Narrowing the Digital Gap in the APEC Region

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Executive Summary

The international digital gap has been a growing concern of the world today. The paper examines this issue in the context of APEC. Based on a statistical review of digitization performance over the period 1995-2000, it is claimed that the digital gap in the APEC region has improved or, at least, has not worsened. The paper identifies, through a regression analysis of 47 economies around the world, that all or some factors such as income, education, network policy, FDI and R&D are the main determinants of major digitization indicators.

As a supplementary extension of the regression analysis, this paper introduces an interactive model for the digital gap and, on the basis of the model, the roles of people, resources, governments, firms, markets, networks, and international organizations in digitization are discussed. Finally, the analysis and discussion lead to an evaluation and suggestions for APEC to enhance member economies' digitization level and narrow the digital gap in the region. In particular, the importance of ECOTECH is emphasized.

Key words: Digital gap, Digitization, Interactive model, APEC

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Contents

Tables

Figure

Narrowing the Digital Gap in the APEC Region*

Yoo Soo Hong

I. Introduction

This paper has several purposes. First, it reviews and assesses the trends in the digital gap in the APEC region.[1] Second, it identifies the factors that contribute to enhancing the digital level or the digitization of economies. Third, it discusses the role of the key actors, resources, institutions, and policies in narrowing the digital gap.[2] Finally, the desirable role of APEC in narrowing digital gaps, if any, between member economies is discussed on the basis of the previous reviews and discussions.

Two complementary approaches are adopted. For the identification of the main determinants of the digital gap, a multiple regression analysis using cross-country data is performed. Since the re-

* An earlier draft of this paper was presented at the 2002 APEC Study Center Consortium Conference, held in Merida, Mexico in June, 2002.

1) In this paper, the APEC region and the Asia-Pacific region are not strictly distinguished.

2) The term digital divide has a connotation of a strong barrier between the have and the have-not whereas the term digital gap has a connotation of distance. These two terms are used interchangeably in this paper.

sults of the regression offer limited information on the concerned issues, an interactive digital gap model is introduced. The model describes various factors and actors in the process of digitization. Based on the model, the relative role and contributions of pairs of factors such as people and resources, the market and government, multinational corporations (MNCs) and international organizations, and TILF and ECOTECH in APEC, are discussed.

The paper is structured in the following way. First, trends in the digital levels of APEC member economies are statistically reviewed. Then, factors affecting the trends are analyzed. The review and analysis are the starting point for the successive broader discussion of the above-mentioned contributors to narrowing the digital gap in the APEC region. The paper ends with some policy suggestions for APEC and member economies to consider for narrowing the digital gap in the future.

II. Trends and Determinants of Digitization

1. Trends in Digitization in the Asia-Pacific Region

In the existing literature, not a few observers have claimed that the digital divide in a region or an economy tends to get wider over time unless proper efforts are made to reduce it (e.g., Rodriguez and Wilson, III, 2000, OECD, 2001). Considering the interesting characteristic that information is subject to increasing returns to scale and positive externalities, it is natural to assume that 'the rich get richer and the poor get poorer'. However, this is not necessarily true. For example, Dasgupta et al. (2001) report that there is no widening digital gap in terms of Internet intensity.[3)]

Empirical observations on the digital gap in Asia are split. For example, Choi (2000) claims that there is no digital divide but a digital disparity in the APEC region. According to him, even the digital disparity will eventually be reduced since the growth of the fixed network in developed economies is at a saturation point whereas developing economies are catching up at a high speed. Compared to Choi, Wong (2002) reports a gloomier picture of wider disparities in IT diffusion between Asian and non-Asian economies. These two contrasting views are enough to suggest that the existence and dynamic change in the digital gap is a matter for empirical testing.

As an economy grows and the convenience of IT is acknowledged,

3) However, the same paper confirms that the change in mobile phone subscriptions over time shows a widening international digital gap. Thus, in their case, it depends on the measure of the digital gap.

