can be applied to identify empirically the determinants of the informatization across countries and over time. For the estimation, it is hypothesized that national informatization is a function of per capita income, infrastructure and government policy and so on. Given that the model is linear in logarithms.

$$INF_{it} = c + \alpha_1 Y_{it-1} + \alpha_2 INET_{it-1} + \alpha_3 TEL_{it-1} + \beta' Z_{it-1} + \mu_i + \varepsilon_t + \eta_{it} \quad (1)$$

where c is a constant term. INFit is defined as the share of ICT expenditure in GDP in country i at time t. Y_{it-1}, $INET_{it-1}$ and TEL_{it-1} denote real per capita income, Internet users and fixed line and mobile phone subscribers per 1,000 people, respectively. The vector Z_{it-1} contains a list of the possible determinants of national informatization, such as the human resource. Variables μ_j and ε_t stand for country and time effects, respectively. The error term η_{jt} is assumed to be identically and independently distributed among countries and years. The fixed country effects μ_j are taken into account by performing the so-called within estimation, in which the average country values calculated over the estimation period are subtracted from the dependent and independent variables for each country.

Fixed effects regression is the model to use when you want to control for omitted variables that differ between cases but are constant over time. It lets you use the changes in the variables over time to estimate the effects of the independent variables on your dependent variable, and is the main technique used for analysis of panel data. If you have reason to believe that some omitted variables may be constant over time but vary between cases, and others may be fixed between cases but vary over time, then you can include both types by using random effects. In order to examine the difference of the estimation results between fixed effect and random effect model specification, two results are reported.

2. Data

All data are from the World Development Indicators Database (World Bank, 2003). These data are available for years up to 2001. Simple linear interpolation has been applied to generate the numbers for the missing years. Variables is employed to represent the factors of national informatization are as follows.

The share of ICT expenditure in GDP (INF) includes external spending on information technology, internal spending on information technology and spending on telecommunications and other office equipment. Y_{it-1} is the first explanatory variable. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 1995 U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 1995 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

Internet users (INET) are people with access to the worldwide network, and the variable TEL is fixed line and mobile phone subscribers per 1,000 people; fixed lines are telephone mainlines connecting a customer's equipment to the public switched telephone network, mobile phone subscribers refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology that provides access to the public switched telephone network. Unfortunately, reliable data on the human resources and the government ICT investment as factors were unavailable for most of the countries which otherwise would be in the sample. High-technology exports are products with high R&D intensity because they include high-technology products such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery.

In addition, the skilled labor has an advantage at learning and the advance in technology is associated with an increase in the demand for skills needed to implement it. Therefore, the share of high-technology exports in manufactured exports (HTEX) and personal computer installed in education

(HUMAN) are used proxies for the government investment and human resources. As the Internet facilitates access to vast and essentially uncontrollable quantities and varieties of information, data, and opinions, the degree of openness of a society is likely to be important. The ratio of exports plus imports to GDP is used as proxy for the openness (OPENNESS). In addition, the variables URBAN and POWER indicate the share of urban population in total population and electric power consumption (1,000 kwh per capita), respectively.

If the variables used in the estimation might be highly correlated, Table 2 reports their correlation coefficients. In general, correlations between measures are not high except for a few notable exceptions. Roughly, the TEL and POWER are highly correlated with INCOME.

Table 2. Correlation Coefficients of Variables

	X1	X2	X3	X4	X5	X6	X7	X8	X9
X1	1								
X2	.693	1							
X3	.558	.429	1						
X4	.715	.877	.603	1					
X5	.497	.442	.760	.459	1				
X6	.317	.430	.601	.307	.827	1			
X7	.483	.405	.401	.323	.446	.509	1		
X8	.524	.696	.317	.703	.320	.221	.109	1	
X9	.644	.882	.422	.885	.411	.246	.241	.678	1

Notes: Number of observations is 500. X_1=*INF*, X_2=*INCOME*, X_3=*INET*, X_4=*TEL*, X_5=*HUMAN*, X_6=*OPENNESS*, X_7=*HTEX*, X_8=*URBAN* and X_9=POWER. The variables are defined in above.

