A Statistical Analysis of ICT Developments and Regional GDP per capita Convergence in Major East Asian Countries

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Abstract: The remarkable development in ICT (Information and Communication Technology) was observed in the past decades that it has an increasing impact on economic and social activities in the world. Similarly, ICT have had a significant role in the economic growth for developed and developing countries. Therefore, no region has been more dynamic in recent years than East Asia, which is one of the most important geographic regions based on ICT. Additionally, focusing on Gross Domestic Product (GDP) per capita income distributions of East Asian countries in this study, it is also aimed to show that ICT and its components are closely linked with socio-economic components in macro and micro level, especially with GDP per capita components. In this regard, the Neoclassical Growth Model and its Convergence Theory are discussed to show the effects of ICT investments and developments as a catalyst factor that would increase the multiregional development achievements. Finally, in the light of analyses, it is observed in this study that there are some evidences for regional convergence as a weak Beta-convergence and a strong Sigma-convergence within homogeneous regions of East Asian countries in terms of GDP per capita income distributions.

Key Words: ICT, Investment, East Asia, Regional Development, Neoclassical Growth Model

1. Introduction

1.1. Background of Study

Some important and significant developments in ICT were deeply observed in the past decades that ICT has an increasing effect on economic and social activities in the world. Thus, ICT have had a significant role in the economic growth for developed and developing countries in the recent years. Many development strategies have mostly focused on pursuing economic strategies and policies that seek to promote a more attractive environment for the ICT industry. Also, development strategies are needed for developing countries to adapt ICT as a potential force not only for creating new economic growth opportunities but also for enhancing political participation of citizens and strengthening of social processes by using the convergence effect of ICT (Ramilo C., 2002).

Within this context, Gross Domestic Product (GDP) and its per capita distributions of countries take very important place in order to examine regional developments and convergence. The components of

GDP in national economies can be basically described as 'goods have to be sold in market', 'it has to be ended product', and 'it has to be produced as current'.

Furthermore, there is a significant relation between ICT development and regional convergence because real GDP growth rate is also affected by some factors (Eren E., 2001), which are closely associated with ICT as focused on it in this study by giving more different regional development view than other studies. These are as following;

1. Population growth and the quality of population such as increasing of education level and qualified labor rate.
2. Technologic developments in terms of more production and increasing of labor productivity.
3. Separating the rate of investments from real income.
4. Economic encouragements.

Finally, related with the economic growth components, ICT is such a sector that also started an economic war, competition and appealing the nation's power among countries and companies. For this reason, the priority has been given to development of ICT sectors in this study to examine the regional relations and interactions.

1.2. Review of Literature

No approach on ICT has any doubt that it has had a significant impact on most countries in the world, especially in the ways of communication, working, and learning (Vu K., 2004a). However, it is still a challenge to assess how and how much ICT has contributed to economic growth at the country as well as the global levels. Furthermore, ICT investment has a significant impact on economic growth not only as traditional investment, but also as a boost to efficiency in growth: A higher level of ICT capital stock per capita allows an economy to achieve a higher growth rate for given levels of growth in labor and capital inputs (Vu K., 2004b). ICT can be a powerful tool to facilitate and enable affordable solutions to economic development, individual development, and social development in emerging economies and to those populations who are socio-economically deprived (Reddy R., Arunachalam V. S., Tongia R., Subrahmanian E., Balakrishnan N., 2004).

Therefore, the approach of this study is also assisted and based on two probative theories with developmental issues that are 'Catch-up Theory' and 'Convergence Theory' in terms of Neoclassical Growth Model. Even though these two theories seem different than each other, it is better to consider them together in the view of growth models, because according to Neoclassical Growth Model, spatial disparities in per capita income should converge over the long run because of the opposite relations between wage and labor. Here, wage indicates the income distributions depending on public or private sector investment. Especially, the level of private sector investments will be a determining factor in

this context.

On the other hand, labor force also indicates the population and/or human tendencies and expectations. This interaction between wage and labor can be simply explained as -capital flows always take a trend toward underdeveloped regions because of cost anxiety, and conversely labor force flows show a trend toward developed regions because of income anxiety (Dincsoy, E.E., and Ichiminami, F., 2006). As to Catch-up Theory, it plays an important role in the point of investments for under developed and/or developing countries by copying the new technologies of industrialized nations.

1.3. The Goal of the Study

The main purposes of this study, after drawing the objectives and policies of ICT sector, are to shape and reconfirm the ICT sector's role. Recently, it is obvious that countries in the world have a tendency to change their economic policies from centralization structure to globalization one. The most important point of globalization can be assumed as development of ICT sector in order to increase the life quality of human being. However, this tendency has not resulted in socioeconomically equal opportunities for all countries as expected yet.

Also, this study focuses on long term development process in East Asia, which is one of the most important geographic regions of the world based on ICT. The region has also some leading countries in terms of ICT. At the same time, it can be said that they are well-organized countries in using the sector for their development process as a primary sector. By making comprehensive and comparative analysis in this study with the country cases, it is aimed to create a different perspective and a new approach for the region.