Table 1. IT Trends and Digitization in the Asia Pacific Region

Region	Economy	Telephone Lines (per 100 inhabitants)			Cellular Mobile Telephone Subscribers (per 100 inhabitants)			Computer in Use (per 100 inhabitants)		
		1995	2000	Rate of Change (%)	1995	2000	Rate of Change (%)	1995	2000	Rate of Change (%)
Northeast Asia	Japan	50	58	16.0	9	53	488.9	12	32	166.7
	Korea	52	58	11.5	4	57	1325.0	11	19	72.7
	China	3	9	200.0	0	7	-	0	2	-
	Hong Kong	53	58	9.4	13	64	392.3	15	35	133.3
	Taiwan	43	57	32.6	4	80	1900.0	10	22	120.0
Southeast Asia	Singapore	41	43	4.9	9	68	655.6	20	48	140.0
	Malaysia	17	21	23.5	5	15	200.0	4	10	150.0
	Thailand	6	9	50.0	2	4	100.0	1	2	100.0
	Philippine	2	4	100.0	1	8	700.0	1	2	100.0
	Indonesia	2	3	50.0	0	2	-	1	1	0.0
Oceania	Australia	49	52	6.1	12	45	275.0	28	46	64.3
	N. Z.	47	50	6.4	10	40	300.0	22	36	63.6
North America	USA	61	69	13.1	13	40	207.7	33	59	78.8
	Canada	61	68	11.5	9	28	211.1	22	39	77.3
	Mexico	9	12	33.3	1	14	1300.0	3	5	66.7
South America	Brazil	9	17	88.9	1	14	1300.0	2	4	100.0
	Argentina	16	22	37.5	1	18	1700.0	2	5	150.0
	Chile	13	22	69.2	1	22	2100.0	3	9	200.0
	Colombia	10	17	70.0	1	5	400.0	2	4	100.0
	Peru	5	6	20.0	0	6	-	1	4	300.0
Average		27.5	32.8	42.7	4.8	29.5	797.4	9.7	19.2	114.9
Coefficient of Variance		81.8	72.4	-	99.2	83.0	-	106.8	98.0	-

Table 1. Continued

Region	Economy	Internet Users (per 1000 inhabitants)			Digitization Index		
		1995	2000	Rate of Change (%)	1995	2000	Rate of Change (%)
Northeast Asia	Japan	16	304	1800.0	68	77	13.2
	Korea	8	403	4937.5	53	75	41.5
	China	0	18	-	16	12	-25.0
	Hong Kong	32	336	950.0	73	82	12.3
	Taiwan	12	281	2241.7	51	80	56.9
Southeast Asia	Singapore	29	299	931.0	71	85	19.7
	Malaysia	2	150	7400.0	25	26	4.0
	Thailand	1	20	1900.0	18	11	-38.9
	Philippine	0	26	-	14	11	-21.4
	Indonesia	0	7	-	13	9	-30.8
Oceania	Australia	28	350	1150.0	90	86	-4.4
	N. Z.	50	217	334.0	86	75	-12.8
North America	USA	76	347	356.6	99	98	-1.0
	Canada	42	413	883.3	91	86	-5.5
	Mexico	1	27	2600.0	20	15	-12.0
South America	Brazil	1	29	2800.0	19	16	-15.8
	Argentina	1	24	2300.0	26	19	-26.9
	Chile	4	116	2800.0	24	26	8.3
	Colombia	2	21	950.0	19	14	-26.3
	Peru	0	3	-	15	12	-20.0
Average		15.3	169.6	2145.9	44.6	45.8	-6.1
Coefficient of Variance		138.9	91.9	-	70.0	76.2	-

Note: 1. Symbol (-) means that calculation is meaningless.

2. All 2000 statistics are preliminary.

Source: Korea National Computerization Agency, *National Information White Paper* 2001. (Basic statistics are from ITU.)

production, dissemination and utilization of information tend to increase. This fact is well demonstrated by Table 1. All of those major economies in the Asia-Pacific region have witnessed increases in the four IT indexes—telephone lines, cellular mobile telephone subscribers, computers in use, and Internet users—during the period of 1995 to 2000.

During the same period, the digital gap in the region, defined as disparity in terms of digitization and measured by the coefficient of variance in each IT index, was narrowed. The only exception is the case of the digitization index, which was quoted from the computation by the Korea National Computerization Agency (KNCA) for 50 economies around the world. The digitization index is the weighted sum of the other IT indexes and some indexes for broadcasting. Since including the index for broadcasting into a weighted digitization index is controversial, the interpretation of the KNCA digitization index needs a caveat.[4)]

Based on the above review and discussion, we can safely conclude that the digital gap in the Asia-Pacific region has narrowed or, at least, not much worsened in recent years.