3. Test for Model Specification

The Hausman specification test is the classical test of whether the fixed or random effects model should be used. The research question is whether there is significant correlation between the unobserved specific random effects and the regressors. If there is no such correlation, then the random effects model may be more powerful and parsimonious. If there is such a correlation, the random effects model would be non-consistently estimated and the fixed effects model would be the model of choice. The test for this correlation is a comparison of the covariance matrix of the regressors in the fixed effect model with those in the random effects model. The null hypothesis is that there is no correlation. If there is no statistically significant difference between the covariance matrices of the two models, then the correlations of the random effects with the regressors are statistically insignificant. The Hausman test is a kind of Wald χ^2-test with k-1 degrees of freedom, where k=number of regressors, on the difference matrix between the variance-covariance of the fixed effect model with that of the random effects model. The Hausman test tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator.

V. Results and Discussions

1. Estimation Results

Table 3 presents the panel estimation results. The countries are listed in Table 1, and the time period is 1992-2001. The Model 1 represents the basic model with income per capita, the Internet users and telephone subscribers as the explanatory variables. In both regressions, variable TEL is strongly significant and has the expected signs. This is implies that a10 per cent increase in telephone subscribers is associated with about 4.1per cent increase in overall level of national informatization. In random effect model, a 10 per cent increase in the Internet users results in a 0.1 per cent increase in the share of ICT expenditure in GDP per capita.

Model 2-4 add more explanatory variables, one at a time, to the basic regression. The estimation presented in Model 2 contains human capital as the first additional explanatory variable, in addition to INCOME, INET and

TEL. Human capital is measured here by the logarithm of personal computer installed in education. As expected, the relationship between ICT expenditures and human capital is positive and significant. A 10 per cent increase in the personal computer installed in education is associated with a 1.4per cent increase in real ICT-related spending per capita. The finding is in line with, for example, the studies by Caselli and Coleman (2001) and Lee (2001) who emphasizes the importance of education for the adoption of ICT. It is also consistent with those theories that regard technological development as skill biased.

The regressions displayed in model 3 and 4 introduce two other possible determinants of national informatization, discussed above, namely the degree of openness and the ICT investment. The former is measured here by the share of exports plus imports in GDP, and the latter by the share of high-technology exports in manufactured exports as proxies for ICT investment. As expected, Openness is positively related with ICT expenditures. However, high-technology export is not is insignificant. The problem may be that the aggregate measure applied here does not capture the proper channels of ICT investment. In Model 5 and 6, the result shows that variable URBAN is insignificant and POWER is a significant determinant but negatively related the informatization.

The results give some implications as follows. First, the adjusted-R2 for the Model 6 is higher than that for the other models. On the other hand, standard error for the Model 6 is lower than that for the other models. This implies that the Model 6 improves the explanatory performance of the model, but this is not dramatic. Second, estimation results for the Model 6 show that in both fixed- and random-effect models, the influence of INCOME is statistically meaningful at the 5 and 1% significance level, respectively. Therefore, it is concluded that income has a significant impact on the level of national informatization. Third, the fixed effects are always statistically a reasonable thing to do with panel data (they always give consistent results) but they may not be the most efficient model to run. Random effects will give you better P-values as they are a more efficient estimator, so you should run random effects if it is statistically justifiable to do so. The Hausman test is carried out to checks which model is appropriate in Model 6. From the result of the Hausman test, the Wald statistics is 8.52. Considering $\chi^2_{0.95}(8)=14.07$, the null hypothesis is not rejected at 5% level in Hausman specification test in all versions of the model. This means that both the estimates of the both fixed- and random-effect model is not different.

