Capacity Building in the ICT sector:
Complementarity between Korea and Australia

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Abstract

It has been argued in some official reports that Australia with its strong basic science infrastructure is a natural partner with Korea, which has a long and successful history of adapting new technologies to industrial production processes. This claim is evaluated in this paper, looking in particular at one of the key technology areas, the Information and Communications Technologies (ICT) sector. The main aim extends to examine potential benefits from the promotion of bilateral technology cooperation in the ICT sector between Korea and Australia.

1. Introduction

While the relationship between the Republic of Korea (hereafter, Korea) and Australia has increasingly matured in promoting two-way trade and investment for mutual gains, the two countries have been constantly interested in developing a new competitive strategy to build a more sophisticated bilateral cooperation. Since the 1990s, it has been increasingly recognised that the new strategy should be based on technology and innovation, and promote a comparative advantage based on the differentiation of the two. Recognising the enormous potential of building a knowledge-based economy, the two countries have increasingly come to the realisation that they should promote bilateral technology cooperation in the Information and Communications Technologies (ICT) sector.

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This paper investigates the significance and potential of technology cooperation between Korea and Australia in the ICT sector, and evaluates a number of claims that have been made concerning the complementarity of the two economies in this area.

2. Technology development processes in Korea and Australia

Technology policy involves not only the enhancement of technological capability through encouraging research and development for successful absorption and improvement of imported technologies, but also the development of processes to create and utilise new products and practices (T. Kim, 1995; L. Kim and Dahlman, 1992, Hahm and Plein, 1997, p. 17). In general, technology policy as a component of general economic planning can be seen as entailing three dimensions: the efficient government's policy measures for improvement of technology development capacity, active participation of the private sector for the improvement of technology diffusion and the utilisation of capacity, and an abundance of sophisticated human resources. Using the analogy of the human body, the first function is that of head, the second is the arms and legs, and the third is the rest of the body. In addition, the catching-up process can be described as the action of running, and advanced technologies can be described as a 'running machine' - the speed of the machine is equivalent to the level of advancement of the technologies. In this context, running fast means the achievement of efficiency in the process of catching-up in technology development, and requires a concerted coordination of each part of the body. For example, although the head wants to run fast, if the arms and legs do not match the required speed, the whole body will lose coordination. This example reflects that although the government is equipped with efficient policy measures for the improvement of the technological base, the outcomes are limited without the dynamic participation of the private sector.

In Korea, two of the most conspicuous characteristics of technology policy are the role of strong government policies, and the active involvement of a vigorous private sector, mainly the *chaebol* (large conglomerates). In other words, the government steered the wheel and supplied fuel, set ambitious goals and directed the private sector with sticks and carrots, while the *chaebol* functioned as the engine (Lin-su Kim, 1997, p. 24). In the process of administering selected major industrial projects,

the government provided financial support to the participating companies through the Bank of Korea (Claessens et al., 1998). However, as the industrial development process developed further, a new demand for advanced technologies soon emerged. The changing environment for achieving international competitiveness in technology development processes of Korea demanded a more market-oriented approach as the most effective way to improve efficiency in adopting technological change (Dahlman and Andersson, 2000). As a consequence, the government gradually took a different stance in the design of its policy measures, and played different roles in order to liberalise the market and improve the level of industrial and technological competitiveness. As can be seen in Table 1, the government has pursued different technology policies for the enhancement of technological capabilities based on different technology demand and supply conditions for the emerging industrial sectors.

Table 1

Technology policies and the role of the government of Korea since 1961

	1961 – 1972	1972 – 1979	1979 - 86	1986 – 1997	1997 – present
Industrialisation	Government -led	Government -led	Adjustment	Adjustment/ Market-led	Market-led
Technology demand	Determined by the government industrial development plans	Determined by the government industrial development plans	Adjustment	Adjustment/ Determined by market force	Determined by market force
Technology supply	Capital imports Turn-key plant imports OEM DFI Restricted	Turn-key plant imports Capital imports OEM DFI Restricted	Indigenous R&D DFI	Indigenous R&D DFI Global sourcing Strategic alliances	Indigenous R&D DFI Global sourcing Strategic alliances
Policy stance	Regulation	Regulation	Deregulation	Liberalisation	Liberalisation
Government role	Regulator	Regulator	Deregulator/ Facilitator	Facilitator	Facilitator

Source: Adapted from Choi and Chung (1998), p. 188

Australian technology policy has been set within a wider policy framework that has aimed to stimulate growth and provide a particular shape to the pattern of development of the economy (Pomfret, 1995, p. 53). At the same time, in the industrial and technology development process of Australia, there have been a

number of different government approaches to the improvement of the capability and competitiveness of the economy within the changing international environment. As can be seen in Table 2, the industrial and technology development process of Australia can be divided into four stages based on a number of internal and external contributing factors: from 1901 to 1940, from 1941 to 1970, from 1971 to 1983, and from 1983 to the present.

Table 2

Technology policies and the role of the government of Australia

	1901 to 1940	1941 to 1970	1971 to 1983	1983 to present
Industrialisation	Government-led	Government-led	Adjustment/ Market-led	Market-led
Technology demand	WWI-boosted industries	Industrial diversification	Adjustment/ Determined by market force	Determined by market force & by key industries
Technology supply	DFI Turn-key plant imports OEM Restricted	Foreign ownership DFI OEM Restricted	Indigenous R&D DFI	Indigenous R&D DFI Global sourcing Strategic alliances
Policy stance	Protection	Protection	Deregulation/ Liberalisation	Liberalisation
Government role	Protector	Protector	Deregulator/ Facilitator	Facilitator

During the first four decades of the 20th century, the main approach in Australia's technology policy strongly concentrated on the protection of domestic industries. New technology demands emerged in the industrialisation process of Australia during and after the War, providing stimulus to the manufacturing sector, particularly the steel industry (Clark et al., 1996, p. 9). However, the government's strong stance on the protection of domestic industries was continuously evident. Since the mid-1970s governments had placed reliance on market forces to determine resource allocation with government deregulation and liberalisation taking a broad policy approach (Department of Industry Technology and Commerce, 1987, p. 34). Support and assistance measures were given to encourage industry to commercialise technological research through indigenous R&D, and this increasingly contributed to the boost of technology supply needed for further industrialisation. Another notable tendency in the pursuit of the government's technology policy for the enhancement of the national technology base was the increasing foreign investment in the Australian market. For example, Australia's Foreign Investment Review Board (FIRB) considered 4437

proposals for foreign investment between April 1976 and December 1979, and rejected only thirty (Jones, 1982, p. 222).

The 1990s saw the development of new technologies as a driving force for economic development. The importance of this worldwide trend has been further reinforced as the use of technology became more closely linked to the efficiency of manufacturing, the quality of manufactured products and the national capacity for innovation. It is also generally acknowledged that technological change and innovation are central to the creation of competitive advantage and national wealth (Porter, 1980).