2. Determinants of Digitization: A Regression Analysis

In order to identify the major contributing factors, or determinants of digitization, a multiple regression has been performed. The regression is based on the following equation:

4) See Hudson (2000), p. 795.

$$D_i = c + \sum_j a_j X_j \quad , \qquad i = 1, 2, \cdots, m \qquad j = 1, 2, \cdots, n$$

where D_i = the ith digitization (component) index,
X_j = the jth determinant (contributing factor),
c = constant, and
a_j = coefficient.

For the test, based on the existing literature, five indexes for D_i as the dependent variables and five variables for X_i as the explanatory variables are considered. As shown in Table 1 and Table 2, they are as follows:

D_1 = telephone lines (per 100 inhabitants),
D_2 = cellular mobile telephone subscribers (per 100 inhabitants),
D_3 = PC in use (per 100 inhabitants),
D_4 = Internet users (per 1000 inhabitants),
D_5 = the digitization index (computed by the KNCA,
X_1 = GNP / Capita,
X_2 = mean school years,
X_3 = the Network Policy Index,
X_4 = FDIS (FDI stock) / GDP,
X_5 = R&D / GNP.

Although several different regression models have been tested, the model reported here is the best in terms of theoretical and explanatory power. The choice of the explanatory variables in the model is well supported by the existing literature. For example, Rodriguez and Wilson, III (2000) used income per capita, investment, FDI, human capital, freedom as explanatory variables for IT changes. Focusing on domestic digital divides, the OECD (2000) listed income,

education, household size, age, gender, etc. as influencing factors. Dasgupta et al. (2001) used urban population, income per capita, an index of competition policy for the test of the digital gap.

The current regression is a cross-economy type for 47 economies in the world. Of the 50 economies that were originally included in the KNCA data set, three economies including Chinese Taipei were excluded due to insufficient statistics. Most data are basically for 1999 due to the lack of accurate data for the more recent period. All of the data for dependant variables borrowed from the data set were prepared by the KNCA. The original source of the data for the categories of telephone lines (D_1), cellular mobile telephone subscribers (D_2), PC in use (D_3), and Internet users (D_4) was ITU. However, some of the figures for Korea were corrected by the KNCA since the ITU's figures were apparently incorrect. As mentioned earlier, the data for the digitization index (D_5) was computed by the KNCA as a weighted sum of several indicators including the above four indicators.

The data for independent variables were borrowed from several reports published by the World Bank such as the World Development Indicators except for 'the Network Policy Index (X_3) which was computed by the International Center for Development at Harvard University as a weighted sum of 15 indicators (see Table 7). Instead of GDP, GNP per capita (X_1) was used for the immediate availability of the latter.[5)]

The results of the regression are robust. The R squares are impressively high without any serious problem of multicollinearity.[6)]

5) The entire data set of all variables used in the regression for 47 economies is available upon request.

6) For the test of the problem of multicollinearinty, variance inflation factor

The statistical results are summarized in Table 2 through Table 6. Based on the regression results, we observe the following.

Table 2. Telephone Lines (per 100 Inhabitants)

Statistics of Regression	
Multiple R	0.936715733
R Square	0.877436364
Adjusted R Square	0.862489579
Standard Error	7.924277774
Sample Size	47

Variance Analysis

	Degree of Freedom	Sum of Square	Mean of Square	F	Significant F
Regression	5	18431.35359	3686.270717	58.70402035	1.29701E-17
Residual	41	2574.561308	62.79417824		
Total	46	21005.91489			

	Coefficient	Standard Error	t	P
Constant	-33.15622578	13.96102008	-2.374914269	0.022313394
X1(GNP/Capita)	0.000807531	0.000230197	3.508004783	0.001110235
X2(School Years)	2.701347454	0.757651938	3.565420106	0.000940268
X3(NPI)	6.43979643	3.26474054	1.972529318	0.055318821
X4(FDIS/GDP)	2.532436198	3.721949552	0.68040584	0.500071976
X5(R&D/GNP)	3.026555099	2.435744403	1.242558577	0.221090477

(VIF) of each independent variable was computed as follows:

VIF of X_1 = 5.12, VIF of X_2 = 1.67, VIF of X_3 = 4.96,

VIF of X_4 = 1.65, VIF of X_5 = 3.78

In general, a serious multicollinearity problem is regarded to exist if the VIF value is over 10.