Finally, ICT sectors in East Asia, we aim to analyze the affect of ICT usage process on GDP per capita according to the years. Additionally, this analysis will allow us to open a multidimensional perspective in terms of understanding the living conditions and standards of people in the region by focusing on convergence tendencies. For this reason, this case study examines the interactions between socio-economic factors and ICT that have affected the GDP per capita income distributions of countries.

2. Economic and Social Measures of ICT impacts

2.1. Economic Components and Objectives of ICT sector

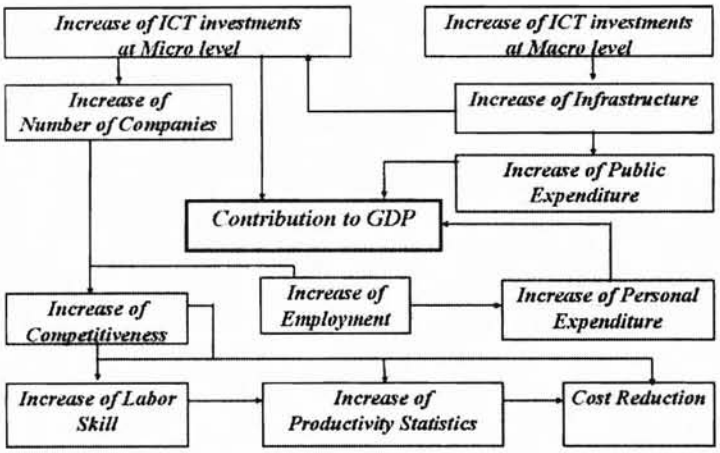
ICT developments have very remarkable impacts on economic components and objectives, which can be summarized under the six basic titles. These are Contribution to GDP, Productivity Statistics, Increased Employment, Cost Reductions, Competitiveness, and Labor Skills.

Therefore, if these indicators are examined together with ICT improvements, it will be clearly seen

that there is a significant relation and interaction between these subjects. In this point, it is also important to show the general economic interactions chart to analyze macro and micro connections (Figure 1).

As seen in Figure 1, there have been significant stream between investments and GDP contributions. As a beginning step, countries have to establish a suitable environment for Foreign Direct Investment (FDI) and other investor groups by providing infrastructure and encouraging governmental policies. In this point; legislative, regulatory, tax, procurement, collaboration incentive (public/private partnership) reforms, and Research and Development (R&D) grants and improvements have to be considered as important factors of the development throughout all socio-economic sectors.

Figure 1. Interactions among ICT Investments and Economic Components



Source: Author's

With this process, it can be also expected that there can be an increase in number of companies in the country. Basically, with the increase of number of companies, there will be two main effects on sectors. These are increases of competitiveness and employment. In this regard, there will be three main effects of competitiveness, which are increase of labor skill, productivity statistics, and cost reduction. As well known, these three results are the most important element of impulse to trade. On the other hand, increase of employment will naturally affect the personal expenditure together with increase of life standards. Finally, these components will be part of contribution to GDP that will be analyzed in the following part of the study in terms of GDP per capita income.

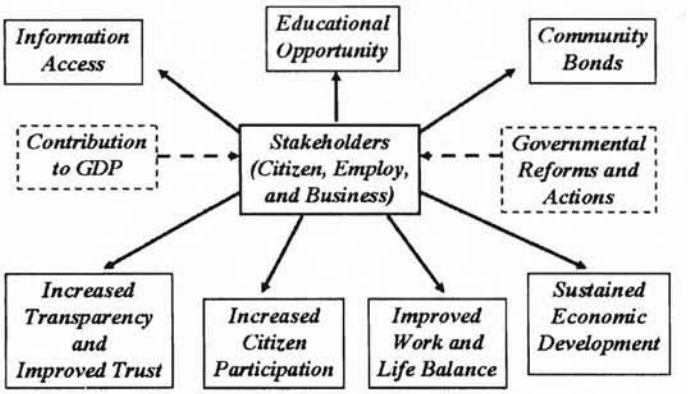
2.2. Social Components and Objectives

Similarly, ICT developments have affected social components and objectives, which are closely linked with seven basic titles. These are Information Access, Community Bonds, Educational Opportunity, Sustained Economic Development, Increased Transparency & Improved Trust, Increased Citizen

Participation, and Improved Work and Life Balance.

It is expected that these components and objectives will grow together with ICT improvements. As seen in Figure 2, ICT components have social effects on people as much as its economic effect. At first sight, all economic sectors point some sub-developments on social structures of the countries; of course, it is a very natural result of them.

Figure 2. ICT Effects on Social Components and Objectives



Source: Author's

However, as also indicated in the previous parts of the study, ICT sectoral developments show more comprehensive and extensive effects than other sectors that these effects appear on social life, directly and indirectly. For this reason, ICT components can be used as a more effective and faster instrument than others for integration with global objectives, and that is why ICT plays very remarkable role in the globalization process as well.