Korea and Australia have each achieved remarkable industrial transformation during the past decades. The technological development process of each economy has involved government policy measures to build capabilities for development of new technologies and capacity for improving indigenous technologies. At the same time, in technological learning each economy has pursued different approaches to technology development for the improvement of the national competitiveness. For example, the role of the *chaebol* in the technology development process of Korea has been crucial, establishing a unique system for the achievement of technological advancement with the government's firm guidance. By contrast, the Australian government has implemented competition policy at an early stage of the technology development process notably since the 1980s, with a minimal level of government intervention in the domestic market. It is increasingly significant that both Korea and Australia further pursue the ongoing transition with major structural adjustments towards high-tech sectors in order to secure a new key source of national wealth creation. Next section investigates the development of the ICT sector in Korea and Australia.

3. The development of the ICT sector in Korea and Australia

Advanced technologies in the ICT sector have become a crucial tool to provide innovations that have greatly expanded communications capacity and increased networking capabilities. An extensive list of indicators can be used to measure the development of ICT, and several of them are employed here. The main aim of this section is to explore the recent developments in the ICT sector in Korea and

Australia, partly as a way of identifying the potential to strengthen bilateral cooperation between these countries.

3.1 The development of the ICT sector in Korea

Korea has heavily invested in its information infrastructure over the last part of the 1990s. When compared with other Asian countries as well as the United Kingdom and the USA, the Korean growth rates during the 1990s are noticeably higher than those of most other countries. As can be seen in Table 3, as a percentage of GDP, Korean investment was 0.8 per cent in the first half of the decade and more than doubled to 1.85 per cent of GDP in the second half. Korea's investment rate was nearly twice that of Hong Kong, and more than five times that of Japan in the second half of the 1990s. With regard to the role of government in building information infrastructure, this strong promotion effort was led by the public sector in Korea. More specifically, the public share of investment for information infrastructure in Hong Kong, Japan, and the United States in the late 1990s was zero per cent in total investment, while for Malaysia, Singapore and the United Kingdom, the public share was 5 per cent or less. In Korea, 25 per cent of investment came from the public sector, although this was down from 48 per cent in the early 1990s. As a percentage of GDP, public investment in information infrastructure in Korea was higher than the total investment in information infrastructure in Japan and the United Kingdom.

Table 3

Korean investment in information infrastructure, 1991-99

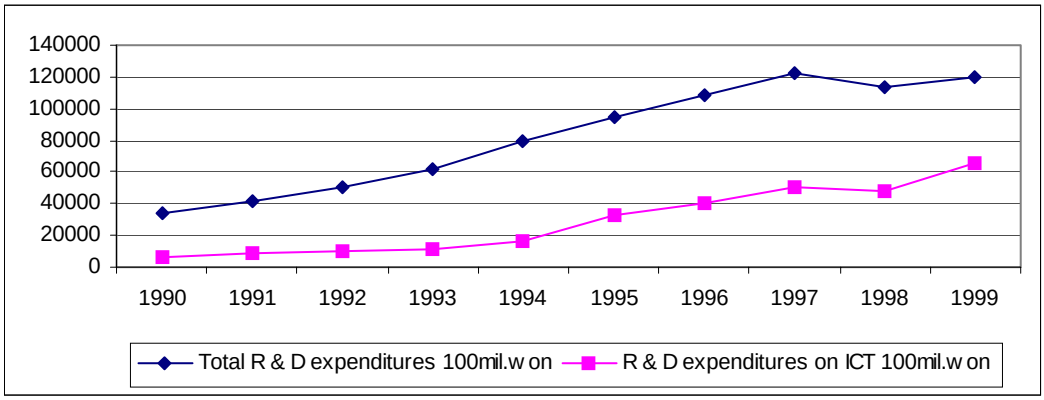
	Investment/GDP (%)		Public investment (% of total)	
	Average 1991-95	Average 1996-99	Average 1991-95	Average 1996-99
Hong Kong	0.58	0.98	0	0
Japan	0.14	0.34	0	0
Korea	**0.80**	**1.85**	**48**	**25**
Malaysia	1.12	1.04	6	5
Singapore	0.35	0.57	38	4
United Kingdom	0.23	0.35	2	2
United States	0.58	0.52	0	0

Source: The International Bank for Reconstruction and Development (2000) p. 82

As investment for building relevant infrastructure for the ICT sector in Korea has increased, R&D expenditures in the ICT sector have expanded. During the 1990s, R&D expenditures in the ICT sector in Korea showed consistent growth in line with the growth of total R&D expenditures. The acceleration of R&D expenditures in the ICT sector is noticeable from 1994 to 1995 with the amount being doubled in 1995 (KRW 32,966 million). It is also noticeable that while the growth patterns of total R&D expenditures in Korea have become weak since the financial crisis in the early part of 1998, expenditure in the ICT sector shows a remarkable increase at a growth rate of 36 per cent compared to the previous year. This increasing R&D input in the ICT sector clearly demonstrates that Korea has recognised the significance of research-based innovation, and in the ICT sector in the formation of a knowledge-based economy.

Figure 1

R&D Expenditures on ICT in Korea



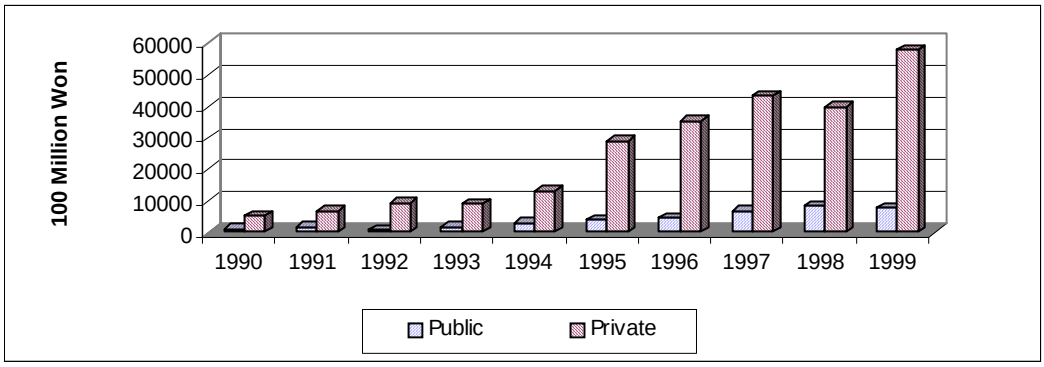
Source: Selected figures from NSO (2002)

The R&D expenditures in the ICT sector in Korea have consistently expanded during the 1990s. In particular, the private sector has heavily invested in R&D activities in the ICT sector, when compared to the public expenditures for ICT-related R&D activities. As can be seen in Figure 2, even though government investment has been impressive, the gap between private and public R&D fundings throughout the decade is remarkable, and widened particularly in 1995, with a growth rate of R&D expenditures on ICT by the private sector at approximately 120 per cent compared to the previous year. Thus, the rapid expansion of expenditure by the private sector during the second half of the 1990s in Korea suggests that government policies on the

ICT sector have promoted active participation of the private sector in building a competitive market environment for the sector.