Table 3. Panel Estimation Results by Models

Variables	Model 1 Fixed	Model 1 Random	Model 2 Fixed	Model 2 Random	Model 3 Fixed	Model 3 Random	Model 4 Fixed	Model 4 Random	Model 5 Fixed	Model 5 Random	Model 6 Fixed	Model 6 Random
INCOME	0.186 (0.310)	−0.096 (0.094)	−0.036 (0.303)	−0.131 (0.093)	−0.107 (0.309)	−0.112 (0.091)	−0.066 (0.315)	−0.122 (0.091)	−0.074 (0.316)	−0.092 (0.104)	0.693 (0.337)**	0.240 (0.132)***
INET	0.002 (0.007)	0.014 (0.006)**	−0.012 (0.007)	−0.005 (0.007)	−0.014 (0.007)*	−0.009 (0.007)	−0.014 (0.007)*	−0.010 (0.007)	−0.013 (0.007)*	−0.010 (0.007)	−0.007 (0.007)	−0.009 (0.007)
TEL	0.410 (0.041)***	0.367 (0.036)***	0.343 (0.041)***	0.329 (0.036)**	0.330 (0.043)***	0.292 (0.037)***	0.323 (0.044)***	0.291 (0.037)***	0.330 (0.049)***	0.296 (0.038)***	0.362 (0.047)***	0.342 (0.039)***
HUMAN			0.140 (0.026)***	0.123 (0.022)***	0.144 (0.027)***	0.140 (0.022)***	0.142 (0.027)***	0.132 (0.023)***	0.138 (0.027)***	0.131 (0.023)***	0.133 (0.026)***	0.126 (0.023)***
OPENNESS					0.095 (0.082)	0.164 (0.055)***	0.086 (0.083)	0.142 (0.057)**	0.069 (0.085)	0.139 (0.057)**	0.053 (0.082)	0.120 (0.057)**
HITECHEX							0.021 (0.031)	0.038 (0.026)	0.023 (0.032)	0.036 (0.026)	0.030 (0.031)	0.027 (0.025)
URBAN									−0.327 (0.399)	−0.089 (0.146)	0.313 (0.404)	0.007 (0.148)
POWER											−0.561 (0.104)***	−0.273 (0.067)***
Constant	−0.741 (0.124)***	−0.288 (0.291)	−0.843 (0.148)***	−1.101 (0.325)***	−1.226 (0.154)***	−1.239 (0.318)***	−0.941 (0.182)***	−1.159 (0.323)***	−1.124 (0.225)***	−0.911 (0.519)*	−1.190 (0.237)***	−0.574 (0.525)
Sample size	450	450	450	450	450	450	450	450	450	450	450	450
# of countries	50	50	50	50	50	50	50	50	50	50	50	50
Adjusted-R^2	0.910	0.138	0.140	0.133	0.140	0.133	0.140	0.133	0.140	0.133	0.136	0.129
s.e.[a]	0.14[illegible]	0.13[illegible]	0.14[illegible]	0.13[illegible]	0.14[illegible]	0.13[illegible]	0.14[illegible]	0.13[illegible]	0.14[illegible]	0.13[illegible]	0.13[illegible]	0.12[illegible]

2. Estimation Results by Income Groups

The effects were also analyzed in two different income groups. The Table 4 presents the panel estimation results by income level. The estimated effects of income per capita on informatization in low income countries are higher and more significant than that of high income countries. The INET variable is statistically significant and positive relationship for high income countries, this implies that increases in Internet users increase the share of ICT expenditure in GDP per capitafor the countries with high incomes per capita, but negative for high income countries. This result agreeswith the majority of studies for developed countries. More telephone subscribers are significantly associated with a higher informatization of both nation groups. In particular, the estimated effects of human resources inlow income countries are positive and significant. This implies that the investment of human resource such in lower income countries is important factor for the future. The variable HTEX and URBAN is positiveand significant for high income countries. This is largely consistent with the research regarding the ICT diffusion. The effect of POWER is different in both two country group. Particularly, the negative effect for low income countries is interpreted thatthe provision of electric power is insufficient and its price is relatively cost.

Moreover, the Hausman test is carried out to check the structural difference in two countries group. From the result of the test, the Wald statistics is 93. 87. Considering $\chi^2_{0.95}(8)=15.51$, the null hypothesis that there is no structural difference between developing and developed country is rejected at 5% level in Hausman specification test. Therefore, we can conclude that the estimation results of this study in both groups is different each other.

Table 4. Panel Estimation Results by Income Groups

Variables	Low income countries		High income countries		Overall	
	Fixed	Random	Fixed	Random	Fixed	Random
INCOME	1.242 (0.545)**	0.720 (0.318)**	-0.772 (0.394)*	-0.273 (0.205)	0.936 (0.337)**	0.240 (0.132)***
INET	-0.022 (0.011)*	-0.025 (0.011)**	0.037 (0.009)***	0.028 (0.009)***	-0.007 (0.007)	-0.009 (0.007)