Finally, in the previous and present parts of the study, we tried to show the interactions and relations between/within economic and social impacts of ICT. In this regard, the tendency of people and their interests are the most important in this process which contribute to GDP and governmental reforms and actions are catalyst items for seven social components and objectives of ICT. Besides, it is also important to remember that instead of trying to extend these impacts on all sectors in the short run, it should be applied with determined and stable steps by diffusing it on the long run which will be more realistic approach than other one.

3. Current Developments in East Asia

In this part, some indicators are analyzed to show recent developments in ICT and some tables are given in below according to the countries for 2003-2005 with percentage changes.

Table 1 shows the internet hosts (per 10000 Inhabitants) and Taiwan has a higher value in 2005

(with 1389.65) than Japan (with 1286.8). Telecom market has been growing remarkably since liberalization in Taiwan and competition has brought more choices and better services to customers at lower prices. In the percentage change, some countries such as Thailand, Philippines, and Indonesia have higher growth rates.

Table 1. Internet Hosts according to the Countries (per 10000 Inhabitants)

Countries	2003	2004	2005	% Change
China	1.24	1.25	1.25	1
Hong Kong	869.29	1132.74	1132.74	30
Indonesia	2.88	5.01	5.01	74
Japan	1015.68	1286.8	1286.8	27
ROK	798.89	1130.06	1130.06	41
Philippines	3.45	7.91	7.91	129
Singapore	1162.37	1202.15	1202.15	3
Taiwan	1228.55	1389.65	1389.65	13
Thailand	16.42	56.56	56.56	244
Malaysia	43.1	52.81	52.81	23

Source: ITU (2006)

As another important indicator, number of internet users (per 100 Inhabitants) is given in Table 2 and ROK is the leader of internet users during last three years. Indonesia and China, even they have highest growth rates, still need impressive efforts to catch ROK.

Table 2. Internet Users according to the Countries (100 Inhabitants)

Countries	2003	2004	2005	% Change
China	6.15	7.23	8.44	37
Hong Kong	47.18	50.32	50.08	6
Indonesia	3.76	5.04	7.18	91
Japan	48.3	50.2	50.2	4
ROK	61.07	65.68	68.35	12
Philippines	4.93	5.32	5.32	8
Singapore	55.14	57.87	57.87	5
Taiwan	51.94	53.81	58.01	12
Thailand	9.55	10.95	11.03	15
Malaysia	34.5	38.62	42.37	23

Source: ITU (2006)

In telephone subscribers as seen in Table 3, a remarkable finding is observed in Taiwan with

negative growths during last two years. Although Indonesia, Malaysia, Philippine, and China have long distance to reach the level of Taiwan, Hong Kong, and Singapore etc, they have higher growth than those countries.

Table 3. Telephone Subscribers according to the Countries (per 100 Inhabitants)

Countries	2003	2004	2005	% Change
China	41.22	49.74	56.53	37
Hong Kong	163.81	173.19	176.54	8
Indonesia	12.35	18.12	26.79	117
Japan	115.09	118.22	119.86	4
ROK	122.72	125.11	128.56	5
Philippines	31.89	44.01	44.01	38
Singapore	128.83	136.79	146.91	14
Taiwan	173.22	159.94	157.16	-9
Thailand	45.07	53.68	36.11	-20
Malaysia	62.66	74.5	91.97	47

Source: ITU (2006)

Therefore, total number and percentage of PCs (per 100 Inhabitants) according to the countries are illustrated in Table 4. It is clearly seen that Singapore with 62.2 and Hong Kong with 59.26 in 2005 have higher values than others. In this point, it is important to mention again that these two countries have different conditions and statues from others, for instance their population advantages, policy implementations, and developmental levels.

Table 4. PCs according to the Countries (per 100 Inhabitants)

Countries	2003	2004	2005	% Change
China	3.9	4.08	4.08	5
Hong Kong	55.3	60.55	59.26	7
Indonesia	1.28	1.36	1.36	6
Japan	40.75	54.15	54.15	33
ROK	50.68	54.49	54.49	8
Philippines	3.51	4.46	4.46	27
Singapore	62.2	62.2	62.2	0
Taiwan	47.14	52.78	52.78	12
Thailand	4.79	5.83	5.83	22
Malaysia	16.77	19.16	19.16	14

Source: ITU (2006)

In the global world ICT as a developing sector, telephone lines have a different dimension in this

process. Thus, telephone components creates the most interested applications either investment tendencies or competitions among companies or countries. To analyze it in detail, Table 5 was also given according to main telephone lines in per 100 inhabitants. Taiwan (59.8), Hong Kong (53.89), ROK (49.17), Japan (45.89) in 2005 have higher values, which show one of their ICT development levels, than other countries; however other countries growth rates are also remarkable.

Table 5. Main Telephone Lines according to the Countries (per 100 Inhabitants)

Countries	2003	2004	2005	% Change
China	20.33	23.98	26.63	31
Hong Kong	55.89	54.42	53.89	-4
Indonesia	3.75	4.49	5.73	53
Japan	47.19	46.64	45.89	-3
ROK	52.51	49.02	49.17	-6
Philippines	4.12	4.16	4.16	1
Singapore	45.3	44.37	43.5	-4
Taiwan	59.08	59.63	59.8	1
Thailand	10.5	10.69	10.95	4
Malaysia	18.25	17.38	16.79	-8

Source: ITU (2006)

As to Cellular mobile Subscribers in per 100 inhabitants (Table 6), it is mostly used in Hong Kong (118.77), Taiwan (100.31), and Singapore (95.51) in the year of 2005, however their growth rates are importantly low than China, Indonesia, Philippines, Thailand, and Malaysia.