Figure 2

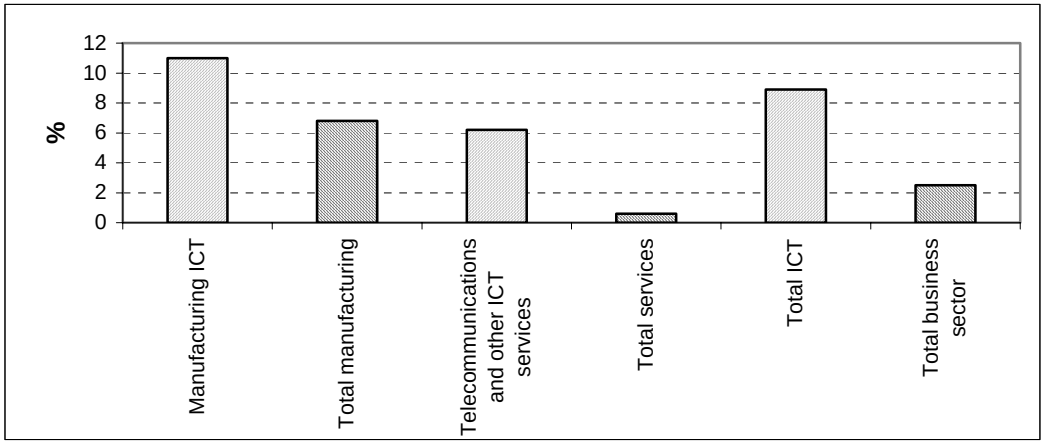
R&D Expenditures on ICT in Korea by private and public sectors



Source: Selected figures from NSO (2002)

Given the rapid expansion of expenditure in the ICT sector by the private sector in Korea during the second half of the 1990s, R&D intensity in the ICT sector shown in Figure 3 demonstrates that the ICT sector is a significant contributor to the total R&D value added in Korea. More specifically, R&D intensity in the total ICT sector as a percentage of value added in Korea was approximately 9 per cent of the total in 1997. ICT manufacturing was the most significant part of the ICT sector in Korea, contributing around 11 per cent of the total manufacturing value added, while ICT services (telecommunications and other ICT services) make up just over 6 per cent of the total value in the total services.

Figure 3
R&D intensity in ICT in Korea, 1997 (as a percentage of value added)



Source: OECD (2000a) p. 99.

The number of patents in a particular sector represents a disclosed potential for economic advantage because it offers monopoly protection for an invention, which can be bought, sold or worked for a profit (IAB, 1999, p. 2). In the ICT sector, the number of patents can be seen as the development level for new economically valuable knowledge and technological output. In this context, the increasing number of patents in the ICT sector in Korea during the 1990s strongly demonstrates the rapid advancement of innovative activities and technological development in the Korean ICT sector. This view is further reinforced when comparisons with other countries are undertaken. As shown in Table 4, the share of ICT-related patents granted by USPTO in 1992 was 28.8 per cent of all patents in Korea, which is significantly larger than the average ICT-related patents in total patents for OECD countries (9.5 per cent) and for the European Union (6.2 per cent). More recently, as a consequence of rapid increases in R&D expenditure in the ICT sector, the share of ICT-related patents in total patents has markedly increased in many countries. By 1998, the share of ICT-related patents in North America had more than doubled when compared to that of 1992, an annual growth rate of 19.6 per cent, while the European Union and OECD countries show a similar increase with an annual growth rate of approximately 16 and 19 per cent respectively. By contrast, in Korea the share of ICT-related patents in total patents in 1998 had slightly decreased compared to 1992, but this was because of the extraordinary growth of total patents during this period. The average annual growth rate for the ICT sector from 1992 to 1998 was still remarkably high at 30.5 per cent.

Table 4

*ICT patents in Korea granted by USPTO**

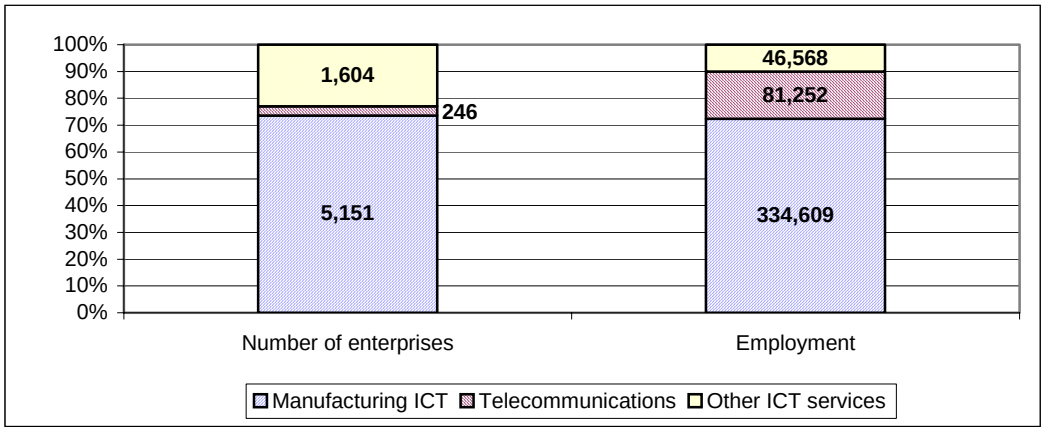
	Share of ICT patents in total patents (%)		Average annual growth rate of ICT patents 1992-98
	1992	1998	
Australia	4.8	8.0	19.6
Canada	5.8	14.7	25.0
Denmark	6.4	3.1	0.0
Germany	4.2	6.7	12.2
United States	8.8	18.4	21.5
North America	5.7	12	19.6
European Union	6.2	11.0	15.7
Korea	**28.8**	**23.4**	**30.5**
Total OECD	9.5	17.6	18.6

Source: Selected figures from OECD (1999) p, 169
Note: *, United States Patents and Trademarks Office

The ICT sector in Korea has developed rapidly in terms of both products as well as service provision. The structure of the Korean ICT sector has changed from a small number of companies which provided basic hardware components and services, to a very diverse structure which has a high level of concentration in ICT activities. At the same time, the size of the workforce in the ICT sector has rapidly grown. In 1997, the number of ICT-related manufacturing enterprises was 5,151 with an employment size of 334,609, more than 70 per cent of the total ICT-related enterprises and employment. The telecommunications industry has contributed a large portion to employment in the total workforce in the ICT sector.

