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Innovation-driven cluster development strategies in Korea

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This paper examined the overall trend of industrial development policies focused on the regional innovation strategies and cluster policies. The policies for industrial and regional development have evolved continuously toward innovation and cluster development despite policy changes by different governments. Since the 1990s, the Korean government has exerted a great deal of effort to promote the development of knowledge-intensive industries. Regional innovation has been the key policy since the beginning of the 21st century. Some future policy issues can be broadly considered in the aspects of sustainability and brain circulation.

Cluster Policy, Regional Innovation Policy, Regional Innovation Systems, Korea

1. Introduction

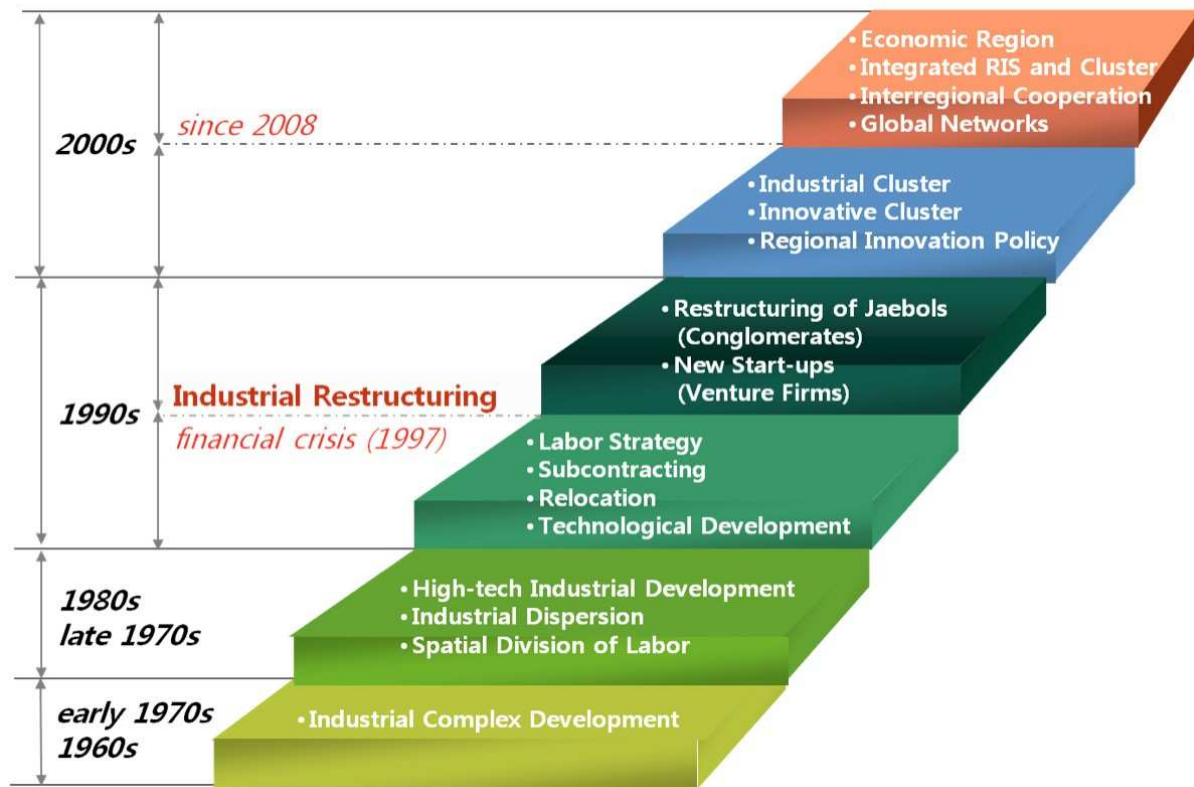
During the last three decades, global economic spaces have been dramatically reshaped. Under the reshaping of economic spaces, uneven development is persistent, and the spatial disparity is not likely to be eliminated or substantially reduced in the global economy. These dynamics of economic spaces have evolved in the global society along with the progress of global megatrends, such as globalization, knowledge-based economy, information society, the service world, climate change, and aging society (Bryson et al., 2004; Hayter and Le Heron, 2002; Park, 2012; *Regional Studies* 42.6, 2008; 46.10, 2012). While global economic spaces were undergoing changes, some countries and regions have experienced considerable growth; on the contrary, other countries and regions have stagnated in terms of economic growth. Along with the global megatrends, national innovation systems, regional innovation systems (RIS), and industrial clusters have been regarded as important policies for the economic growth of nations and regions (*Papers in Regional Science*, 90.2, 2011).