Table 3. Cellular Mobile Telephone Subscribers (per 100 Inhabitants)

Statistics of Regression	
Multiple R	0.871151826
R Square	0.758905504
Adjusted R Square	0.729503736
Standard Error	10.31378178
Sample Size	47

Variance Analysis

	Degree of Freedom	Sum of Square	Mean of Square	F	Significant F
Regression	5	13728.4068	2745.681361	25.81156035	1.11478E-11
Residual	41	4361.337876	106.3740945		
Total	46	18089.74468			

	Coefficient	Standard Error	t	P
Constant	-26.21484441	18.17085652	-1.442686226	0.156705552
X1(GNP/Capita)	0.000585597	0.000299611	1.954528642	0.057481232
X2(School Years)	-0.708124714	0.986115956	-0.718094773	0.47677106
X3(NPI)	8.37356093	4.249197522	1.97062172	0.055544601
X4(FDIS/GDP)	7.120844556	4.844274338	1.469950721	0.149207828
X5(R&D/GNP)	5.801741167	3.170224083	1.830072895	0.074515799

Table 4. PC in Use (per 100 Inhabitants)

Statistics of Regression	
Multiple R	0.961011
R Square	0.923542
Adjusted R Square	0.914218
Standard Error	4.745373
Sample Size	47

Variance Analysis

	Degree of Freedom	Sum of Square	Mean of Square	F	Significant F
Regression	5	11152.143	2230.429	99.048447	8.777E-22
Residual	41	923.26106	22.51856		
Total	46	12075.404			

	Coefficient	Standard Error	t	P
Constant	-40.9451	8.3604142	-4.8975	1.559E-05
X1(GNP/Capita)	0.000619	0.0001379	4.488898	5.705E-05
X2(School Years)	1.707963	0.4537121	3.764421	0.0005242
X3(NPI)	6.690207	1.9550565	3.422002	0.0014209
X4(FDIS/GDP)	3.503026	2.2288514	1.571673	0.1237126
X5(R&D/GNP)	1.427422	1.4586206	0.978611	0.3335115

Table 5. Internet Users (per 1000 Inhabitants)

Statistics of Regression	
Multiple R	0.896596
R Square	0.803885
Adjusted R Square	0.779969
Standard Error	59.66886
Sample Size	47

Variance Analysis

	Degree of Freedom	Sum of Square	Mean of Square	F	Significant F
Regression	5	598360.3	119672.1	33.61223	1.754E-13
Residual	41	145975.3	3560.373		
Total	46	744335.6			

	Coefficient	Standard Error	t	P
Constant	-444.336	105.1248	-4.22674	0.000129
X1(GNP/Capita)	0.001593	0.001733	0.919294	0.363319
X2(School Years)	16.67014	5.705028	2.922008	0.005635
X3(NPI)	75.90673	24.58311	3.08776	0.00361
X4(FDIS/GDP)	47.21317	28.02583	1.68463	0.099659
X5(R&D/GNP)	14.58129	18.34086	0.795016	0.431182

Table 6. Digitization Index

Statistics of Regression	
Multiple R	0.978344
R Square	0.957158
Adjusted R Square	0.951933
Standard Error	6.904938
Sample Size	47

Variance Analysis

	Degree of Freedom	Sum of Square	Mean of Square	F	Significant F
Regression	5	43673.02	8734.605	183.1993	6.44E-27
Residual	41	1954.805	47.67817		
Total	46	45627.83			

	Coefficient	Standard Error	t	P
Constant	-74.5809	12.16514	-6.1307	2.82E-07
X1(GNP/Capita)	0.001005	0.000201	5.009909	1.09E-05
X2(School Years)	3.129446	0.660191	4.740211	2.58E-05
X3(NPI)	15.01934	2.84478	5.279614	4.54E-06
X4(FDIS/GDP)	6.909035	3.243176	2.13033	0.039192
X5(R&D/GNP)	4.714969	2.122422	2.221504	0.031897

