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Revolution of Digital Communication and Asian Competitive Creativity Chasm

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Summary

This study aims to identify changes that have taken place in the Asian technological creativity after the post-communication revolution of digital technologies. After examining the utility patent applications forwarded to the US Patent Office by 24 Asian countries between 1965 to 2007, the study partially supports the claim that the "digital communication revolution have influenced the competitive creativity development in Asia."

However, the development growth model is shaped like a snail shell, and digital technologies have not been the silver bullet that promoted the leapfrogging of creativity in stagnating countries. Information and communication technologies (ICT) should be considered as a means of technological learning rather than the end of creativity development. The challenge of strengthening stagnating Asian countries to become competitive and innovative nations will continue until the next decade. Unless necessary steps are taken to improve technological learning and local innovations in stagnating countries, their technological dependency will increase and thus deepen the marginalization in the coming eras.

Keywords: digital communication, creativity development, local innovations, Asia, ICT

1. Introduction

Digital communication technologies have changed the ways and means of information diffusion throughout the world. The period from 1980 to 1994 was the era that drastically changed the means of communication because a high percentage of widely used modern technologies were invented during this period. Therefore, this period is recognized as the era

of digital communication revolution (Linda, 2000). Since then, digital communication technologies have expanded all over the world. From their hi-tech status, they have now become low-cost essential tools in every aspect of human life. E-learning, e-health, e-banking, and e-security are just a few of the vast array of applications of digital communication technologies in the modern world. In a broader context, the digital revolution has converted the traditional production and agrarian societies to information and knowledge societies. In knowledge societies, knowledge has become a marketable product like any other traditional physical product or service (Drucker, 1989). Therefore, the market for technological inventions and knowledge products has increased, and the protection of intellectual properties has become more important today than in any other era of mankind.

Since the development of the Internet and digital technologies, world patent applications have increased rapidly. The rapidly increasing patent applications since 1995 illustrate the impact of digital communication revolution on creativity and innovation all over the world. According to the WIPO Patent Report 2007, especially Northeast Asian countries have shown steady progress in patent applications since 1995. It also depicted that the number of non-resident patent applications applied by Northeast Asian countries in competitive patent offices such as USA, Europe, and Japan has increased remarkably (WIPO, 2007).

However, how the digital communication revolution has affected the improvement of creativity in less developed Asian regions is still questionable. Geographically, the Asian continent consists of more than 30 countries (apart from the Middle East countries), and Northeast Asia represents only 25% of it. Therefore, unbiased measurement to measure the competitive development is required to establish sustainable creativity development strategies with in all the countries of Asian continent.

Section 2 of this article further explores the context of the study in detail to illustrate the significance of the research issue and explains the questions in Section 3. Section 4 briefly explains the sample, data collection, and data analysis method of the study. Section 5 explores the data analysis and findings of the study. Section 6 describes the conclusion and policy implications of the study.

2. Digital Communication Revolution and Competitive Creativity Measures

For 15 years, from 1980 to 1995, the traditional ways and means of world communication have changed, and a revolutionary development in information and communication technologies has occurred. In 1980, IBM hired Microsoft to develop an operating system for

their proposed personal computer. In 1982, they introduced their personal computer with the MS-DOS operating system. Within the next three years, Sony Company introduced the compact disk (CD); Compaq introduced the PC-clone technology; and the first laptop was introduced (Carlson, Burgess & Miller, 1997). These technological inventions have influenced computation and mass communication more than in any other era, with the invention of the first desktop publishing software and Motorola's 32-bit 88000 RSIC microprocessors.

Without stopping there, digital communication further evolved beginning in 1989 with the emergence of the Internet. Tim Berners-Lee proposed the World Wide Web (WWW) project; Intel introduced the 80486 microprocessor with significant processing speed; and Microsoft introduced the Windows 3.0 version in 1989. The following year, the world's most dominant communication media, the Internet, started to expand around the world, with Tim Berners-Lee's initial prototype of the World Wide Web (WWW) and the official decommissioning of the ARPANET. In 1993, MOSAIC, the graphical user interface for the Internet was introduced; in 1994, the introduction of the NETSCAPE web browser and Windows 95 expanded Internet usage all over the world (Carlson, Burgess & Miller, 1997).

With the improvements in information and communication technologies (ICT), the digital revolution was expected to influence the diffusion of innovations and technology transfer from developed to developing countries. The direct impact of the Internet and digital technologies as knowledge disseminators has increasingly become popular through the electronic versions of newspapers, podcasts, and online video streaming of television channels (Linda, 2000). Technical information on new products and technologies is now available in electronic patent databases which anyone can access and gain knowledge from.

Hence, to a certain extent, modern ICT has increased the diffusion of knowledge around the world. If the users are creative and innovative enough, they are encouraged to further develop the existing knowledge to invent secondary and tertiary inventions (Johnstone, 2003). It will not only take the technological knowledge further, but it can also give economic benefits to the inventor, and to a broader context, to the country of origin through the commercialization of knowledge products. Therefore, in modern economic development, the agenda of competitive technological innovations are given higher priority, and marginalized countries are encouraged to pursue technological catch-up to become competitive and innovative nations (World Bank, 1999; United Nations, 2007).