Korea has achieved remarkable economic growth during the last five decades. Korea was among poorest countries in the world following the devastating Korean War (1950-1953). The per capita GNP of Korea was less than US\$100 in 1960, but it increased to US\$20,000 in 2007. Such a remarkable achievement in the economic growth is closely related to the government's successful implementation of industrial development strategies, innovation and cluster policies, as well human resource development.

Industrial policies and regional development policies have evolved since the launch of the First Five-Year Economic Development Plan in 1962. In early industrial and regional development policies, industrial district development was the major policy in Korea, shifting the strategic industries from labor-intensive industries to heavy and chemical industries. Since the mid 1980s, high-technology industries, such as semiconductors, have been increasingly favored. Beginning in the 1990s, especially following the financial crisis in November 1997, the Korean government has exerted a great deal of effort to promote the development of knowledge-intensive industries so as to open up the country to trade and capital movements,

to restructure the economy including the financial sector, and to make the labor market flexible. Regional innovation has been the key policy since the 21st century (Figure 1).

Figure 1. A Brief History of Korean Industrial Policy



Source: Park, 2010.

Dynamic spatial patterns and processes have progressed in the space economy of Korea during the last five decades. In the early industrialization phase, the spatial disparity of economic activities increased with the bipolar concentration of industries. Spatial disparity has been persistent, given the continuous concentration of the population, the creation of a new spatial division of labor between the Capital region and the rest of the country, and the path-dependent trends of industrial development. Despite the persistent disparity of economic activities, the spatial disparity of per capita gross regional domestic product (GRDP) has considerably decreased in the last two decades. Along with the decrease of the spatial disparity of per capita GRDP, a new path creation trend has evolved in cities of provincial and rural areas with the development of information and communication technology (ICT).

Considering the changes in industrial policies and spatial dynamics, this paper aims to examine the overall trend of industrial and regional innovation, and industrial cluster policies in Korea. The focus lies on the major innovation and cluster strategies in the 21st century. In Section 2 following this introduction, the government's industrial policies before 2000 are discussed. Sections 3 and 4 respectively discuss the major contents of regional innovation policies during the Participatory Government and industrial cluster policies. In the final section, the future direction of the industrial policy is explored.

2. Government's Industrial and Innovation Policies before 2000

2.1. Industrial policies before the early 1990s

Understanding the government's industrial policy is critical in comprehending the spatial transformation in Korea because the industrial policies have progressed in relation to the

spatial policies. Since the launch of the First Five-Year Economic Development Plan in 1962, the Korean national government has taken a leading role in the promotion of sectoral and spatial industrial policies. Export-oriented industrialization was a major strategy in the early 1960s. The strategy was fashioned to promote the most promising industries, referred to as “strategic industries,” at a certain stage. Labor-intensive industries such as textile and apparel were the key sectors for the expansion of industrial exports before the early 1970s, whereas heavy and chemical industries such as petrochemicals, shipbuilding, automobile, and consumer electronics were the strategic industries for export expansion in the late 1970s and early 1980s. The government’s heavy and chemical industrial policy contributed to the evolution of the Jaebol system in the Korean economy by allowing the Jaebol to borrow foreign capital and by granting them several incentives to encourage investment in the heavy and chemical industry (Park and Markusen, 1995).

Along with the sectoral policies, the national government established several large industrial complexes, especially in the southeastern part of the country. The major new industrial cities of Ulsan, Changwon, Pohang, Kumi, Kwangyang, and Ansan were created as a result of the industrial policies implemented in the late 1960s and the 1970s. Jaebols heavily contributed to the development and growth of industrial cities by establishing large branch plants with imported technology and borrowed foreign capital. The industrial policy focusing on the development of industrial estates can be regarded as a strategy to establish production systems in the nation. However, the idea of territorial production systems or industrial cluster was not successfully implemented in the earlier development stage. That is, at the initial stage, the industrial estates in the industrial cities had limited local inter-firm linkages, and they were merely agglomerations of production activities without significant intra-regional production networks.