Table 7. Computation of the Network Policy Index

	Factors	Remarks
ICT policy micro-index	1. Internet access cost	Hard data
	2. Perceived effect of telecommunications competition in quality and price	Survey data
	3. Perceived effects of ISP competition on quality and price	Survey data
	4. Legal framework supporting IT businesses	Survey data
	5. ICTs as overall priority for the government	Survey data
Business and economic environment micro-index	1. Income per capita (PPP)	Hard data
	2. Rule of law	Survey data
	3. Government effectiveness	Survey data
	4. Regulatory burden	Survey data
	5. Number of days to start a new firm	Survey data
	6. Women's participation in the economy	Survey data
	7. Minority groups' participation in the economy	Survey data
	8. Country's relative position in technology	Survey data
	9. New government's respect for previous government's commitments	Survey data
	10. Trust in public postal system	Survey data

Note: All factors are equally weighted.

Source: International Center for Development at Harvard University. *Global Information Technology Report 2002.*

First, the index of telephone lines is significantly affected by GNP per capita, mean school years and by the Network Policy Index (NPI).

Second, the index of cellular telephone subscribers is significantly affected by GNP per capita, NPI and by the R&D intensity (R&D /

GNP).

Third, the index of computers in use is significantly affected by the same variables as the index of telephone lines.

Fourth, the index of Internet users is significantly affected by mean school years, NPI and by the intensity of FDI (FDIS / GDP).

Last, the overall digitization index is significantly affected by all the explanatory variables.

Among all the explanatory variables, the Network Policy Index is the only variable that significantly affects al1 indexes. Dasgupta et al. (2001) report a similar result but with different regression models. In their work, all variables were rates of change rather than levels. They found that the rates of change in the urban population and a policy index were significant determinants for the rate of change in the ratio of Internet subscribers to total main line connections. For mobile telephone growth, again population and the policy index were significant, but income per capita was also significant. Instead of discussing the statistical results in more detail, a broader discussion follows below, in order to offer a better understanding of the mechanism of the digital gap and richer policy implications.

III. An Interactive Model of the Digital Gap

1. The Model

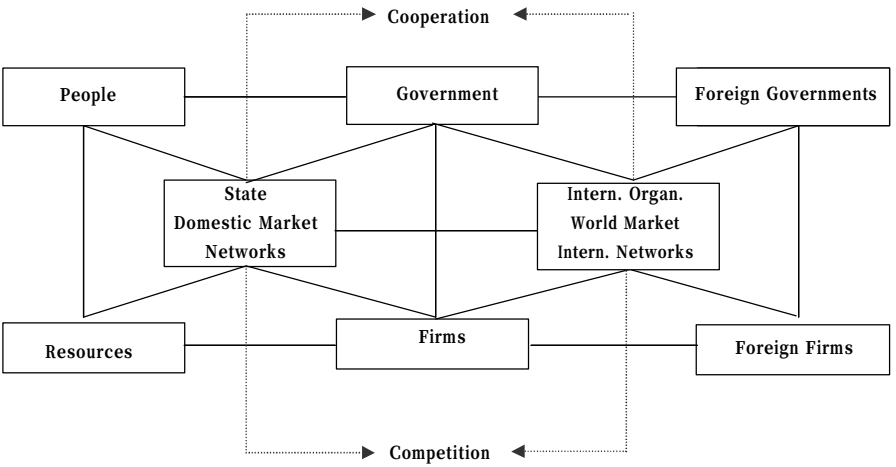
The regression analysis has two drawbacks. First, although the results are very impressive, the model may not capture some important variables that should be taken care of. Second, even if all the important variables are identified and included, the model does not explain the interactions between variables or actors in the real world.

As a result of the interactions among these determining factors and actors, the relative performance of digitization or the digital gap of economies is materialized. In order to grasp these complex interactions, a model describing the domestic and global relationship between the major agents and components of the digitization process is introduced. Figure 1 shows six major actors and components, namely, people, resources, government, domestic firms, foreign governments, foreign firms, and the connecting mechanisms of the state, domestic markets, domestic networks, international organizations or institutions, the world market, and international networks such as strategic alliances or MNC networks.

The interactions involve various transactions and flows of knowledge and information. The interactions may be pro-competitive or pro-cooperative depending on the purpose and situation. In terms of information, the interactions shape the digital performance of each economy and the resulting digital gap between economies.