Figure 4

Number of enterprises and workforce in the ICT sector, Korea 1997

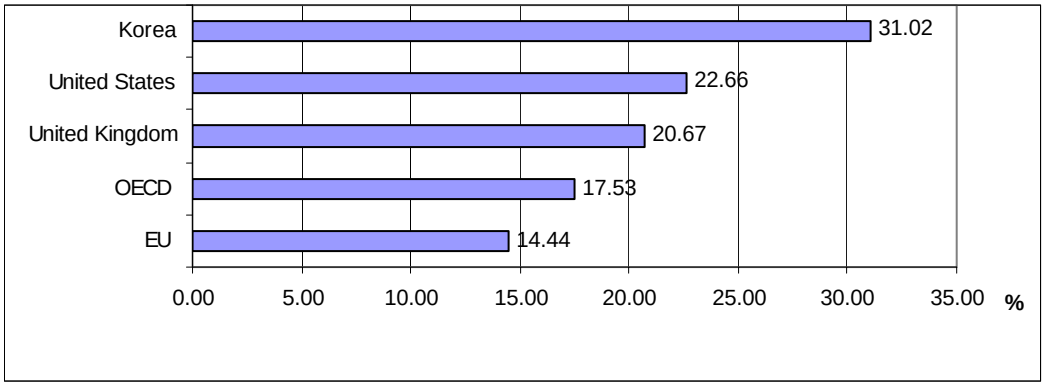


Source: Selected figures from OECD (2000a)

The ICT sector forms a significant part of the Korean economy, with the composition of international trade in manufactured goods increasingly shifting towards the ICT sector. The view of the growing importance of the Korean ICT sector in total manufacturing trade is further reinforced when compared with other economies. As indicated in Figure 5, Korea ranked the highest in the share of ICT manufacturing trade in total goods trade in 1999. While the average share of OECD and EU member economies reached 18 and 14 per cent respectively, that of Korea reached 31 per cent.

Figure 5

ICT manufacturing trade by country (Share of total goods trade) 1999



Source: Selected figures from OECD (2001b)

The strong performance of manufacturing in the Korean ICT sector is further emphasised in a recent report by the Bank of Korea (2000), which reported that an

annual growth rate of value added in the Korean ICT sector of 23.9 per cent was achieved over the 1991-99 period. This far surpassed an average economic growth rate of 5.9 per cent. In particular, as seen in Table 5, the amount of production in ICT manufacturing and the telecommunications sector in 1997 was US$100,856 million, equivalent to just less than 80 per cent of the total production in the ICT sector. At the same time, total ICT exports account for more than 98 per cent of the manufacturing ICT, but much less (less than 2 per cent) for the service component. Furthermore, the balance of trade in ICT goods was strongly positive, while that of telecommunications and other ICT services was in deficit. This strongly suggests that the capacity for ICT services such as software development should be improved in order to establish a more competitive ICT sector in Korea.

Table 5

The ICT sector in Korea, 1997

	Manufacturing ICT	Telecommunications	Other ICT services	Total ICT
1997	US$ Million			
Production	100,856	21,468	8,022	130,346
Value added	46,107	12,982	3,632	62,722
Capital expenditure	13,164	7,024	-	-
Wages and salaries	8,058	3,057	1,545	12,660
Imports	25,505	865	66	26,436
Exports	35,687	652	3	36,342

Source: Selected figures from OECD (2000a) p. 100

The development process of the ICT sector in Korea has undergone radical change as global competition has intensified. The government, in an effort to facilitate the advance of the knowledge-based economy, has taken a significant role. In particular, the second half of the 1990s saw active promotion of the ICT sector. Major government policies were enacted to achieve the development of the ICT sector throughout the nation, with a view to joining the ranks of advanced information societies early in the 21st century. They included the *Basic Act on the Promotion of the Development of Telecommunication and Information Technology* (1995), the *Master Plan for the Promotion of the Development of Telecommunication and IT* (1996), and the *Annual Action Plan for the Promotion of the Development of Telecommunication and IT*. In particular, the development of the *Korean Information*

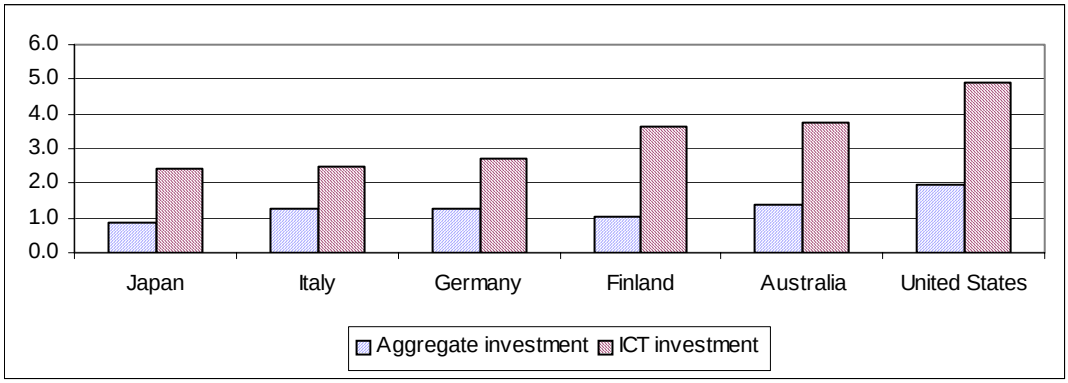
Infrastructure (KII), the backbone of the emerging information society which will be supported by electronic interconnections between homes, offices and industry, was initiated in 1995 for completion by 2010. While a publicly funded government information network aims at deploying a nation-wide backbone of optical cable, the public network, funded by private telecommunications service providers, aims at satisfying end users' demands for high-speed information and communications service (ASTEC, 1995, p. 14). Furthermore, in April 1999, taking into account the growing importance of the knowledge-based economy and the explosive proliferation of the Internet, the government initiated *Cyber Korea 21*, elaborating on the *Master Plan for the Promotion of the Development of Telecommunication and IT* (Dahlman and Andersson, 2000). *Cyber Korea 21* is a blueprint for the promotion of telecommunications and IT, outlining the vision and major policies for building a knowledge-based society. It is anticipated that the completion of KII, coupled with government initiatives such as *Cyber Korea 21*, will further enhance national productivity and promote new businesses related to information infrastructure.