The amount of R&D expenses compared with the GDP and patent applications and grants-related indicators are becoming popular measurements of technological and innovative capabilities of countries (Tseng, 2008). "Patent is an exclusive right granted by a state, for an invention that is new involves an inventive step and is capable of industrial application"

(WIPO, 2006). A patent is a territorial right, limited to the patent-granting country or region. Owing to the objective nature of the patent, it can be identified as a better tool for measuring technological innovation. Hence, in academic literature, patent statistics is identified as the most commonly used measurement of innovativeness. The patent statistics of Japan, the European Patent Office (EPO), and the United States Patent and Trademarks Office (USPTO) are often cited in world innovation literature (Tuska, 1955; Kobayashi & Yu, 1993; Tijssen, 2002; Encaoua, Guellec & Mart´ınez, 2006).

According to the WIPO Patent Report-2007, 38% of the patent applications in the world are non-resident applications, and the increased patent filings by non-residents thus reflect the "internationalization of technology and markets" (WIPO, 2007). In patent jargon, a non-resident is an applicant who is not a citizen or registered organization of the recipient country or region of the patent application. Inasmuch as the US is one of the three dominant patent hubs of the world, a large number of patent applications are forwarded to the USPTO (Atkins, 2001). Owing to the large number of patent applications with the USPTO, over 90,000 patent applications forwarded in the year 2005 are still pending (WIPO, 2007). According to the report, apart from Japan, the USPTO is the largest recipient of Asian patent applications. Based on its Western orientation and its highly reputed evaluation standards, the current study identifies the patent applications forwarded to the USPTO as better measures to evaluate the competitive creativity standard of Asian countries over the applications filed within the Asian region.

Non-resident patent applications are evaluated by the recipient country according to their intellectual property laws, policies, and procedures. Therefore, applicant inventions are naturally expected to be of higher inventive standard, high market potential, and with large amounts of investment for applying, processing, and maintaining the patents. For that reason, the number of patent applications forwarded by a country to a competitive international market indicates the overall competitive creativity of that particular country. Competitive creativity shows the innovative capacity of a particular country to be internationally competitive in inventions. In this study, a non-resident patent application is defined as a comprehensive measurement, which measures the invention quality, market orientation, and investment capacity of innovation promotion in a competitive market.

3. Research Problem and Objectives

In the last two decades, academic literature has consistently highlighted the rapid economic and technological development in Asia. Owing to this rapid growth, a very high percentage of foreign direct investments (FDI) has been channeled to China, India, and rest of the east and Southeast Asian countries (Chantasasawat, Fung, Lizaka & Siu, 2004; Noorbakhsh & Paloni, 2001). However, with the current global economic downturn, a significant number of FDI-based industries in Asia are receiving shutdown warnings. This raises the question of the sustainability of Asian development in the post-digital communication revolution era, and it creates the importance of concentrating on technical and technological knowledge creation more than providing mere manufacturing facilities to physical products on behalf of Western countries. Therefore, the measurement of a competitive creativity is becoming an important policy concern for Asia, especially for the less-developed Asian countries.

In the same way that knowledge products have become more demanding, patenting the innovations in competitive markets has also increased steadily. However, not all the countries in the world have shown similar trends in competitive innovations. There is a continuing debate on this stagnation influenced by the traditional limitations such as lack of inventions, lack of investment capacity in patents, and lower impact of digital revolution (Archibugi & Pietrobelli, 2003; Herani, Shirazi, Zaman & Alam, 2007; Arunachalam, 1999). The questions on the real impact of digital technologies on bridging the creativity divide between the developed countries and the developing world and how far this digital communication revolution changes the technological creativity of stagnating nations have not yet been answered. By examining the non-resident utility patent applications forwarded to USPTO by Asian countries, the current study expects to bridge the said knowledge gap in the Asian context.

The research questions of the current study are the following:

(1) Does the digital communication revolution have an impact on the competitive creativity in Asia?

(2) What is the nature of the development of competitive creativity in Asia? Is it a leapfrogging, discontinuous, or continuous development?

(3) What has been the growth model of the competitive creativity development in Asia from 1965 to 2007?

4. Research Methodology

Regarding the stiff competition in gaining US patents, the number of patent applications forwarded to the USPTO by Asian countries is identified as the measurement of the competitive creativity or innovativeness in the Asian region. Asian countries (except Middle East countries, Japan, and North Korea) that forwarded at least single utility patent applications to the USPTO within the 43-year period from 1965 to 2007 were selected as the sample for the study. Middle East countries were omitted from the study because of their established status as a separate region of the world rather than as part of the Asian region. Japan was likewise omitted from the study because of its well-established status as a developed country, and the world's top ranking number of patent applications in Japan made it an outlier. In recent years, the number of patent applications from North Korea to the USPTO has drastically reduced owing to the political conflict between the US and North Korea. As the number of applications in recent years does not justify competitive creativity, North Korea was also omitted from the study. Based on the selection criteria, 24 Asian countries were selected, and the number of utility patent applications forwarded to the USPTO was collected from the patent technology monitoring team report published by the USPTO in June 2008 (USPTO, 2008).