We should acknowledge that the mere existence of the digital gap or the difference of digitization level among economies does not nec

Figure 1. An Interactive Model for the Digital Gap



Note: _____ represents interactive relations including the production, dissemination, and utilization of information.

Source: The author

essarily mean that the gap or difference should be immediately eliminated. This is because the level of digitization of an economy may reflect the level of economic development and the necessity of digitization or the demand for modern IT services is determined by each person's socio-economic situation. Only to the extent that the convergence of economic development is desirable, can we claim that the digital gap should be narrowed. In what follows, we discuss the role of the main components and actors in narrowing the digital gap on the basis of the assumption that the convergence of economic development is a desirable thing.

2. People and Resources

In the knowledge and digital economy, people are the core. People produce, disseminate and use knowledge and information. The income of people is an important factor for all these activities. Further, the quality of people, manifested in the human resources, affects the digitization level of an economy. This is the reason for the emphasis on human resource development (HRD) as a policy for enhancing digitization or narrowing the digital gap.

Resources such as capital, labor, technology, natural resources are another set of fundamentals of an economy in general and of the digital economy in particular. The possession and composition of these resources determine the comparative advantage of an economy and growth. The relative importance of people vs. resources is hard to judge. However, people have labor power, which can utilize natural resources from which other resources are produced. Further, information and knowledge are human phenomena. Considering these facts, we may claim that the quality of people is more important than resources per se.

For the quality of people, 'mean school years' (X_2) was used as a proxy variable in the regression in Section 2-2. The variable GNP/Capita (X_1) can be regarded as a proxy for resources. At the same time, it can be regarded as a proxy for demand, which in turn may indirectly represent the importance of the market. It is interesting to observe that each of the variables X_1 and X_2 significantly affects four dependent variables.

3. The Market and Government

Narrowing the digital gap can be achieved by either competition or cooperation among economic agents. In the past, the telecommunications sector was used to being under heavy government control due to its technological characteristic of economies of scale and to its quality of being a public good. However, the general trend in liberalization in the world economy and the digitization of economies pressed governments to deregulate the sector and to encourage competition through the market.

Encouraging marketization has several implications and impacts on the development of the IT sector and the digital gap. It has been observed that performance in the sector, especially in terms of efficiency, tends to improve with deregulation and increased competition. However, at the same time, the uneven performance of the sector may result in widening the digital gap within an economy as well as between different economies.

There have been significant changes in government views and policies on the telecommunications industry. In the past, regulation of the industry was the dominant approach on the basis of the natural monopoly argument. However, the rapidly changing nature of technology in the industry and the general trend in liberalization or deregulation changed the government's views and policies in the direction of active private sector participation through an enhanced role of the market mechanism.

A recent report prepared by the Australian APEC Study Center (2002) emphasizes this aspect; namely, the importance of the market in bridging the digital divide. The growing importance of the role of

the market in the development of IT is not denied. Rather, it is strongly supported. However, the fact to be emphasized in this paper is that the role of government should also be strengthened at the same time in order to develop the IT industry and narrow the digital gaps. This is due to the following reasons:

First, the role of government shifts towards the creation of a favorable business environment and provision of infrastructure including human resource development. Since these factors crucially affect firms' competitiveness, the role of government should be strengthened.

Second, as in the case of the e-government, government itself is at the center of the digital revolution. Government procurement creates important demand for the IT business.

Third, the need for the government to play a role in managing conflict and coordinating various activities and projects is greater in the digital economy due to ever-increasing complexities.

As in the case of the Information Super Highway Strategy of the U.S., most governments with developed IT sectors initiated well-planned IT development strategies and policies for digitization of their economies.

The importance of the role of government is well demonstrated by the regression results in Table 2 through Table 6. As mentioned earlier, the Network Policy Index significantly affects all dependent variables.

The OECD (2000) identified three policy areas of particular importance to reducing the digital divide within an economy: pro-competitive regulatory initiatives to increase network competition (short-term), increasing access to public institutions including schools (medium-term) and education and training (long-term). Table 8 summarizes the policy packages adopted by OECD member economies. It is interesting to notice that these developed economies are less dependent on

international cooperation for reducing their domestic digital divide.