Sectoral and spatial industrial policies have significant effects on the spatial structure of the economy. In the early industrialization phase, export-oriented industrial policy and heavy and chemical industrial policy reinforced the spatial disparity with the bipolar concentration of industries in the Capital and in the South-East region. On the one hand, the government’s industrial decentralization policy has resulted in the spatial division of labor, with the concentration of the headquarters of Jaebols in Seoul and the decentralization of the production functions to non-Capital regions. On the other hand, the high technology industrial policy since the mid 1980s has triggered industrial reconcentration in the Capital region because of the locational advantages that the Capital region has for high-technology industries. The concentration of high-technology industries and advanced services including R&D activities in the Capital region intensified the spatial division of labor in Korean production systems and in the space economy in the 1980s (Park, 1993).

2.2. Innovation policies before 2000

In Korea, the issues of innovation were relatively neglected in the early industrialization phase of the 1960s and 1970s because the national goal then was to provide a foundation for industrialization. The government took the national innovation system initiative in the 1970s. Research institutes supported by the government took a major role in improving industrial technologies during this period. Most firms were more interested in technology transfer from industrialized countries than in their own promotion of R&D activities. Firms endeavored to digest and learn imported technology, thereby raising their technology level. The major role of universities in the innovation system at that time was supplying human resources to technology development. Therefore, the national systems of innovation in the 1970s were mainly directed by the government’s science and technology policy, which supported the technology transfer to firms and the learning process of imported technology. Imported

technology, rather than the impact of inbound foreign direct investments (FDIs) on the development of innovation systems, was a crucial element in the 1970s.

However, beginning in the 1980s, the major role in R&D and innovation began to shift from the government to private firms (Park, 2001). Many firms began establishing their own R&D centers, which significantly increased R&D expenditure. The share of private firms in the total national R&D expenditure accounted for 56% in 1981, the point in which the share of private firms became greater than that of the government. Since then, the share of private firms had rapidly increased, eventually reaching 81% in 1985 (MOST, 1990). In 1980, only 54 firms, most of which belonged to Jaebols, had their own R&D centers; the figure increased to 2226 in 1995 (KITA, 1995, 1996). In the early 1980s, Jaebols aggressively established R&D centers. Later that decade, even small and medium enterprises (SMEs) began to establish their own R&D centers. By the 1990s, more than two-thirds of the total R&D centers had been established by SMEs. Although the number of R&D centers of SMEs was much larger than that of large firms, the large-scale in-house technology development projects had been mostly conducted by large firms included in Jaebols. Some distinctive characteristics of R&D activities of firms in the national systems of innovation in the 1990s are as follows (Kim, 1997): 1) Large firms of Jaebols established strategic alliances with world-wide high-tech firms; 2) Large firms that mostly belonged to Jaebols aggressively established foreign R&D centers and labs; 3) As obtaining a license for leading-edge complex technology was difficult, large firms became actively involved in the merger/acquisition of high-tech firms in developed countries to secure original technology.

Since the 1990s, beyond the national innovation systems, in which large firms took a predominant role, regional innovation networks have begun to evolve with the development of regional clusters of SMEs in technology-intensive sectors. In addition to the Daeduck Science Town, the establishment of science parks and high-tech parks in non-Capital regions since the 1990s has also contributed to the development of local clustering of innovation networks. According to the survey conducted right after the financial crisis in December 1997, SMEs became more involved in R&D activities during the mid-1990s, which was one of the strategies in industrial restructuring (Park, 2000). A significant increase in the proportion of SMEs that conducted R&D activities during the 1990s was observed. Out of 825 firms that responded to the questionnaire survey in 1997, about 20% conducted R&D activities in 1993. The ratio increased to 34% in 1996. The survey revealed that larger SMEs were more participative in R&D activities than smaller SMEs. However, among the firms that conducted R&D activities, smaller SMEs showed a higher ratio of R&D expenditure to total sales compared with larger SMEs, which led to a conjecture that a considerable proportion of smaller SMEs that conducted R&D activities in the 1990s were evolving high-tech businesses.