Based on the time period of the digital communication revolution explained in the introduction section, the study divided the period of 1965 to 2007 into three sub-eras.

- The period 1965–1979 is identified as the pre-digital communication revolution era (Pre-DCR).
- 1980–1994 is identified as the transition era (T-DCR).
- 1995–2007 is defined as the post-digital communication revolution era (Post-DCR).

Each of the eras was further subdivided into three segments containing five years for each segment (except 2005–2007). To maintain analytical simplicity, the number of utility patent applications forwarded by 24 Asian countries was collected and summarized for these nine sub-segments. However, primary data analyses were done particularly based on the bigger segments explained earlier as pre-, transition, and post-digital communication revolution eras.

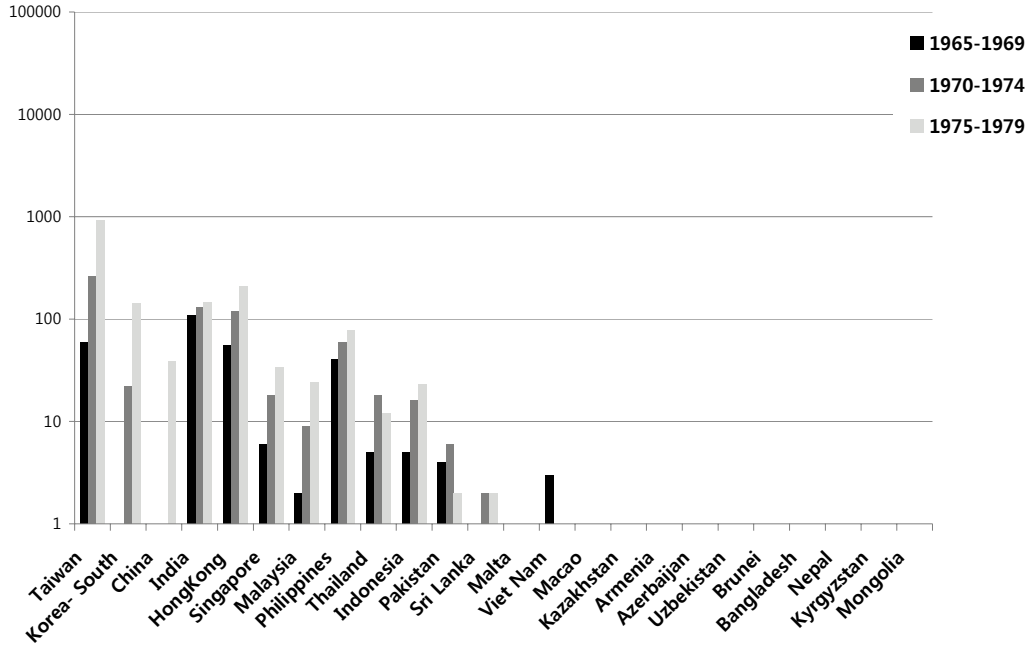
5. Data Analysis and Findings

The first objective of the study is to identify the changes that took place in competitive inventions during the digital communication revolution (I980–1994). Figure 1 shows the development of internationally competitive inventions of Asia in the pre-, transition, and post-digital communication revolution (DCR) eras.

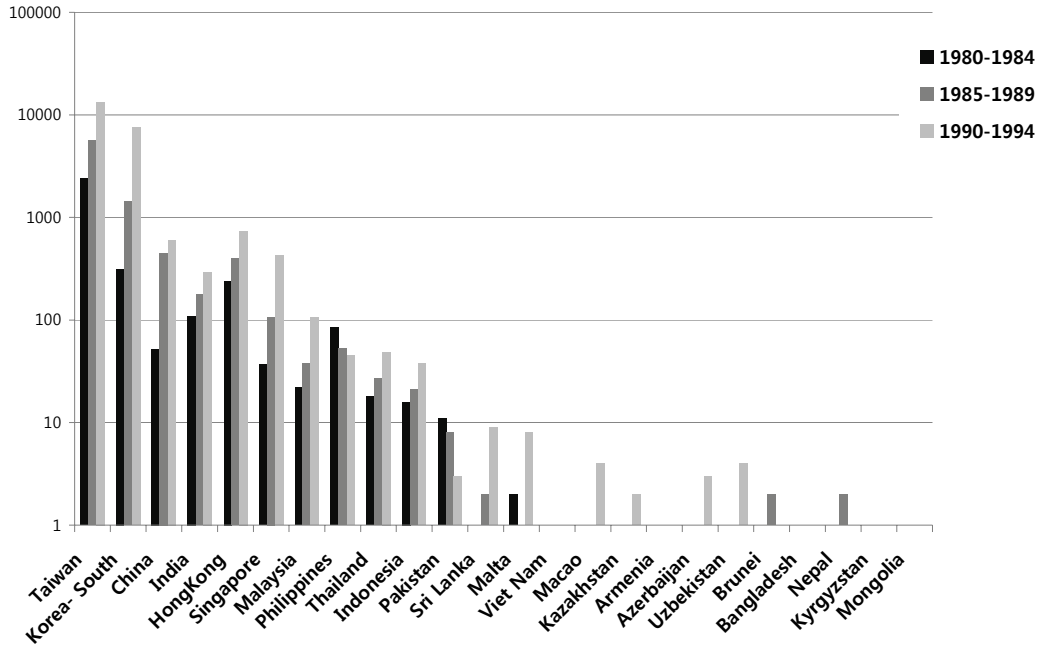
Figure 1(a) shows that Taiwan, South Korea, India, Hong Kong, the Philippines, Singapore, Malaysia, Indonesia, and Thailand have applied for US patents since 1965. Although the numbers are not in the thousands, they have been the top rating Asian countries since 1965, and signs of their competitive innovative capabilities are visible. China has entered the competition only during the 1975–1979 period. With its new economic reforms, however, China has quickly achieved a high rank.