3.1 The development of the ICT sector in Australia

In Australia, the ICT sector also forms a significant part of the economy. In particular, the investment in the ICT sector, among other sectors, expanded particularly in the 1990s. As Figure 6 suggests, compared to the amount of investment in the ICT sector in Australia in 1990, the amount in 1999 was 3.8 times larger, while the total investment over the entire economy in 1999 was only 1.4 times larger than that of 1990. This remarkable increase in investment in the ICT sector is further reflected when compared with other OECD countries. The growth in total investment between 1990 and 1999 in Italy and Germany shows a similar increase (1.2 and 1.3 times larger than the total investment in 1999 respectively) to that of Australia; however, the growth in investment in the ICT sector during the time period was much smaller than that of Australia.

Figure 6

Growth in ICT investment in selected OECD countries, 1999 index (1990 = 1)

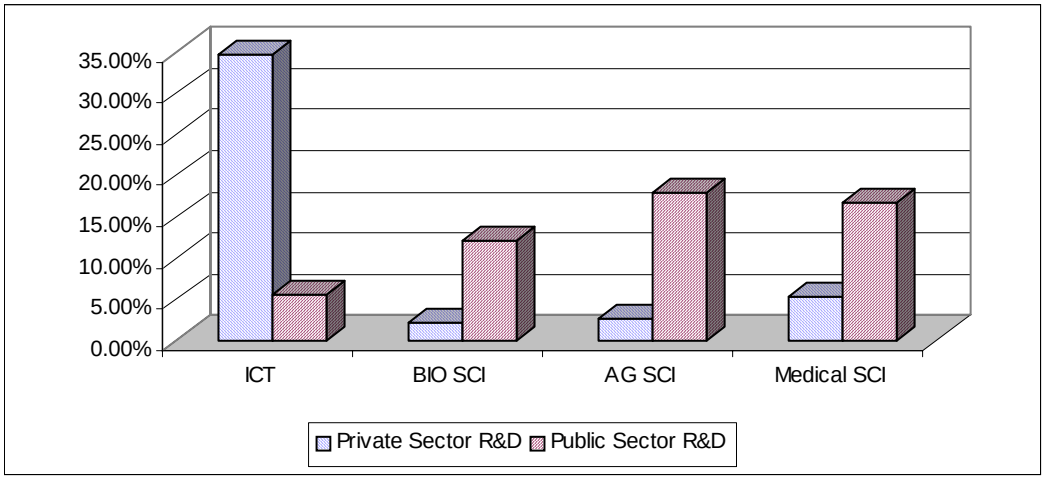


Source: Selected figures from OECD (2001b)
Note: Price ratios between ICT and non-ICT products have the same time patterns across countries, with the United States as the benchmark.

There is a substantial difference between the public and private R&D expenditures in the ICT sector in Australia. The Australian ICT sector relies heavily on private investment funding, compared to other sectors such as biological, agricultural and medical science. The amount of R&D expenditure funded by the private sector was approximately six times larger than public funding in 1998-99. In the public sector, the largest portion of R&D funding is consumed by biological, agricultural and life science R&D, nearly nine times the level of public research expenditure on the ICT sector. This pattern of R&D expenditures on ICT and other sectors can be explained by the presence of a large number of international companies in Australia that have actively promoted research activities due to comparative advantages, such as a technically skilled workforce and the high quality of ICT intellectual property and products.

Figure 7

Public & Private R&D by Field of research in Australia, 1998-99



Source: Selected figures from ISR (2000a) p. 51

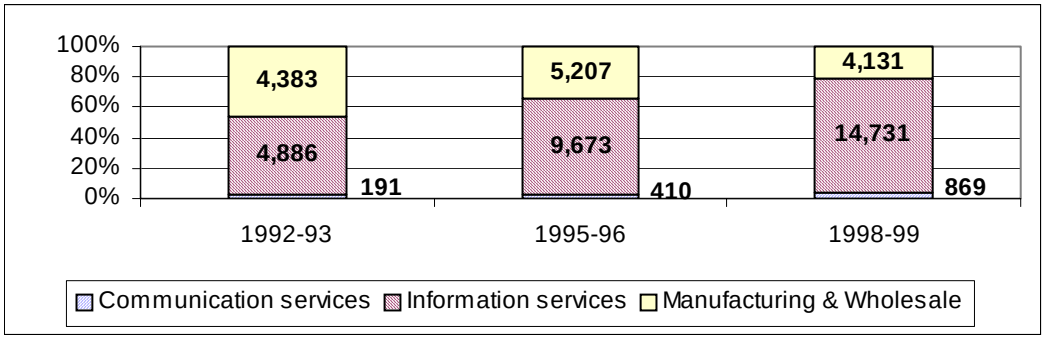
With regard to the average growth rate of ICT patents between 1992 and 1998, the Australian ICT sector accounted for 19.6 per cent, larger than the average annual growth rate of ICT patents for OECD countries (18.6 per cent) (refere to Table 4). Although the actual share of ICT patents in total patents in 1992 and 1998 is lower than that of other OECD countries, the high average annual growth rate in the Australian ICT sector indicates that Australia has pursued a dynamic process to establish a competitive environment for R&D activities in the sector.

The role of the ICT sector in Australia has gained extra weight as the Australian economy has moved forward to a knowledge-based economy from a resource-based one. This view can be further emphasised when the increasing number of ICT-related companies is examined. During the 1990s, the growth of the number of ICT-related companies in Australia showed a strong increase in both information and communication services. More specifically, the communication sector recorded a 350 per cent increase in the number of establishments from 1992-3 to 1998-9, while the number of companies providing information services increased from 4,886 in 1992-93 to 14,731 in 1998-99, a growth rate of approximately 200 per cent. The information services sector shown in Figure 8 consists of data processing, data storage and retrieval, computer maintenance, and computer consultancy areas. The largest contribution to the information service sector in terms of the number of businesses was made by the computer consultancy area, with over 14,000

establishments by 1998-9, a growth rate of 225 per cent since 1992. This remarkable growth demonstrates the increasing capability of information services, such as system integration and software development, and the competitive infrastructure available in the Australian ICT sector. On the other hand, Australia's performance in manufacturing and the wholesale sector in ICT was much less impressive in terms of the number of start-ups during the same period, implying a lack of production base in ICT equipment area and heavy dependence on foreign sources.