3. Major Contents of Regional Innovation Policies during the Participatory Government (2002-2007)¹

The Participatory Government, which was established in 2002, emphasized balanced national development and promoted regional innovation and cluster policies. Regional innovation policies, which were promoted as essential for a balanced national development policy, were an integration of “talents,” “technology,” and “industry.” The four major policies for regional innovation are as follows: 1) providing the basis for the establishment of RIS, 2) strengthening the innovation capacity of universities in provinces, 3) promoting science and technology in provincial regions, and 4) establishing industry–university–research center

¹ The content of this section is based on the revision of some parts of the work of Park (2007).

networks (Park 2007). The major contents of the four strategies are elaborated in the following sections.

3.1. Providing the basis for the establishment of RIS

To establish RIS, the organization of regional innovation councils, activation of regional innovation networks, and the holding of regional innovation conventions and exhibitions were promoted. These three major strategies provided the basis for general directions in the construction of RIS. The following sections discuss the strategies further.

First, regional innovation councils were organized and operated at regional and county levels. A regional innovation council is an organization that deliberates and coordinates important issues for a balanced national development in the concerned region and devises development plans for regional innovation. The council consists of professionals representing diverse functions, such as industries, universities, and research institutions. Fourteen provincial-level regional innovation councils were created, with 845 members from 16 provinces and special cities, because of the two integrated regional innovation councils of Gwangju city and Jeonnam province as well as Daegu city and Gyungbuk province. One hundred thirty-two primary regional innovation councils were also organized from the 230 primary administrative regional units, counties, or districts.

The regional innovation councils fulfilled four roles: 1) innovator who facilitate an innovative atmosphere within the region by suggesting innovation strategies for regional strategic and traditional industries while creating unique ideas for the community; 2) coordinators who deliberate the Five-Year Plan of Regional Innovation Development, prioritize regional innovation projects, and discuss the relations between policy issues and the direction of regional development; 3) facilitators who promote networking among the actors of regional innovation for collective learning and for the progress of regional innovation systems; and 4) linkers who bridge regional innovation actors and national innovation actors. Members of the regional innovation councils at the provincial level actively participate in the core projects for national development, while members of the basic-unit level regional innovation councils operate the regional innovation academy and promote regional innovation atmosphere through diverse forums and workshops related to urgent regional issues. The management of the regional innovation councils involves a typical bottom-up strategy for strengthening the basis of regional innovation systems because provinces or counties organize the council members by themselves, and the councils are authorized to decide over the selection of regional strategic industries.

Second, the revitalization of regional innovation networks was promoted. One strategy for the strengthening of networks was the establishment of Inno Cafes and Network Hubs as places for innovation diffusion through interactions and face-to-face meetings of regional specialists. This strategy is aimed at encouraging the flow of knowledge and information through formal and informal meetings of regional specialists of industry–university–research institutions. At first, Inno Cafes were opened by the Industrial Promotion Corporation for SMEs, Industrial Complex Corporation, and by techno parks as a model for others, subsequently extending them to diverse operating organizations with the participation of industry–university cooperation centers of provincial universities, the chamber of commerce and industry, and so on (Presidential Committee of Balanced National Development and Ministry of Industry and Energy, 2006).

Regional innovation networks of industry–university–research institutions were established through diverse formal and informal meetings in Inno Cafes or Network Hubs, including the presentation of new products and new technology among the participating members, transfer of university technology, and diverse technology cooperation between firms and universities. Users of Inno Cafes in 2005 reached 130,000; consultations for the supply of information and

introduction of cooperative interactions reached 66,000, and seminars and meetings conducted here numbered to 1,133. Business services were supplied in the Network Hub with the cooperation of the local government, SME complexes, Industrial Complex Corporation, universities, research and financial institutions, KOTRA, and so forth. In the Network Hub, a Council for Business Support supplies business services, such as technology development, manpower, marketing, location, and so on to the selected promising firms.

Third, regional innovation atmosphere was promoted throughout the region by holding the Regional Innovation Convention and Exposition. Starting in Busan in 2004, the convention and exposition had been annually held at the major metropolises, such as Daegu, Gwnagju, Daejon, and Seoul. The convention and exposition can be regarded as an innovation festival of the holding city because its purposes were to diffuse the success model of regional innovation, to establish interactive learning systems, and to enhance the regional innovation atmosphere for the people. During the convention and exposition, diverse activities were carried out, including reports on the vision of balanced national development and the result of promotions as well as announcements of success cases of regional innovation, academic conferences, exhibitions by various regions and institutions, cultural events, and so on.