Table. 8. Policies and Programs to Reduce the Digital Gap (OECD)

	No. of economies
General policies	
Broad policies	16
Infrastructure development	11
Regulatory initiatives to enhance Network competition	10
Diffusion to individuals and households	
Access in other public institutions	12
Access in schools	11
IT for the elderly/disabled	8
Access in rural/low income areas	6
Programs to lower costs of IT	8
Demonstration and awareness	3
Programs to increase demand for IT	3
Diffusion of ICT equipment	4
Diffusion to businesses	
Support and training for SMEs	11
Assistance to regions and rural areas	8
Diffusion of information	8
Encourage high-tech start-ups	2
Government projects	
Government services on-line	11
Governments as model users of ICT	9
Foster ICT applications	2
Education and training	
Training in schools	13
Vocational training	12
Teacher training	8
Lifelong leaning	7
Distance leaning	5
IT Certification	1
International cooperation	
Multilateral cooperation (EC, UN)	10
Bilateral programs	5

Source: OECD. DSTI/ICCP/IE (2000), p. 35. Adapted.

Although OECD economies are less concerned with international cooperation for their domestic digital divide, this is not necessarily the case for developing economies. Developing economies are exposed not only to a domestic digital divide but also to an international digital divide or digital gap, which makes their situation and problem worse. Even worse, their problem is more structural and combined with other kinds of gaps (Chung, 2001 b).

4. MNCs and International Organizations

Firms compete with each other, but they cooperate as well. Strategic alliances, standardization and networking are good examples of the latter behavior. In the case of IT and digitization, the cooperation among firms tends to increase because of the network externalities or the benefits of sharing resources, assets and information. However, this kind of cooperation is merely another measure of competition against a third party.

In this age of globalization, governments also compete. The international competitiveness reports by IMD or WEFA prove this fact. However, the international relationship among governments is more one of cooperation than competition. Or, at least, their main role in the international context is to establish a mutually acceptable environment for competition among firms. The WTO is a good example of this. This case of inter-governmental cooperation draws our attention to the potential contributions of APEC to narrowing the digital gap in the Asia-Pacific region.

The role of MNCs and FDI in shaping the digital divide has been well documented. For example, Clarke (2001) reports that FDI in-

creases Internet access for firms in the transition economies. Their effects on narrowing the digital gap may be positive or negative, depending on the relative contributions to host country and parent company. In the regression, the variable related to FDI is FDIS / GDP (X_4) and it significantly affects two dependent variables, D_4 and D_5.

The roles of MNCs and international organizations in the digital gap differ from each other. The difference is analogous to the case of the market vs. government. While MNCs are more concerned with competition, international organizations are more concerned with cooperation. The present regression did not include any proper variable for international organizations so that the discussions here on these organizations are solely descriptive. International organizations such as the OECD, World Bank, and UN have been working to narrow the digital gap in various ways. Regional multilateral organizations including APEC also have been making efforts towards the same goal.

A recent initiative for dealing with the world digital divide is the proposal for a Global Information Society, adopted at the Okinawa summit of the G-8 in 2000. Although the original announcement reflected the liberalization-oriented views and interests of developed economies, the final report, *Digital Opportunities for All: Meeting the Challenge* of 2001 was more balanced to take into account the situation of the developing economies.

IV. Implications for APEC

The role of international organizations has not been explicitly tested in this paper. However, on the basis of the finding of the importance of government policy, which is significantly affected by international organizations and multilateral policy negotiations and agreements, we draw some implications from the quantitative analysis and qualitative discussion so far for narrowing the digital gap in the APEC region. Due space constraints, the following is a sketch rather than a thorough discussion.

APEC aims at regional economic cooperation on the basis of open regionalism. IT or digitization should be regarded as an important facilitator for community building, if the ultimate goal of APEC or any sub-regional institution is achieving an economic community like the EU. The importance of digitization in the case of the EU has been pointed out by Holms (1990):

> The provision of telecommunications infrastructure and services play a crucial integrative role in the fabric of the (EU) Community system. (Parenthesis added by the author)