Figure 8

Number of Businesses in the Australian ICT sector, 1992-93 to 1998-99



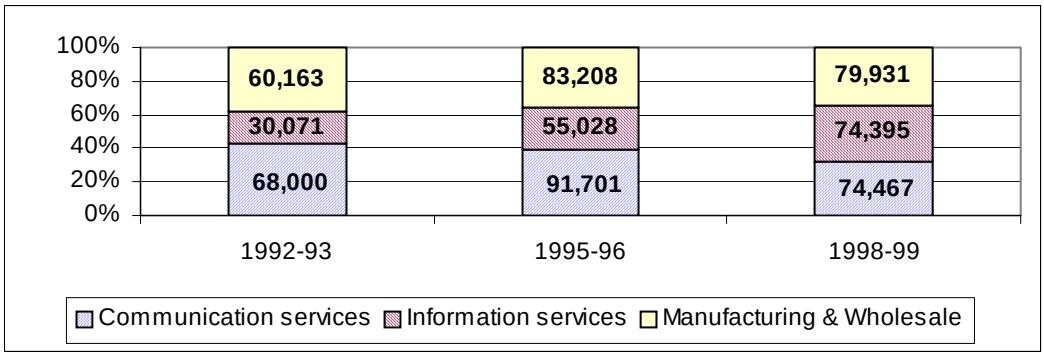
Source: Selected figures from Houghton (2001)

However, as is shown in Figure 9, the pattern of employment change in the Australian ICT sector is rather different. In 1992-93, communication services and manufacturing and wholesale sectors dominated the workforce in the Australian ICT sector, employing 60,163 and 68,000 workers respectively. By 1998-99, however, the information services sector increased manpower substantially, from 30,071 in 1992-93 to 74,395 in 1998-99, a growth rate of 147 per cent. This area came to absorb some 30 per cent of the total workforce in the Australian ICT sector by 1998-99. Although the number of establishments in the communication services sector doubled in 1998-99, compared to that of 1995-96 (refer to Figure 8), employment decreased substantially, from 91,701 in 1995-96 to 74,467 in 1998-99, with an overall growth rate of 9.5 per cent between 1992-92 and 1998-99. This growth rate was noticeably weaker than those in the sectors of information services and manufacturing and wholesale (147 and 32 per cent respectively). Thus, it can be argued that the Australian government's policy reforms for the improvement of efficiency and competitiveness in the communiction services industry through opening competition

and privatising public companies have led to a considerable decrease in the workforce.

Figure 9

Australian Employment in the ICT sector, 1992-93 to 1998-99

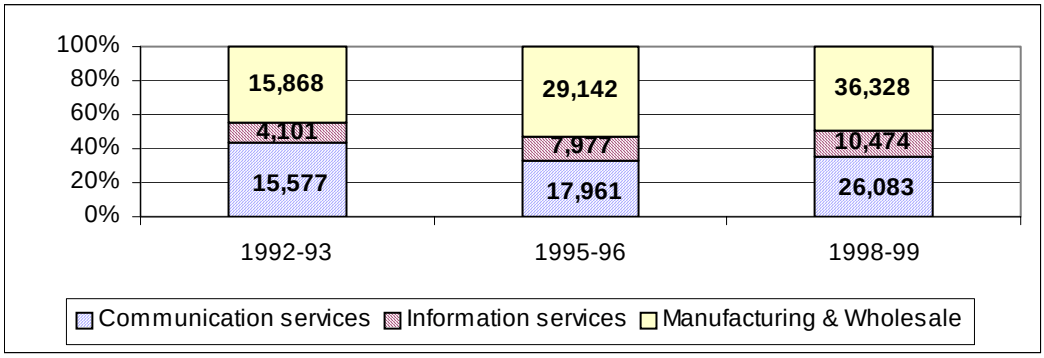


Source: Selected figures from Houghton (2001)

With regard to income in the Australian ICT sector, as can be seen in Figure 10, while a significant increase is shown in all areas of communication services, information services and manufacturing & wholesale, the manufacturing and wholesale area serves the Australian ICT sector in the most profitable way. Although ICT equipment manufacturing in the manufacturing and wholesale sector has grown as a stable basis for the industry, at a growth rate of 18 per cent from 1992-3 to 1998-9, the main income source is computer wholesaling and business machine and equipment sales, contributing over 80 per cent of the whole income for the manufacturing and wholesale sector (Houghton, 2001). Although the employment size of the information services sector is the largest among the three sectors in the Australian ICT sector, the scale of income generated is relatively small. However, the information services sector has the highest growth rate at 155 per cent from 1992-3 to 1998-9 among the three sectors during the same time period (67 per cent for communication services and 130 per cent for manufacturing and wholesale sectors). It is also noticeable that the share of the manufacturing and wholesale sector in the total income of the Australian ICT sector decreased between 1995-6 and 1998-9, pointing to the need for further efforts to improve the commercialisation of technologies for ICT equipment manufacturing.

Figure 10

Income in the Australian the ICT sector, 1992-93 to 1998-99 (A$ million)



Source: Selected figures from Houghton (2001)

The production capability in the Australian ICT sector is mainly led by the services sector, contributing more than 50 per cent of the total production in 1998-99. In terms of value added, it is also noticeable that the Australian ICT sector is service-oriented, with telecommunications services contributing the largest industrial component (almost 52 per cent). While the balance of trade in ICT goods is strongly in deficit, ICT exports account for over 80 per cent of ICT production in the ICT manufacturing area. Australia is highly dependant on imports of ICT manufacturing goods to meet domestic demand. In terms of the service trade, only 2 per cent of total production of the ICT services sector was exported. This suggests that further efforts need to be made to develop various channels for international cooperation in order to create a significant share of services sector in the Australian ICT sector.

Table 6

The ICT sector in Australia, 1998-99 (US$ million using PPPs*)

	Manufacturing ICT	Telecommunications	Other ICT services	Total ICT
Production	2,436	20,049	23,056	45,540
Value added	484	7,968	5,950	14,402
Capital expenditure	-	4,101	-	-
Wages and salaries	352	2,836	4,354	7,542
Imports	9,072	940	244	10,257
Exports	2,006	814	375	3,194

Source: Selected figures from OECD (2000a), p. 40
Note: *, Exchange rates for trade data do not use Purchasing Power Parities (PPPs); Trade data relate to the 1996 year

As international competition intensifies, knowledge-gaining costs become more extreme, creating pressure for economies to develop new channels for international cooperation. The ICT sector has been one of the most rapidly growing industrial sectors in Australia, particularly during the 1990s. Although the services sectors in the Australian ICT sector have achieved substantial growth during these years, Australia has not been successful in stimulating the growth of a strong export focused ICT manufacturing base. Given the global shift towards a knowledge-based economy, it is significant to increase concerted efforts by the public and private sectors to achieve more international competitiveness for the Australian ICT sector. Next section examines technology complementarity in the ICT sector between Korea and Australia, and presents potential benefits from the promotion of bilateral technology cooperation in the sector.

4. Technology complementarity in the ICT sector for bilateral technology cooperation between Korea and Australia

As set out by APEC in defining and indicating the level of competitiveness in the ICT sector, the overall ICT sector can be divided into four areas - human resource development, innovation system, ICT infrastructure, and business environment - based on the level of capability in technology acquisition, technology creation, technology dissemination, and technology use (APEC, 2000, p. 18). These four areas have various indicators, which can be used for the evaluation of national competitiveness in the ICT sector.