The top 10 countries in the pre-DCR era have shown accelerated development in both the T-DCR era and the post-DCR era and have maintained their status from 40 years back. These conventionally top innovative countries have not yet been challenged by any of the newcomers even in the post-DCR era. In the pre-DCR era, the Philippines and India had higher applications than even China, Singapore, Malaysia, and Thailand. However, in the T-DCR, those countries outperformed the Philippines, but India continued its neck-and-neck development with them. Even though Malaysia, the Philippines, Thailand, and Indonesia showed challenging developments in the post-DCR, since the T-DCR era, the superiority of Taiwan, South Korea, Hong Kong, and Singapore has seriously been challenged by China and India.

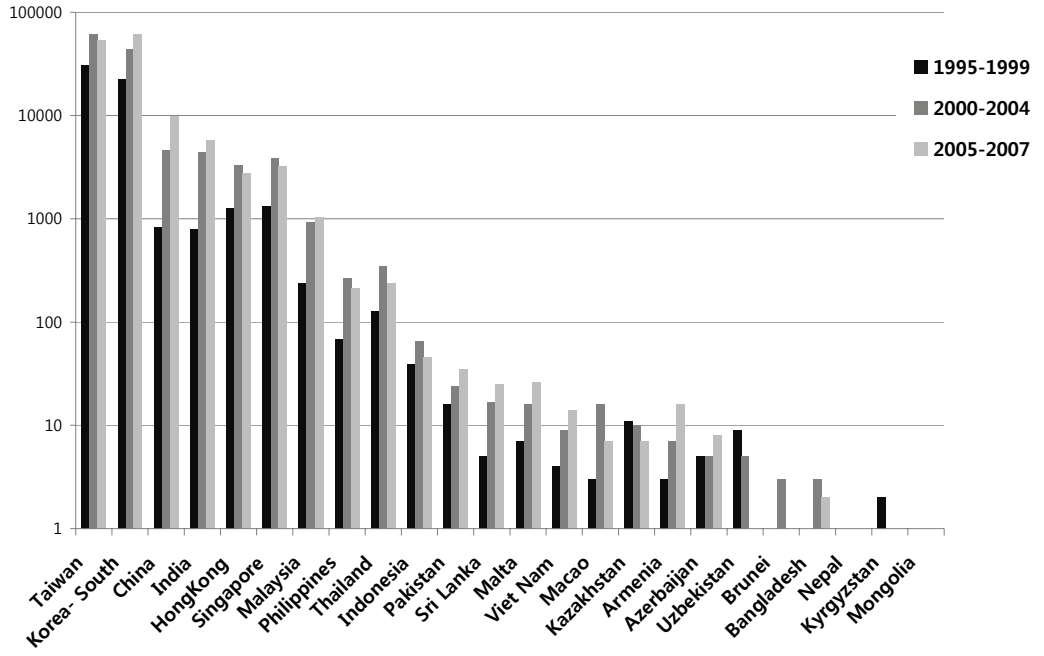
Figures 1(a), 1(b), and 1(c) depict the improvement in the number of utility patent applications at the USPTO by stagnating Asian countries in the pre-DCR. Figure 1 clearly illustrates the marginal increase in the dry-zone innovative nations (countries with less than 10 applications per year) in transition (b) and the post-DCR (c). During the T-DCR, countries that were at the zero level in the pre-DCR started to rise, and countries such as Pakistan, Sri Lanka, Malta, Uzbekistan, Azerbaijan, and Macao showed little improvement. In the post-DCR era, this trend expanded further; other than Brunei, Bangladesh, Nepal, Kyrgyzstan and Mongolia, the rest of the Pre-DCR (a) stagnating countries showed some level of visible improvement.