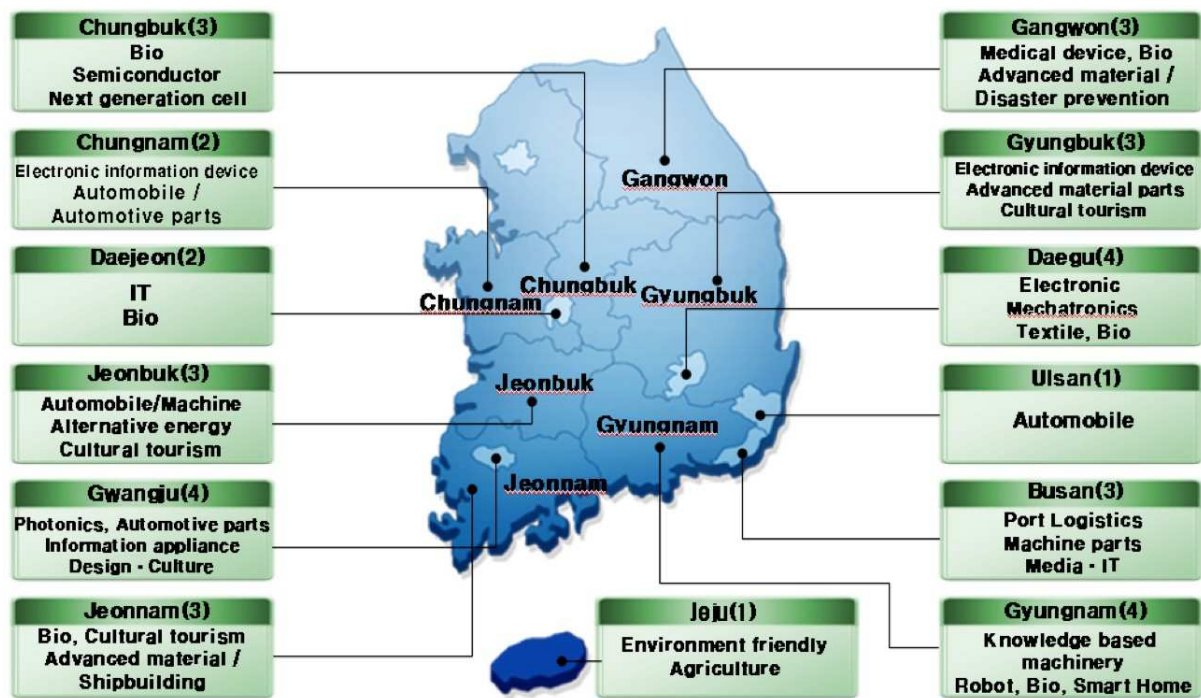
3.2. Strengthening the innovation capacity of provincial universities

Universities played the role of core actors in the establishment of regional innovation systems and industry–university–research institution networks by nurturing talents, promoting R&D activities, and by retraining manpower. In Korea, however, talents were concentrated in the Capital region, and provincial regions lagged behind because of the weak competitiveness and the lack of job opportunities for the graduates of provincial universities. Accordingly, projects to develop provincial universities were promoted to support these institutions in nurturing talents and in taking a central role in the cooperation among industry–university–research institution networks in the provincial areas.

The NURI project was designed to strengthen the innovation capacity of the provincial universities. The NURI project basically aimed to support provincial universities in nurturing manpower. The major strategies of the NURI project included attracting good students by offering scholarships and foreign internships, operating appropriate curriculum while considering industry demands, promoting job creation and new start-ups, and facilitating the specialization of universities in connection with regional strategic industries.

In 2007, the number of NURI team projects reached 131 (37 large projects, 33 medium projects, and 61 small projects), thereby attracting the participation of 109 universities, over 190,000 students (about 10% of the total students), and 7,484 professors. From 2004 to 2008, about 1.2 billion won was allotted to the NURI projects. Universities were at the core of the NURI projects. However, the projects intended to enhance regional innovation capacity through industry–university–research institution networks with the collaboration of the local government, industrial firms, research institutions, and NGOs. In all, 37 out of the 52 strategic industries were selected for support by each provincial region (Figure 2).