Table 6. Cellular Mobile Subscribers according to the Countries (per 100 Inhabitants)

Countries	2003	2004	2005	% Change
China	20.89	25.76	25.76	23
Hong Kong	107.92	118.77	118.77	10
Indonesia	8.6	13.63	13.63	58
Japan	67.9	71.58	71.58	5
ROK	70.2	76.09	76.09	8
Philippines	27.77	39.85	39.85	44
Singapore	85.76	95.51	95.51	11
Taiwan	114.14	100.31	100.31	-12
Thailand	34.57	42.98	42.98	24
Malaysia	44.41	57.12	57.12	29

Source: ITU (2006)

Finally, in East Asian countries' group which analyzed and compared in this section have different

level of ICT developments. The different developments and growth rates among countries are very expectable and acceptable results because they have different socio-economic conditions and developments with limits to growth. However, the important point is that developing or underdeveloped countries how much they spend effort to catch up their rival companies and/or countries in terms of socio-economic competition that can result in a regional convergence. The effects of these developments on GDP per capita will also analyze in the following parts of the study.

4. REGIONAL CONVERGENCE AND ICT

4.1. Neoclassical Growth Model

One of the key predictions of the Neoclassic Growth Model is that spatial disparities in per capita income, which is a key indicator of social and economic welfare, should converge over the long run (Armstrong, H. and Taylor, J., 2001). This will occur because of the opposite relations between wage and labor. Therefore, the Neoclassical Growth Model of Solow and Swan, based on the assumption of diminishing returns to scale, implies conditional convergence of per capita output; per capita growth decreases as an economy approaches its steady state level of output (Barro, R.J. and X. Sala-i-Martin, 1992). Thus, among economies that converge to the same steady state, this model implies absolute convergence of per capita output; poorer economies catch up with richer ones.

Therefore, convergence approach of Growth Model can be explained in two dimensions. Firstly, σ-convergence (Sigma-convergence), which is a decrease in the dispersion of per capita income over time, and regions would be expected to converge to a common rate. Secondly, β-convergence (Beta-convergence), which indicates that if poor regions grow faster than richer ones, the per capita income of the former would catch up with the latter. This assumption is referred to as absolute convergence but this is more likely to apply across regions within countries than across countries.

On the other hand, there is another assumption that per capita growth rates have little correlation with the initial level of per capita income due to the cross-country evidence and Endogenous Growth Theory. In this point, population movements and tendencies are very important as a powerful impact on convergence, while capital accumulation and flows are mainly an anti-convergence force. Although differences in technology, preferences and institutions do exist across regions that are within a single country and share a common central government, institutional and legal system, these differences are likely to be smaller than those across countries. When regional economies are not structurally similar and steady states differ, they are not expected to converge to the same level. This is referred to conditional convergence and predicts that a lower starting value of per capita income tends to generate a higher per capita growth rate (Gezici, F. and Hewings, G., 2001).

Furthermore, some studies on convergence have tried to explain the convergence process by the effects of some economic variables such as public investments (Fujita and Hu, 1999), human and public capital (Lall and Yilmaz, 2000) and FDI as an indicator of globalization. In this regard, as focused on this study, ICT and its components will play a very determining role on this process with its recent developments.

In the per capita version of the Solow model, permanent population growth is incorporated. In this case, the steady state is defined in per capita terms, while absolute quantities continue to grow. Therefore, the economic variables such as income, consumption, savings, capital stock and investment are all expressed in per capita terms. It should be noted further that in the steady-state, all absolute quantities grow at the same rate as the population. In this regard, the per capita Solow model can be shown as follows;

Equation	*Evolution of the per capita capital stock:*
The per capita production function	$\Delta k=sy-(n+d)k$
$y=Y/L=(AK^{\alpha}(HL)^{1-\alpha})/L=Ak^{\alpha}H^{1-\alpha}$	

Variables:

"A: state of production technology, y: per capita output/income, d: rate of depreciation, n: population growth rate, sy: per capita saving, k: per capita capital stock, cy: per capita consumption, H: human capital"

The Neoclassical Growth Model emphasizes the role of technological progress and labor productivity in maintaining a sustained long-run rate of growth as well. Besides, these conditions, of course, directly affect the dynamics of the growth process. In steady state, therefore, the growth rate of output is equal to the rate of population growth and the rate of technological progress. This shows that output per worker will grow at the rate of technological progress in a state of balanced growth over the long run.

Similarly, this study emphasizes that economic growth is dependent upon the stock of capital-both human and physical-and technological progress. Human capital refers to the increase in labor productivity due to levels of education, skills and experience, and the health of people. Physical and technological progresses signify the instruments, which is utilized in the phases of production at any level.