(a) Pre- DCR era



(b) T-DCR era



(c) Post-DCR era

Figure 1: Competitive Innovations of Asia in the Pre-, Transition, and Post-Digital Communication Revolution Eras

The second objective of the study aims to determine the nature of the continuation of the development of competitive creativity in Asia. The expansion of digital communication technologies generated the hype of second-mover advantages, discontinuous development, and leapfrogging capabilities of developing countries (Archibugi & Pietrobelli, 2003; Herani, et al, 2007; Tseng, 2008). The continuity model tries to determine the statistical impact of the digital revolution on Asian competitive creativity development.

The Pearson product movement correlation is used to measure the linear relationship between numbers of patent applications in three eras. Every country's' patent applications in each era is identified as variables and is expected to measure the linearity of the creativity development in the three eras. Higher R-values are expected to show the linear relationship in the creativity development in Asia through the pre-transition and the post-DCR eras. Based on the expected R-values, the hypotheses showed the following relationships:

- **R<= 0.33 = Leapfrogging development**

  Leapfrogging development means unexpected radical improvement from a very low

level to a very high level.

- **0.33<R>=0.67 = Discontinuous development**
  Discontinuous development means there is positive development, but from one era to the next era, the improvement is stepwise rather than significantly linear.

- **R>0.67 = Continuous development**
  Continuous development means having a clear linear development trend from one era to another.

Although the modern ICT literature reveal the leapfrogging and discontinuous development was focused only on Northeast Asian countries, the findings of the study show that the nature of improvement in the competitive creativity of Asia is that of continuous development rather than leapfrogging or discontinuous development. The R-value between the pre-DCR and the T-DCR is 0.891, and it shows strong continuous development. This means that the continuity pattern between the pre-DCR and the T-DCR is a positive linear relationship. However, the R-value between the pre-DCR and the post-DCR is 0.760, and it indicates a little decrease in the linearity. However, it is not very significant to identify any leapfrogging.

Between the T-DCR and the post-DCR eras, the R-value is 0.946. This higher R-value indicates that the momentum created by the digital communication revolution is linearly continuing in the post-DCR era (Table 1). Figure 1 also supports the findings of the R-values by not showing any leapfrogging country setup as isolated high towers or drastically dropping countries beyond the overall trend pattern.

Table 1: Correlation Statistics in the Development of the Three Eras

		Pre-DCR	T-DCR	Post-DCR
Pre-DCR	Pearson Correlation	1.000	.891**	.760**
	Sig. (two-tailed)		.000	.000
	N	24.000	24	24
T-DCR	Pearson Correlation	.891**	1.000	.946**
	Sig. (two-tailed)	.000		.000
	N	24	24.000	24
Post-DCR	Pearson Correlation	.760**	.946**	1.000
	Sig. (two-tailed)	.000	.000	
	N	24	24	24.000

Note: **Correlation is significant at the 0.01 level (two-tailed).

Therefore, the positive accelerated impact of the digital communication revolution on the competitive creativity development of Asia is expected, although the strength of the impact is not very significant to justify a claim of leapfrogging or discontinuous creativity development especially in stagnating Asian countries.

For the third objective of the study, a growth model analysis was designed to find the development trend patterns of the patent applications from Asian countries in order to predict the competitive creativity development in the next decade. Each era's patent application data was plotted in a logarithmic scale radar diagram after sorting the total number of applications from 1965 to 2007 in descending order. The shape of the spider-web was expected to indicate the competitive creativity growth pattern in Asia.

The radar diagram in Figure 2 shows the overall competitive creativity development pattern in Asia in the pre-DCR era. The overall level of patent applications for the USPTO is significantly lower than that of the other eras. However, it clearly indicates the shaping of Northeast and Southeast Asian countries and India to become competitively creative countries beginning 1965. Figure 2 shows that clockwise from Indonesia to Mongolia, none of the North and South Asian countries (except India) show any visible contribution.