Figure 2. NURI Projects Related to the Regional Strategic Industries



Source: Ministry of Education and Human Resources, 2006.

3.3. Promotion of science and technology in the provincial region

Policies for the promotion of science and technology in provincial areas were expedited for a balanced national development through the strengthening of the regional innovation capacity and self-supporting regional development. Strategies for the promotion of science and technology consisted of expanding the provincial R&D investment, strengthening regional specialized industries through regional innovation projects, nurturing regional centers for R&D activities, and supporting regional R&D-oriented universities for education of talents in the provinces (Presidential Committee of Balanced National Development and Ministry of Industry and Energy, 2006). The major contents of the strategies are as follows.

First, the innovation capacity of the provinces was enhanced by increasing the share of the provincial regions in the government's total R&D investment budget. The national government's support was critical for the provinces because the private firms' R&D investments in the provinces were insufficient. At the start of the expansion of R&D investments in the provinces in 2003, 73.0% of the government's R&D investments, 67.3% of the R&D manpower, and 69% of the R&D organizations were concentrated in the Capital region and in Daejeon city. The share of the provincial regions, excluding that of the Capital region and Daejeon city, increased from 27% in 2003 to 36.2% in 2006, representing a significant increase of R&D investments in the provincial regions during the Participatory Government. The investments focused on technology development and manpower training related to the regional strategic industries rather than on the construction of R&D infrastructure, such as facilities and equipment for R&D activities. Such an increase in R&D investments was related to the government's special R&D investments for balanced development. The share of the special R&D investments for balanced development in the government's total R&D investments decreased in the Capital region and increased in the provincial regions during the Participatory Government.

Second, regional technological innovation was supported to enhance the competitiveness of regional specialized industries. Focus was placed on the construction of regional R&D cluster, support of R&D activities of regional strategic industries, and on the support of the local research center for the development of high value-added products from regional

specialized industries. In June 2006, Gyungbuk National University, Seonmun University, Changwon University, Jeonnam National University, and Gangreung University were selected and supported as the core university in each region for the establishment of the regional R&D cluster. In addition, eleven regional research centers, including Busan High Tech Parts and Materials Research Center and Hadong Green Tea Research Center, were likewise supported for the development of local research centers. The support for regional innovation should be systemized through networks of local research centers, regional R&D clusters, and diverse regional innovation institutions.

Third, the promotion of the regional R&D center was supported. The IT Research Center (ITRC) was promoted to develop core IT technology and to provide advanced education in the field of IT. This project began in 2000, and 47 ITRCs from 27 universities were supported in 2007 (23 in the Capital Region and 24 in the provincial regions). Annually, 3,200 graduate students, 500 professors, and 500 researchers from industrial firms join the research activities in the ITRC. Graduates of the ITRC are working at Samsung, LG, and other research centers such as ETRI. The development of a regional science park was also supported to locate firms, universities, and research institutions in the same place for the purpose of strengthening industry–university–research institution networks and promoting new businesses using the results of research. Ohchang in Chungbuk, Jeonbuk, and Gwangju regional science parks have been supported. In addition, R&D projects for the specialized sector that strategically support the region’s specialized technology development were supported to solve regional technology problems and to improve the quality of life of the locals.

Fourth, higher education was supported to improve the competitiveness of local universities. Four national universities of Busan, Jeonbuk, Choongbuk, and Jeonnam were selected and developed as research universities in the provincial regions. This project aimed to improve the regional industrial structure and to develop new start-ups using technologies and manpower educated by the regional research universities by conducting specialized studies related to the regional strategic industries. Specifically, original technologies developed from the university contributed to the start of new businesses through the application and improvement of university venture firms or research centers and through the industry–university collaborative development of new products.

The aforementioned strategies in promoting regional science and technology basically focused on strategically linking regional industries to R&D activities because of the weak relationship between these two elements in the provincial regions. They were directed toward the development of provincial regions by strengthening innovation capacity and by embedding the networks with talents, technology, and industry.