4.2. Discussion

This study has indicated that ICT and its components are closely linked with socio-economic components in macro and micro level, especially with GDP per capita components, in the developing world; and an efficient ICT policy that helps poor regions (countries) obtain balanced and/or converged

regional development. In this regard, the Neoclassical Growth Model and its Convergence Theory, which is more conducive to ICT investments and entrepreneurship, would increase the multiregional development achievements. In this study, this approach was used for a regional convergence based on country cases, but it can be also helpful for any country in its regions and domestic markets. It is important to mention here that heavy regulation on markets and market players can result in low regional homogeneity, productivity, and investments. Conversely, investing in R&D, the encouragement of new technologies may assist developing and underdeveloped countries for their agricultural and rural areas achieve higher levels of output per capita; and similarly for improving their land and resources.

As an assumption in developing the Neoclassical Growth Model come at the price of simulating the realistic nature of the model in reflecting the real world. Any major component of social infrastructures or the political arenas of countries lies primarily outside the workings of this model. This, therefore, limits the ability of economists and policymakers to investigate a full spectrum of ideas concerning the reduction of poverty. For instance, one major component of social infrastructure that lies outside the workings of this model is the idea of eliminating social barriers for women, ethnic minorities, and socially disadvantaged groups in making growth broad based. Other considerations that lay beyond the reaches of the Neoclassical Growth Model include such areas as policies, institutions, history and geography (World Bank, 2001). Hence, increases in use of ICT components with its investments may play a significant role for regional development problems.

As mentioned before, ICT investment and various other factors will affect the rate of growth of per capita output depending on the improvements in technology as well. For instance, education and external trade will lift the level of output that can be produced from given inputs through increased efficiency. Thus, levels of income per capita will rise as a result because this is equivalent to an improvement in technology. Other words, low levels of literacy, characteristic of unskilled workers have affected the growth in much of the developing world (Stone, D., 2004).

Finally, ICT is realized in this model to be the key factor in sustaining long-term economic growth and balancing regional diversifications. Thus, the Neoclassical Growth Model has dominant factors that can guide people to focus on ICT policies, which increase contribution to GDP, employment, health, productivity, and education to help the underdeveloped countries. In deed, many different factors may control regional developments and economic growth, and it is very difficult to explain these factors with Neoclassical Growth Model and Convergence Theory, but some instruments like ICT can be used for a better regional development in countries. From this perspective, it will be applied and examined in the following part of the study via East Asian Countries' case study.

4.3. Methodology

The general approach as based on two convergence approaches, it will be assumed that there is Beta-convergence if poor countries tend to grow faster than rich ones; and there is Sigma-convergence if the cross-sectional standard deviation of real GDP per head for a group of economies (countries) is decreasing during the years.

In this study, GDP per capita data was formed as time series and cross-country sectional data to analyze convergence tendencies among selected countries in East Asia by using the annual data among 1960-2002. And secondly, data was adapted in logarithmic series from the set of positive real numbers to the set of all real numbers.

Firstly, the Beta-convergence tendencies were examined by giving each year growth rates of countries in the figures. This analysis has generally been employed in order to investigate convergence across economies or regions by ignoring the spatial dimension to the pattern of growth across economies. However, rates of economic growth according to the initial income level may be interdependent across regions due to spillover effects. In cases where regions pursue their own growth promoting policies, there may be spillover effects from that regions to the adjacent regions. Thus, incorporating spatial effects into the analysis may impact significantly on any estimated convergence effects (Yildirim, J., 2005).

Secondly and finally, the graph of standard deviations was drawn to show the diversification and differentiations among GDP per capita distributions by focusing on Sigma-convergence. In this regard, a significant and negative relation (or decreasing tendency) in coefficients according to the initial income level will be commented as the evidence of convergence with verifying the prediction of the Neoclassical Growth Model otherwise divergence by giving R^2, which indicates the significance in coefficient of income correlations among regions (Dincsoy E.E.and Okur M., 2005).

4.4. Data Analyses and Findings

To analyze the Beta-convergence, firstly, the annual growth rates are given country by country. These data may show the general growth tendencies of countries. However, it is not sufficient to conclude as there is a Beta convergence tendency among countries that will be shown in a linear trend line by using least squares method in Figure 17.

Figure 8 shows the annual GDP per capita growth rates of China among 1960-2002. It is difficult to say that there is a stable growth in China but optimistic point is China has no negative growth after 1976. Hong Kong, China among 1960-2002 (Figure 9) shows very unstable growth but decreasing rates may affect the convergence finding positively, if relatively less developed countries show increasing rates at the same periods. Indonesia among 1960-2002 (Figure 10) shows similar growth