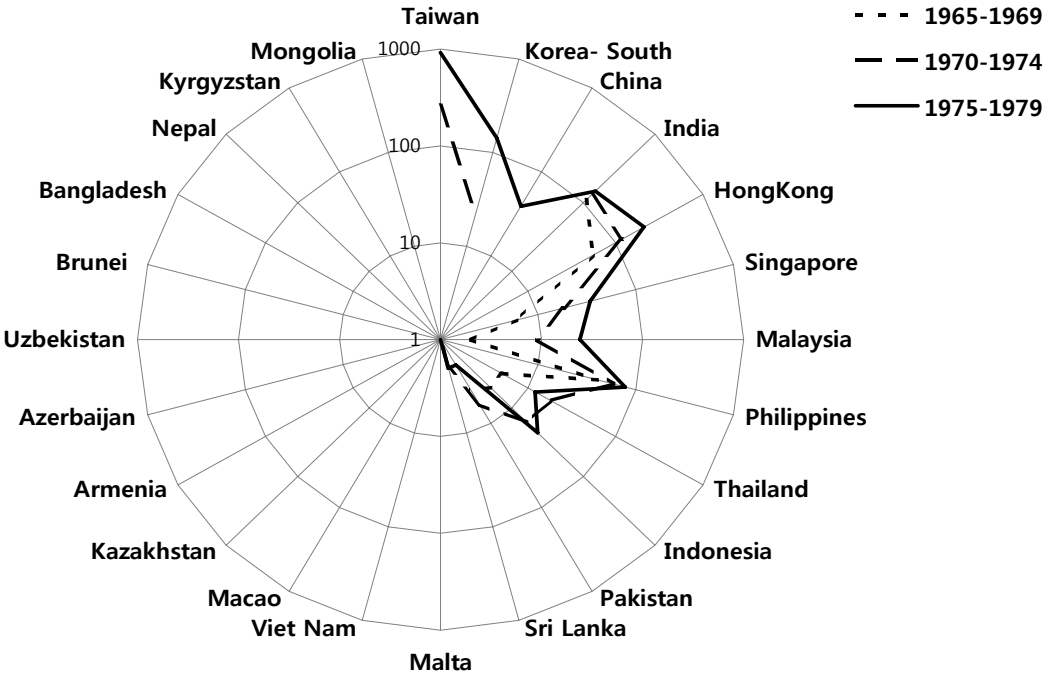


Figure 2: Asian Competitive Creativity Growth in the Pre-DCR Era

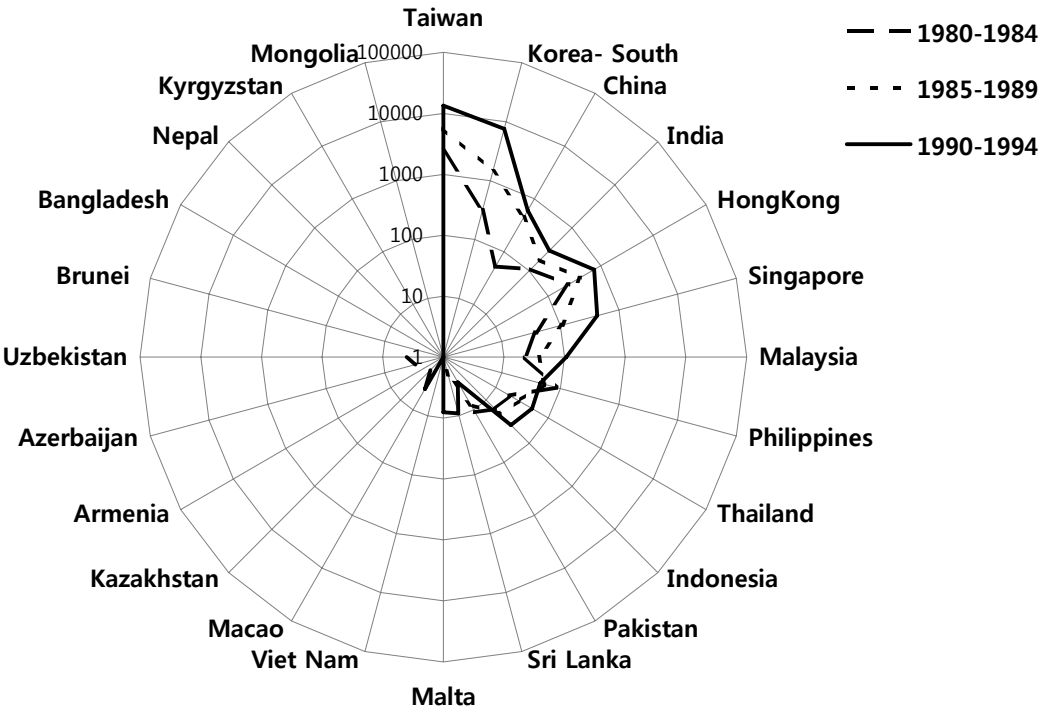


Figure 3: Asian Competitive Creativity Growth in the T-DCR

Figure 3 shows the improvement of the competitive creativity development of Asia in the T-DCR era. Compared with Figure 2, growth was led by Taiwan and South Korea, while Hong Kong, Singapore, Malaysia, and Thailand had grown further. However, compared with the acceleration of these countries, China and India showed lesser acceleration in the T-DCR. Apart from that, some of the stagnating countries in the pre-DCR era indicate slight visibility in the competitive creativity development in the T-DCR era (Figure 3).

Figure 4 depicts the further expansion of the established competitively creative countries in the past two eras. They maintained their superiority in the post-DCR as well. Apart from the overall development of the top 10 inventive nations, the acceleration achieved by China and India is highlighted in this era. China and India have clearly outperformed the Philippines, Thailand, and Indonesia and are challenging the top five places among competitively creative countries in Asia. Figure 4 also indicates a marginal improvement in countries from Indonesia to Uzbekistan compared with their stagnant performances in the pre-DCR and the T-DCR. However, countries from Brunei to Mongolia in Figure 4 have been clearly marginalized in the post-DCR.