As can be seen in Table 7, there are a number of comparative strengths and weaknesses in the ICT sectors in Korea and Australia. Given these different levels of development, there are a number of expected benefits from enhanced bilateral technology cooperation between the two countries. Firstly, the number of graduates majoring in natural science-related studies in Korea in 1997 was 3,169, which is around twice as many as the average of the OECD member nations. In addition, the Australian performance in this area also shows remarkable strength in the comparison with the OECD nations. More specifically, the number of natural science graduates per million in Australia was 88.9 in 1997, while that of the OECD countries averaged at 41.3. Thus, when technology-involved business dealings between Korean and

Australian companies are promoted, there are expected benefits such as cost-saving for training local workers through the exchange of researchers and engineers between Korea and Australia. In the ICT sector, the cost of educating the workforce to allow them to be knowledge-equipped is relatively high due to the complex technologies in the sector, and the time-consuming process needed to improve knowledge gathering and absorbing capabilities of the workforce. Furthermore, exchange of R&D activities can be strengthened through transfer of knowledge and technology in the sector.

Secondly, development of new technology is the most crucial issue in the ICT sector, and the key to future success lies in research and development. With regards to the innovation system in the ICT sector in Korea and Australia, the figures show different strengths that can be utilised in future cooperation between the two countries. In particular, the number of patents at a national level indicates the level of capability for creating commercial values from local inventions. In this context, the Korean ICT sector performs well, with a larger number of US patents than the average number of OECD countries in 1997.

Thirdly, the level of infrastructure in the ICT sector also presents different strengths between the two countries. In building a knowledge-based economy, it is critical to build a foundation based on a competitive ICT infrastructure equipped with high capability for software and hardware development. The figures indicate the infrastructure in the Australian ICT sector has been competitively constructed compared to the average level of ICT infrastructure of OECD member nations. In Korea, the government has recently established a programme aimed to improve ICT infrastructure called *Cyber 21*. This programme will increase government investment for the construction of the national information infrastructure, and stimulate private participation through government initiatives. One major outcome of the programme is the establishment of the digital network that will cover every household with high-speed Internet access. As a result, the overall infrastructure level of the ICT sector in Korea will undoubtedly be improved, leading to an increase in productivity and efficiency. Furthermore, electronic commerce is a fast growing area for extended business activities. In 1997, the total income of Internet-based companies in Korea through B-to-B (Business to Business) and B-to-C (Business to Customers) was US$720 million. In this regard, the growing size of the online market in Korea can

present new opportunities for Australian Internet service companies to provide software development technologies in joint business activities.

Fourthly, the overall business environments in Korea and Australia suggest a number of areas for bilateral technology cooperation to enhance mutual benefits. In particular, cooperation between the private and academic sectors contributes to the reduction of technology development costs, avoidance of overlap in technology development, and to some extent to the establishment of standardisation in technologies. In this context, stronger inter-company technology cooperation in the ICT sector between Korea and Australia can provide new opportunities for establishing strategic technology alliances and contributes to an increase in the utilisation of new technologies in the sector. In addition, the increasing risks and costs of R&D activities caused by the shortening technology life cycle in the ICT sector can be reduced. Although there are a large number of conglomerates equipped with strong overseas marketing capabilities in Korea, the scarcity of dynamic technology-based SMEs has been a major weakness. In Australia, the strong performance of technology-driven SMEs is critical in the market. In this context, it is highly likely that an increase in the establishment of strategic technology alliances between companies in Korea and Australia will provide new opportunities for improving overseas marketing capability for Australian companies and for increasing technology competitiveness for Korean SMEs.

As shown in the business environment area in the Table 7, the level of transparency in the Korean government policies for the financial and competition systems in the market suggests that the government should further recognise the significance of establishing a fairer business environment to improve infrastructure for the ICT sector. It can be suggested that the government further deregulate the market, improve government transparency, and establish a more transparent financial system in order to gain leverage in more advantageous technology cooperation with Australia. In so doing, more sophisticated business activities and new opportunities for technology innovation by the private sectors in both Korea and Australia can be initiated, based on a competitive infrastructure and a supporting environment.

Table 7

Indicators in the ICT sector in Korea and Australia, 1997

	Korea	Australia	OECD average
Human Resource Development			
Human Development Index	0.894	0.932	0.92
Newspapers (per 1,000)	394	297	245
Natural Science Graduates per annum	3169	1683	1564
Natural Science Graduates (per million)	68.9	88.9	41.3
Innovation System			
US Patents	2359	720	2220
Business Expenditure on R&D/GDP	2.24	0.82	1.04
Gross Expenditure on R&D/GDP	2.79	1.67	2.15
Scientists & Engineers (per million)	2636	3166	2207
ICT Infrastructure			
Internet Hosts (per 10,000)	40	420.57	317.65
Internet Users (% of population) (1999)	8.53	30.5	18.5
Computers (per 1,000)	150	431	273
Phone Lines (per 1,000)	467	530.7	507
Mobile Phones (per 1,000)	304.2	323.8	223.3
E-commerce (US$ Million)	720	380	Na
Business Environment			
Company-Uni Cooperation (rating)	3.2	5.09	4.4
Company Cooperation (rating)	3.11	5.07	5
Openness (rating)	3.83	7.22	7.34
Competition Policy (rating)	5.44	6.75	6.04
Financial Transparency (rating)	3.39	7.25	6.56
Government Transparency (rating)	3.45	6.76	5.47
FDI/GDP	0.6	2.3	1.9
High-Tech Exports (% of GDP)	11.83	3.60	10.2
Services Exports (% of GDP)	5.75	4.48	9.39
KBI (% of GDP)	40.3	48	51