rates and the negative effect of Asian Crisis in 1997 was also observed in Indonesia like Hong Kong, China; but unlike Hong Kong, China, Indonesia could not recover it in the following year in 1998. Japan among 1960-2002 (Figure 11) shows very stable decreasing rates but showed stronger response than other countries exception China in 1997-98. ROK among 1960-2002 (Figure 12) had similarly its biggest negative growth in 1997-98. However, it showed very remarkable recovery of economy and growth in 1998-99. It would be more remarkable if it could be constant. Malaysia among 1960-2002 (Figure 13) shows similar growth rates like ROK, but unlike ROK it had negative growth in 2000-01 like in 1997-98. Philippines among 1960-2002 (Figure 14) shows most unbalanced growth rate. The economy is not stable and plays very important role affecting convergence or divergence finding among countries. Singapore among 1960-2002 (Figure 15) is also affected by 1997-98 and 2000-01 economic fluctuations with negative growth. However, as taking the second highest GDP per capita after Japan, it is also very determining country in the region. Thailand among 1960-2002 (Figure 16) shows unstable growth according to the initial years like some other countries, but the most important point is Thailand had a negative growth in 1996-97, which is one year earlier than other countries. It also indicates the root of 1997 economic crisis in East Asia.

The Beta-convergence analyses were examined according to the periods below. In the analyses of Figure 17, it is observed that there is no significant Beta-convergence in the periods of 1960-70 and 1960-80.

Figure 8. China

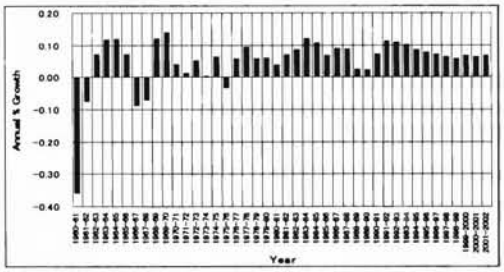


Figure 9. Hong Kong, China

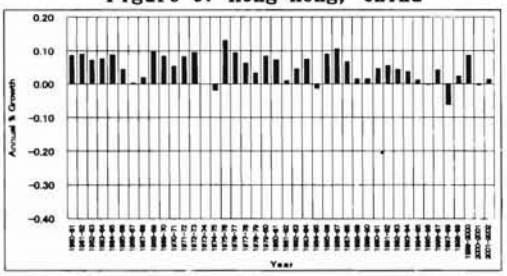


Figure 10. Indonesia

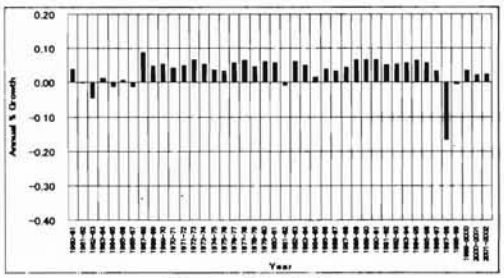


Figure 11. Japan

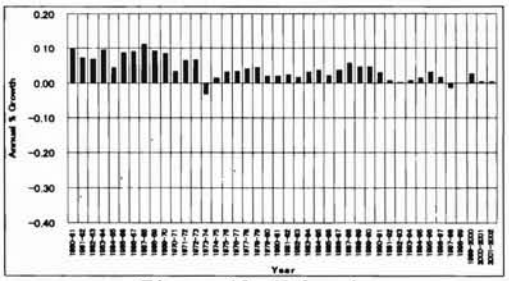


Figure 12. ROK

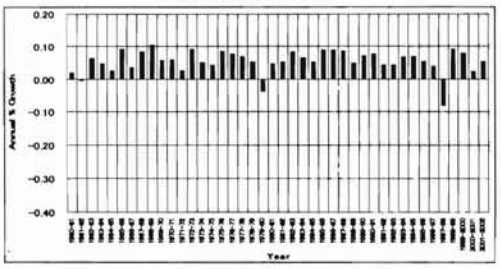


Figure 13. Malaysia

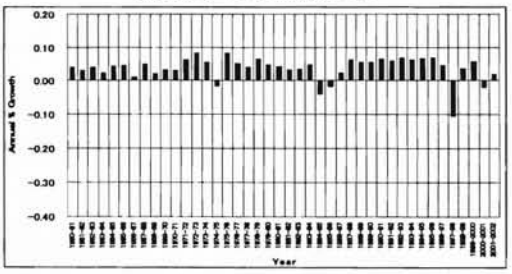


Figure 14. Philippines

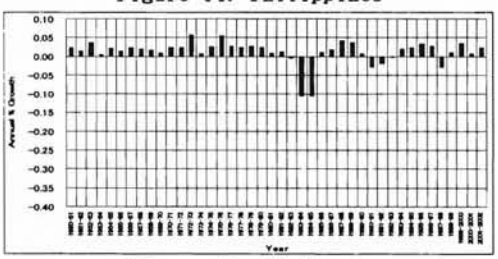


Figure 15. Singapore

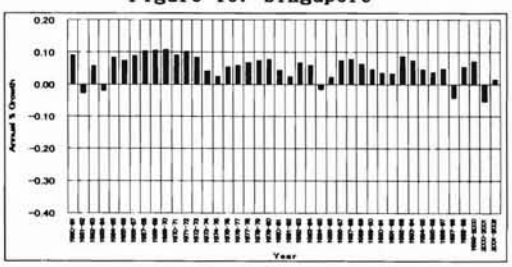
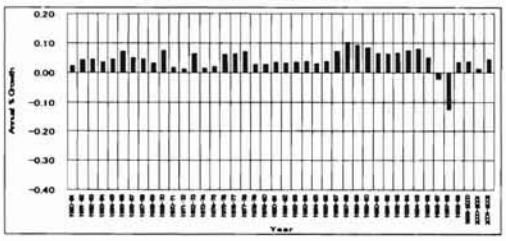