With the reference to the EU case, one can also emphasize the importance of the efforts made by APEC to narrow the digital gap through various initiatives and programs. In fact, APEC has been working in collaboration with member economies to narrow the digital gap in the Asia-Pacific region for a long time. From the earlier stage of its development, the organization well understood the im-

portance of IT. It introduced institutional innovation and initiated several important programs. A special attention to the role and relationship of TILF (trade and investment facilitation) and ECOTECH (economic and technological cooperation) is needed for the discussion on APEC's efforts to narrow the digital gap. TILF and ECOTECH may be seen as complementary, like the interaction between the market and government. The desirable complementary relationship of the two basic activity columns in APEC has been well documented and need not be repeated here. (See APEC Economic Committee, 2001 and Ahn and Han, 1998, among others.) However, it should be emphasized that ECOTECH is more important for narrowing the digital gap since TILF may not necessarily narrow the gap or, at best, it may narrow the gap only indirectly whereas, ECOTECH can directly narrow the gap. The importance of ECOTECH for the promotion of the KBE in general and for the development of IT in particular has been emphasized in various reports (e.g., APEC Economic Committee, 2000) and articles (e.g., Hong, 2000).

Sidorenko and Findlay (2001) emphasize that the right policy environment to deal with the digital divide should include strong economic and social fundamentals, utilization of IT, an innovative environment, HRD, and a means of fostering entrepreneurship. This view is in line with the above view emphasizing the role of ECOTECH. The active role of the TEL Working Group of APEC, together with other related working groups such as the IST Working Group and the HRD Working Group, is a good example of this (Chung, 2001a; Chung, 2000). Another area for APEC to contribute to narrowing the digital gap is the dissemination of knowledge on digitization among members. For example, the APEC Economic Committee (1998) pub-

lished a comprehensive report on APEC's status and strategy for digitization. Another important report of the APEC EC (2001) is on the new economy, which includes a discussion on the issue of the digital divide.

Existing efforts and initiatives of ECOTECH are highly evaluated for the narrowing of the digital gap. Among others, the programs of the TEL Working Group and 'e-APEC' are of great importance. It is also recognized that the three APEC programs for the promotion of the KBE, namely, the igniting policy, the KBE indicators, and the APEC Knowledge Clearing House are also important initiatives for narrowing the digital gap.

From the viewpoint of narrowing the digital gap in the region, the e-APEC strategy of inaugurated at the Shanghai Leaders' Meeting in 2001 is an important example of an earmarking achievement and progress of APEC towards its objectives. (For the details, see APEC, 2001.)

V. Concluding Remarks

We have observed that the digital gap in the APEC region has recently been narrowing. We also noticed that among the factors contributing to narrowing the gap, the IT-related policy package is the most significant and that there is much for APEC to do as a regional multilateral organization for economic cooperation in order to further narrow the digital gap in the region.

The efforts of APEC so far to enhance digitization in member economies are highly evaluated. Among various initiatives and programs in line with ECOTECH, the activities of the TEL and HRD Working Group and the initiative of e-APEC deserve positive acknowledgement.

Developed economies tend to emphasize liberalization and the role of the market and competition. They may be more concerned with their own domestic digital divides than the international one. To a certain extent competition is helpful in solving the digital gap. But, excessive competition does more harm than good (see the Group of Lisbon, 1995). Since the situation of the digital gap or the digital divide in developed economies may differ from developing economies, it is strategically very important for APEC to emphasize ECOTECH.

All of those factors contributing to digitization should be considered for narrowing the digital divide and a policy package that includes all the possible measures affecting those factors should be developed. However, under the constraints of resources and relative effectiveness, prioritization is inevitable.

Each individual government and people in the APEC region

should work towards narrowing the digital gap within and across economies. However, the discussion on the relative importance of contributing factors in this paper has emphasized the importance of the role of APEC, especially, ECOTECH in narrowing the digital gap in the Asia-Pacific region.

The future course of strategy and action for APEC is recommended as follows:

First, implementation of the existing initiatives and programs of APEC should be strengthened and accelerated.

Second, the bilateral and multilateral initiatives announced by leading member economies in IT and by sub-regional institutions such as ASEAN and NAFTA should be materialized. In particular, an effective and accelerated implementation of the e-APEC initiative is strongly recommended.

Third, an action plan like eEurope and a new grand program similar to the EU Framework should be seriously considered by APEC and member governments in order to facilitate technological capability building in general and IT development in particular.

APEC and member governments should also encourage firms to strengthen international business networks by providing a proper environment and incentives, since strengthening international networking is both a cause and effect of narrowing the digital gap.

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