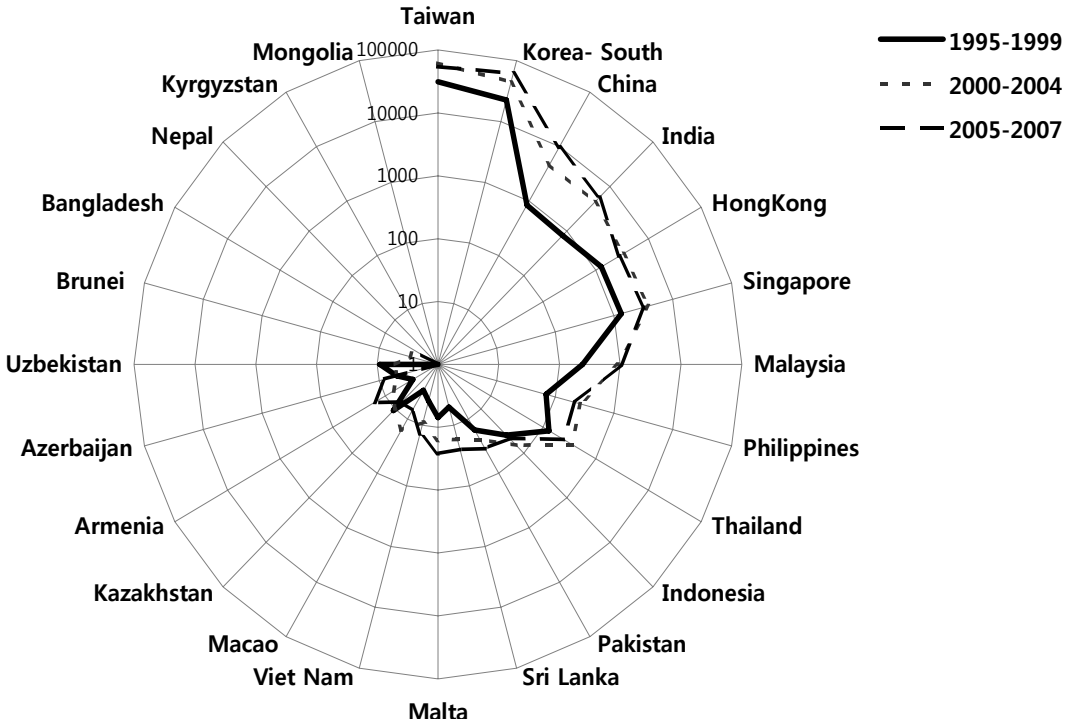


Figure 4: Asian Competitive Creativity Growth in the Post-DCR

6. Conclusions and Discussions

The main objective of the study is to determine the impact of digital communication revolution on the competitive creativity development in Asia. The findings of the study partially support the claim that the "digital communication revolution had influenced the competitive creativity development in Asia". Both vertical (number of patent applications from individual countries) and horizontal (number of countries forwarded the patent applications) development have been evidenced. However, digital communications have not significantly influenced the conversion of less innovative countries in the pre-digital revolution era to strong inventive countries in the post-digital revolution era. Although ICT was expected to influence the developing countries with leapfrogging and discontinuous development, competitive creativity development in Asia is on an accelerated continuous development rather than significant leapfrogging or discontinuous change.

Figure 5 summarizes the development of the competitive creativity in Asia from the pre- to

the post-DCR era from 1965 to 2007. Countries that have been creative since 1965 have continuously improved their competitiveness, while marginalized countries only showed marginal improvement. The countries in the top right quarter of the radar diagram from Taiwan to Malaysia have accelerated their competitive creativity development to an unprecedented reach as super performers, and they are expected to expand their non-resident patent applications further in the next decade as well. The Philippines, Thailand, and Indonesia dominated in their quarter as high performers, but they are not expected to accelerate their applications as super performers in the next decade.

Although Pakistan and Sri Lanka have fallen from the high-performers quarter, countries from Pakistan to Uzbekistan are just starting to appear in the competitive creativity development after the post-DCR, and they are not expected to show remarkable improvement to challenge current high performers. Owing to the historical stagnation of the top-left quarter countries in the radar diagram, countries from Brunei to Mongolia are presented as underdeveloped in the competitive creativity growth, and they would likely face serious problems in the next decade and in the coming years.