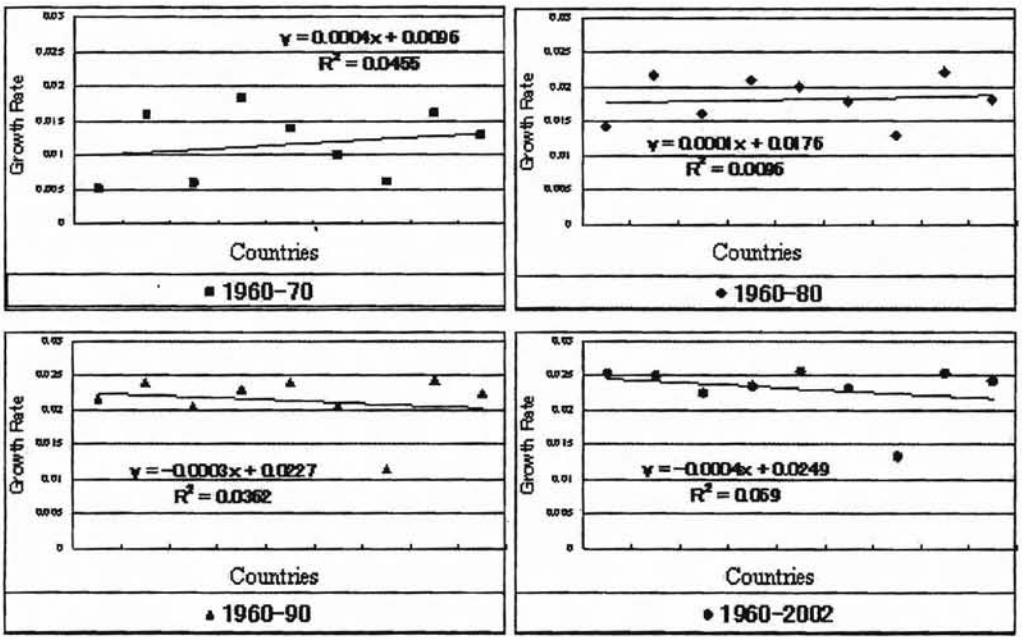
Figure 16. Thailand



Sources: WDI (2004)

The optimistic point is that there has been a decreasing finding from 0.0004 in 1960-70 to 0.0001 in 1960-80. On the other hand, in the analyses, a different point was observed that there has been Beta-convergence in the periods of 1960-90, and especially 1960-2002 with the negative coefficient of X (-0.0003 and -0.0004). Even though the R^2 is not very significant (0.0362 and 0.069), the highest R^2 value is in the period of 1960-2002, which means regions (countries)in East Asia show more significant Beta-convergence in the long term.

Figure 17. Beta-Convergence among East Asian Countries



Source: Calculations of growth rates in the figures for East Asian countries

For the analysis of Sigma-convergence, the data summarize was given country by country among 1960-2002 in Table 7; and also the data was examined in Figure 18. According to the Figure, there has been divergence trend from 1960 to 1972, and after 1972 these countries (China, Hong Kong-China, Indonesia, Japan, ROK, Malaysia, Philippines, Singapore, and Thailand) have stagnation period in the standard deviation of GDP per capita growth till 1991. With the development and expansion of ICT sector and its components, it is clearly seen that there has been convergence trend among these countries. This evidence also shows the effect of ICT within one of convergence factors in macro level on regional development and its stability.

Finally, as an assumption of Neoclassical Growth model, it is expected that convergence trend can be achieved in long term. In this regard, the countries' steady state levels are very important, which affects the convergence tendency. On the other hand, the homogeneity among regions can not be built in

short term, including solution of unsteady state circumstances. This assumption is also observed in Figure 18 as divergence at the beginning years of analysis (1960-72), which also verified by Beta-convergence. In the stagnation period, countries are beginning to enter steady state and homogeneity phase. In the convergence period, countries show higher steady state and homogeneity tendency, which resulted in Sigma and Beta-convergence. In these circumstances, of course, some economic and social factors influenced the convergence results. For instance, after 1997 there have been some fluctuations because of 1997 Asian Crises. In these kinds of crises, all countries' economies and their policies are affected in different levels based on the size of GDP and its per capita including population tendencies.