TEL	0.341	0.331	0.348	0.304	0.362	0.342
	(0.077)***	(0.063)***	(0.051)***	(0.046)***	(0.047)***	(0.039)***
HUMAN	0.215	0.218	0.020	-0.005	0.133	0.126
	(0.047)***	(0.043)***	(0.025)	(0.020)	(0.026)***	(0.023)***
OPENNESS	0.193	0.278	-0.141	-0.061	0.053	0.120
	(0.131)	(0.116)**	(0.092)	(0.048)	(0.082)	(0.057)**
HITECHEX	0.025	-0.004	0.067	0.082	0.030	0.027
	(0.052)	(0.042)	(0.029)**	(0.027)	(0.031)	(0.025)
URBAN	-0.457	-0.146	0.471	0.620	0.313	0.007
	(0.799)	(0.267)	(0.338)	(0.173)***	(0.404)	(0.148)
POWER	-0.604	-0.454	-0.122	0.034	-0.561	-0.273
	(0.163)***	(0.114)***	(0.118)	(0.066)***	(0.104)***	(0.067)***
Constant	-1.874	-1.068	-3.612	-2.398	-1.190	-0.574
	(0.507)***	(0.992)	(0.347)***	(0.916)***	(0.237) ***	(0.525)
Sample size	207	207	243	243	450	450
# of countries	23	23	27	27	50	50
Adjusted-R2	0.880	0.892	0.921	0.927	0.921	0.928
s.e.e..[a]	0.171	0.163	0.080	0.078	0.136	0.129

Note: Standard errors are in parentheses. ***, ** and * are significant at 1, 5, 10% level, respectively. [a] s.e.e. denotes standard error of estimate.

Ⅵ. Concluding Remarks

Panel data analysis is an important method of longitudinal data analysis. It permits a sophisticated family of regression analysis in both spatial and temporal dimensions. When the data are from various sites and the time series or too short for separate time series analysis, panel data analysis may provide the only way to longitudinally analyze the data. Even if the series are long enough for separate analysis, panel data analysis provides a rich family of techniques with which to long at change over time common to a particular type of cross-sectional unit. In short, these techniques may be a necessary part of the toolkit of the social or behavioral researcher.

The goal in this paper has been to provide some initial probes into the role of the trends of informatization across countries. Of course, some of the issues that seem important today will no doubt fade into insignificance in the near future, while as yet-unheard-of issues will arise to take their place. Nevertheless, given the transforming effects of informatization in the social and cultural worlds, it is imperative for scholars of international communication to begin to understand how these forces will affect not only the foundational theoretical assumptions of our scholarship, but also the significant impact of these trends on the actual practice.

The paper examines the informatization in a sample of 50 countries, spanning both developed and developing countries, from 1992 to 2001 using a cross-country analysis. Consistent with previous works, the income and the infrastructure such as Internet users and telephone subscribers are important determinants as well as infrastructure endowments, using Internet and telephone densities as proxies. In particular, the results show that training and educating consumers to become sophisticated users of ICT will encourage their participation in the information economy and promote the use of ICT in developing countries.

In the information society, the classic view on the rise and fall of a nation may be invalid. Instead, nation's competitive strength will be enhanced when it truly prepares itself for an information society by effectively developing a vision for informatization, aggressively carrying out social and economic reform and actively supporting new ideas and methods of private individuals and businesses. The information policies of Japan and the United States clearly demonstrate the important role the government plays. However, in an information society, the role of a nation must not remain limited to that undertaken in an industrial society. Rather, it must adopt a new paradigm for development decentralization of social powers and for promoting an open society.

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국문초록

국가정보화의 결정요인 분석: 다국가분석

李 忠 起*

인터넷을 중심으로 하는 정보통신기술의 진보는 정보유통의 비용과 시간을 극적으로 저하시키고 밀도 높은 정보의 교환을 용이하게 함으로써 개인, 조직, 사회 간의 관계를 일변시키고 있다. 그 결과 세계는 지식의 상호 연쇄적인 진화에 의하여 고도의 부가가치가 창출되는 지식창조형 사회로 급속히 이행되어 가고 있다. 본 논문은 1992년부터 2001년까지의 선진국과 개발도상국을 포함한 50개국의 패널 데이터를 이용하여 1인당 정보통신 관련 지출로서 측정된 정보화 사회의 주요 결정요인들을 분석하였다. 분석결과는 기존의 문헌에서 확인된 바와 같이 소득, 인프라, 인적투자, 경제정책 등이 정보화 사회를 추동하는 주요 원인으로 나타났다. 특히, 개발도상국에 있어 인적자본에 대한 투자는 국가 정보화에 유의하게 기여함을 보여준다. 정보통신기술이 향후 우리나라 성장엔진으로서 자리매김하고 있는 현실에 비추어 볼 때, 본 연구의 결과는 정책입안자들에게 시사하는 바가 크리라 생각된다.

■논문접수일 : 2007년 3월 27일, 논문심사일 :2007년 5월 3일, 게재확정일 :2007년 5월 17일

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