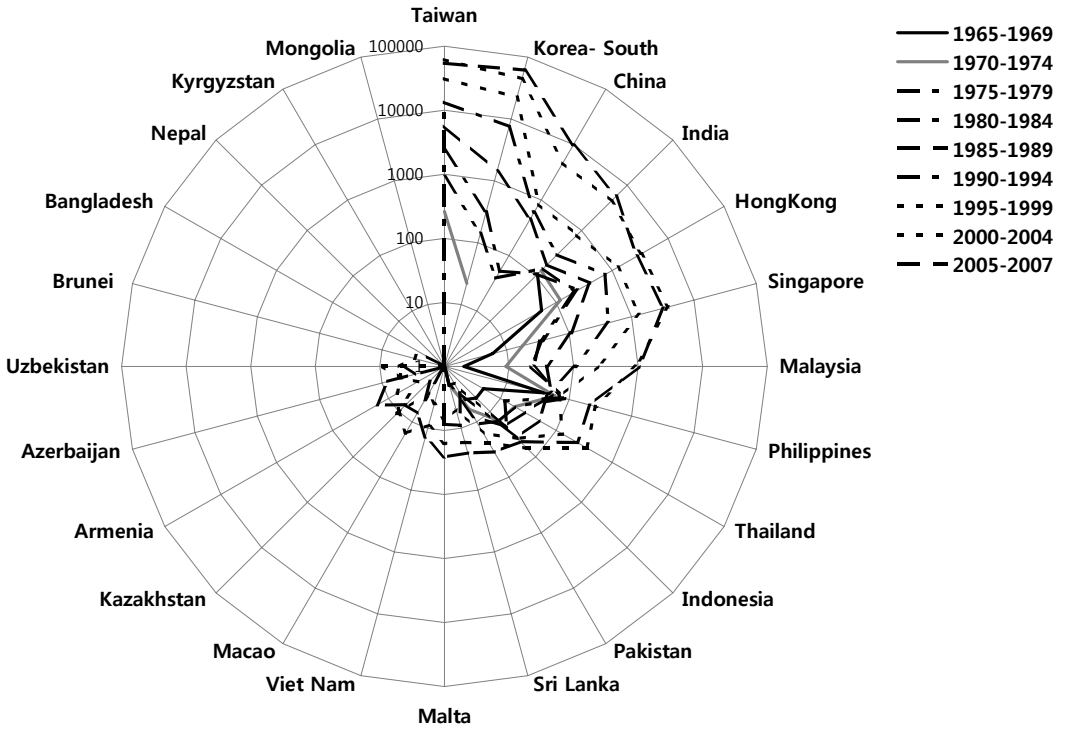


Figure 5: Overall Asian Competitive Creativity Growth

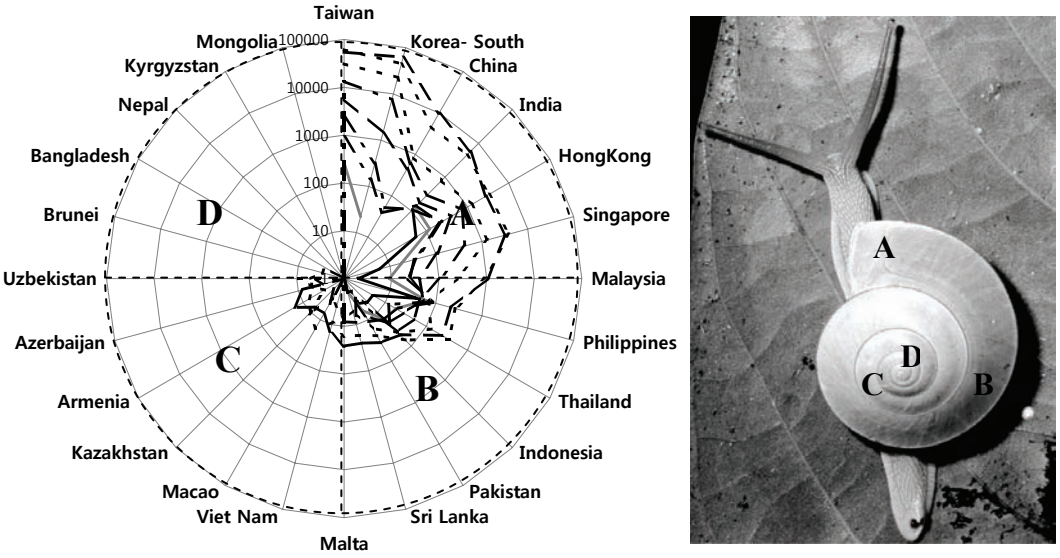


Figure 6: Snail-shell Growth of Competitive Creativity Development in Asia

According to the analysis, competitive creativity development in Asia is showing a snail-shaped spiral growth (Figure 6). In this snail-shaped spiral growth model, less creative countries are still located close to the midpoint of the shell, and they are gaining lower growth rates. While they marginally increase their competitive creativity, highly creative countries that are located far away from the center of the shell achieve accelerated development, and the gap between high and low creative countries tends to increase rather than decrease, causing a creativity chasm in Asia.

Therefore, digital technologies will not be the silver bullet that will cultivate creativity in stagnating countries. ICT should be considered as a means for technological learning rather than the end of creativity development. Each of the sub-components of competitive creativity may have individual and collective influence on the level of the competitive creativeness of a country. Lack of inventive skills, low market orientation in inventions, and low investment capacity would be serious issues for stagnating countries, and they need to be substantially studied in the future. Discussions on the digital divide should be more realistic than they are in the current practice. Bridging the digital divide should not only be about improving access and affordability but also about the improvement of usage and utilization of ICT in competitive creativity as well. The importance of creating an innovative culture in less developed countries is essential, and within the macro level, economic and technological

planning should be given higher priority. Therefore, unless necessary steps are taken to improve the technological learning and local innovations in stagnating countries, their technological dependency will increase, which will further deepen the marginalization in the coming eras.

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