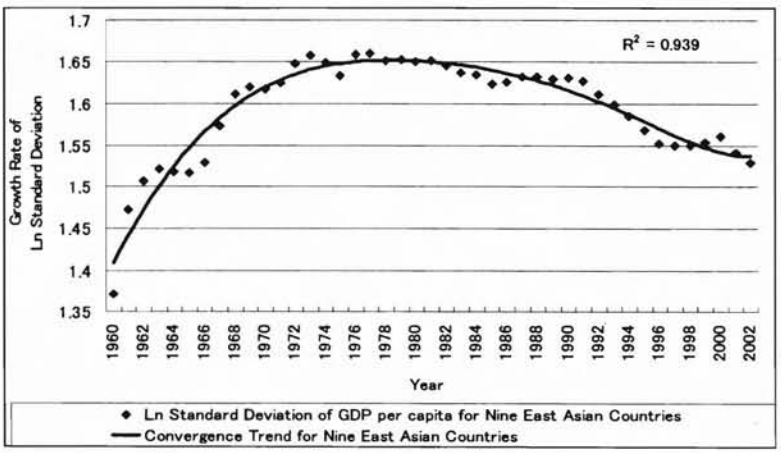
Table 7. Data Summarize in GDP per capita for East Asian Countries Among 1960-2002

Country Name	Average	Maximum	Minimum	Median	S.D.	Confidence
China	297.2	944.1	64.7	173.2	253.8	75.9
Hong Kong	13215.0	25455.8	3073.3	12417.4	7528.0	2250.0
Indonesia	584.1	1149.6	245.3	528.8	300.4	89.8
Japan	28964.0	45029.5	8381.5	28806.8	11737.8	3508.3
ROK	5685.4	14279.9	1324.9	4098.7	4004.4	1196.9
Malaysia	2548.0	4840.3	975.0	2397.0	1268.6	379.2
Philippines	1007.4	1209.0	724.7	1044.6	145.1	43.4
Singapore	12937.3	28295.3	2738.2	11601.6	8243.1	2463.8
Thailand	1455.4	3014.9	464.6	1158.1	866.7	259.0

Source: WDI (2004)

Note: The sample size is 43 and alpha value is 0.05 (indicates %95) for confidence level for all countries.

Figure 18. GDP per capita Sigma-Convergence among East Asian Countries



Source: Calculations from data Table 14

5. CONCLUSION

ICT sectoral developments brought an additional input for East Asian countries and gave an idea about how to use ICT components that can be used for an instrument in balancing regional inequalities, but for balancing regional inequalities we also need to focus on ICT components not only sectoral benefits of it, but also to extend the diffusion of ICT. Thus, Government-led investments in ICT can also encourage employment opportunity and improve economic development by providing competitive advantages and innovations.

Optimal market conditions are not always easily achieved. It needs efficient economic and social plans and projects as focused on ICT policies as mentioned in this study. In some cases, it may be necessary for countries in micro and macro levels to take early actions where market players may show anti-competitive tendencies as telecommunications monopolies in some East Asian countries.

In terms of steady state level and its conditions, government policies can also play a significant role, especially, with its influences on both domestic and international markets. In this regard, this study emphasizes that economic growth is dependent upon the stock of capital-both human and physical-and technological progress. Human capital refers to the increase in labor productivity due to levels of education, skills and experience, and the health of people. Physical and technological progresses signify the instruments, which is utilized in the phases of production at any level.

Under the light of this study's assumptions and explanations, this research subject can be also extended for following studies to lead more advanced relations and structures between ICT and growth models (Endogenous and Exogenous). Even though it is difficult to prove theoretically that governments have positive effects on per capita income growth in terms of growth models, it will not be also out of the theoretical background of Neoclassical Growth Model because it can be posited as policies affect per capita income in short run and limited. Besides, governmental policies on ICT can have fundamental influences on individual actions, which are related with neoclassical growth, instead of direct effect on economic growth. In addition, governmental investments in infrastructure can be assumed as one of the market factors of service and/or production sectors within this context. In this point, a critique on endogenous growth models (New Growth Theories) is to omit the advantage of ICT with globalization process on individual and company tendencies toward profitability increase. As a result, since the effects of governmental policies and technical progress within income can not be easily measured and the assumption of perfect competition is relaxed in some new growth models, then individual tendencies in accepting technical progress as constant with Catch-up Theory will be more dominant factor for the explanation of growth as an exogenous impact of ICT.

Under this theoretical background, GDP per capita convergence evidences are observed in this study

as a weak Beta-convergence and a strong Sigma-convergence within homogeneous East Asian countries in terms of income distributions by interpreting the evidence of direct effect of ICT. Besides, it was not possible for the income gap among the countries to narrow down, if the initially poor countries do not grow faster than the initially rich countries. In other words, Beta-convergence is an essential condition for Sigma-convergence. On the other hand, if a divergence tendency was observed, it would be expected that countries or regions showed different socio-economic propensities in technologic possibilities, population growth rates, savings and/or initial capital-labor ratio.

Finally, to catch up or overreach the most developed countries of East Asia in basic sectors is not easy for any developing countries in the world in short run. However, I think that ICT is the key factor in sustaining long-term economic growth and indicates the balanced and positive regional development components by economically catalyzing regional convergence. In this point, the developed countries need to sustain systematically their economic growths in the future because regional convergence can not be logically achieved without losing markets and/or decreasing rates in GDP per capita growth in the developed countries.

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