Source: Selected figures from APEC (2000) p. 195-96

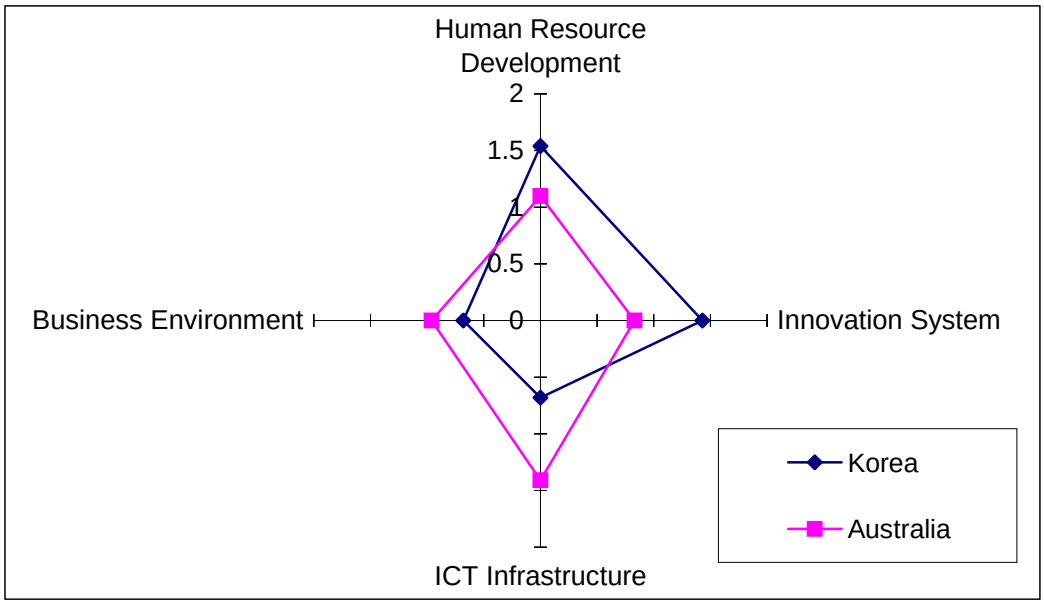
When the indicators in the four areas – human resource development, innovation system, ICT infrastructure, and business environment - are integrated, as can be seen in Figure 11, Korea and Australia are competitively positioned to gain mutual benefits from their complementarity in the ICT sector. More specifically, it is evident that in the comparison of the ICT sector in Korea and Australia, the areas of human resource development and innovation system represent comparative strengths for Korea, while those of ICT infrastructure and business environment perform stronger in Australia. This clearly characterises the unique potential for the Korean and Australian ICT sectors and suggests that further promotion of bilateral technology cooperation

between Korea and Australia would yield benefits.

Figure 11

Combined Indicators in the ICT sector in Korea and Australia, 1997

(Scale: 1.00 = OECD Average for the Indicators)



Source: Selected figures from APEC (2000) p. 195-96
Note: In the indicator of human resource development, only the number of natural science graduates per annum was calculated for the analysis of national capacity.

There is already evidence of the bilateral cooperation in this sector. Korea is the first country in the world that has commercialised Code Division Multiple Access (CDMA) for its national wireless telecommunications infrastructure. The format has been proved to be one of the most successful technologies in telecommunications, with about 30 countries adopting the CDMA format for their wireless communications systems, as of the end of 1998 (The Korea Herald, 1999a). In Australia, KT Freetel and Hansol PCS have started operating CDMA systems in Sydney and Melbourne (The Korea Herald, 1999b). The project is part of a A$210-million deal between Samsung and Hutchison Telecom Australia Ltd., in which Samsung exports CDMA systems and handsets on a turnkey basis. The two firms signed on with Samsung Electronics to export their systems management expertise and dispatch engineers to run operating and maintenance centres in the two Australian cities. Another example is the provision of innovative software technology developed by PowerSource Software Pty. Ltd in Australia to leading Korean ICT organizations including Daewoo Information Systems Co. Ltd (DISC), Korea Electronics

Technology Institute (KETI), and Samsung SDS since 1997 (Porter 2001). Furthermore, there is increasing collaboration in R&D activities between research centres in Korea and Australia. An example is the involvement of the Korea's Optical Internet Research Centre in collaborative research with the University of Sydney (the Australian Photonics Cooperative Research Centre) and the University of Melbourne (the Centre for Ultra Broadband Information Networks). Another example is the joint technology cooperation in the pursuit of R&D activities between the Korea-Australia Science and Technology Exchange Centre (KASTEC), which is based at the Busan National University in Busan, Korea. The joint R&D activities mainly target the promotion of commercial linkages using new environmental technologies between Korea and Australia (Porter, 2001, p. 7).

5. Conclusion

Emerging demand for technological change in the process of technology learning in Korea and Australia have encouraged the governments to pursue strong policies for the improvement of national capacity. In particular, the ICT sector is a growing area that both Korea and Australia are increasingly dependent on future economic growth. Given different strengths and weaknesses in the ICT sector in Korea and Australia, there are a number of potential benefits when bilateral technology cooperation is further promoted:

- *Pooling of human resources in joint cooperation activities.*
  Abundant human resources in Korea and sufficient knowledge workers in Australia can provide cost-effectiveness and time-saving in the training local workers. The costs of instructing and educating the workforce to be "knowledge-equipped" is relatively high due to the complex technologies involved and time-consuming process of improving knowledge gathering and absorbing capability of workforce in the ICT sector.

- *Promotion of joint R&D activities for the transfer of knowledge and technology at private, public and academic levels in the sector.*
  Development of new technology is the most crucial issue in the ICT sector, and a key to future success lies in research and development. It is particularly significant in the sense that collaboration of technology cooperation among

private, public and academic sectors contributes to the reduction of technology development costs, avoidance of overlap in technology development, and to some extent, to establishment of standardisation of technologies.

- *Stronger inter-company technology cooperation*.

  Stronger inter-company technology cooperation in the ICT sector between Korea and Australia can provide new opportunities for forming strategic technology alliances, and contributes to the increase of utilisation of new technologies in the sector. In addition, the increasing risks and costs of R&D activities caused by the shortening technology life cycle in the sector can be reduced.

- *Healthier Korean SMEs and stronger overseas marketing for Australian companies.*

  Although there are a large number of conglomerates equipped with strong overseas marketing capabilities in Korea, the scarcity of dynamic, technology-based SMEs has been a major weakness. In Australia, the strong performance of technology-driven SMEs is critical in the domestic market. In this context, it is highly likely that an increase in strategic technology alliances between companies in Korea and Australia will provide new opportunities for improving overseas marketing capability for Australian companies and for increasing technology competitiveness for Korean SMEs. In addition, joint venture projects should be developed to facilitate dynamic cooperation activities for SMEs as part of the bilateral economic links. In so doing, mutually profitable business opportunities in either country or third countries can be created.

- *Construction of a more competitive infrastructure in the ICT sector in Korea and Australia.*

  In terms of the level of infrastructure in the ICT sector, the two countries have different strengths. In building a knowledge-based economy, it is critical to build a foundation based on a competitive ICT infrastructure equipped with high capability of both software and hardware development. Coupled with the high software development capability of Australian

companies and hardware development capability of Korean ones, stronger joint technology cooperation will improve the overall productivity and efficiency in the construction of a competitive ICT infrastructure.

- *Competitive market environments in Korea and Australia.*

  With regards to the overall business environment in Korea, the government should further recognise the significance of establishing a fairer business environment to improve infrastructure for the ICT sector. It can be suggested that the government further deregulate the market, improve government transparency, and establish a more transparent financial system in order to gain leverage in more advantageous technology cooperation with Australia. In so doing, more sophisticated business activities and new opportunities for technology innovation by each of the private sector between Korea and Australia can be initiated, based on a competitive infrastructure and supporting environment.

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