3.4. Strengthening the regional industry–university–research institution networks

The strategies for constructing regional innovation systems, strengthening innovation capacity of local universities, and promoting regional science and technology are all directly or indirectly related with the strengthening of industry–university–research institution networks. To strengthen the regional networks, the development of core universities for industry–university cooperation, promotion of industry–university cooperation, activation of industry–university–research institution cooperation and regional network of technology transfer, and promotion of the Connect Korea (CK) program were supported.

The development of core universities for industry–university cooperation involved nurturing regional hubs to transform a major industrial cluster of the region into an innovative cluster. The core universities have established practical industry–university cooperation by restructuring the curriculum, introducing an industry–university cooperation system as well as a technology development–transfer–guidance system, and by providing appropriate education

based on industry demands. For example, polytechnic universities such as the Korea Polytechnic University and the Hanbat University are focused on education for technology development and support for actual practice in industrial plants. Support from core universities was effective in minimizing the retraining costs incurred by firms, given the participation of 4,745 firms, 153 industry–university cooperation agreements, exchange of 2,072 people, and participation of 13,581 students in specialized programs in 13 universities in 2006. The organization of university firms and foreign internships were supported to promote industry–university cooperation among local universities. Consortiums for joint technology development through industry–university–research institution networks have also been supported since 1993.

Technology transfers from universities and public institutions to local firms for product development and improvement of productivity have been relatively weak in Korea compared with the cases in advanced countries. With this weak effect of technology transfer in the provincial areas, the CK program was launched in 2006 to promote technology transfer from universities and public research centers. The CK program was a supporting organization with a brokering function to promote innovation circulation through two-way feedbacks between people and technology of universities and research centers and firms as well as financial institutions (Presidential Committee of Balanced National Development, 2007). The major activities of the CK project were aimed at supporting direct costs for the organization of technology transfer and for the operation of diverse programs (Table 1).

Table 1. Major CK Program Activities

Programs	activities
Springboard program	Strengthening the capacity of business planning, screening out the feasibility of technology and training the process of developing technology and establishing the firm
Partnership program for the actors related to industry-university cooperation	Promoting the partnership among actors through meetings of the regional specialists including researchers, enterprisers, investors and advanced service suppliers
Advisory committee	Consisting of a financial agency, the president of a university and CEOs and advising firms and researchers in a university
Business consulting program for firms by professors	Solving the problems of firms and building a relationship based on trust between firms and universities through business consulting by professors like as the Technology guidance project of Small and Medium Business Administration
Connecting program between enterprisers and researchers in a university	Holding a seminar and forum for discussing methods of building cooperative networks
Meeting program for researchers in a university	Introducing the experience of enterprisers about firms activities including difficulties of funding to researchers in a university through programs
Holding an exhibition for technology transfer and commercialization of technology	Holding an exhibition connecting with the technology and finance forum or the technology transfer exhibition of Ministry of Health and Welfare and Korean Intellectual Property Office

Award for advanced firms	Awarding a prize to a firm which is successful in the technology transfer and commercialization of new technology and taking advantage of awards for marketing
Training program for the actors related to industry-university cooperation	On-the-job training at home and abroad including management of patent, technology transfer and evaluation of technology
Management of intellectual property	Connecting with the projects for supporting experts of patent security and management Constructing the technology information systems for the Korea Institute of Patent Information and NTB

Source: Bureau of Regional Innovation, Presidential Committee of Balanced National Development, 2006.

4. Industrial Cluster Policies in Korea

In Korea, despite the start of the industrial complex development in the 1960s, the history of industrial cluster policies is relatively short. Since the early 2000s, the government has strongly promoted industrial cluster policies in relation to the balanced national development policies of the Participatory Government. In the next regime, the Lee Myung-bak Government also supports industrial cluster policies, but considerable changes can be observed.

4.1. Industrial Complex Cluster Program in the Participatory Government

Except for some cases such as the Teheran Valley at the Gangnam Area in Seoul, Korean industrial clusters are closely related to industrial complexes that are artificially built by the national and local government. Industrial complexes have constructed since the early 1960s and became the main axis of the Korean industrial development. Until the late 2000s, these complexes accounted for over 70% of all manufacturing exports, about 60% of production, and over 40% of employment.

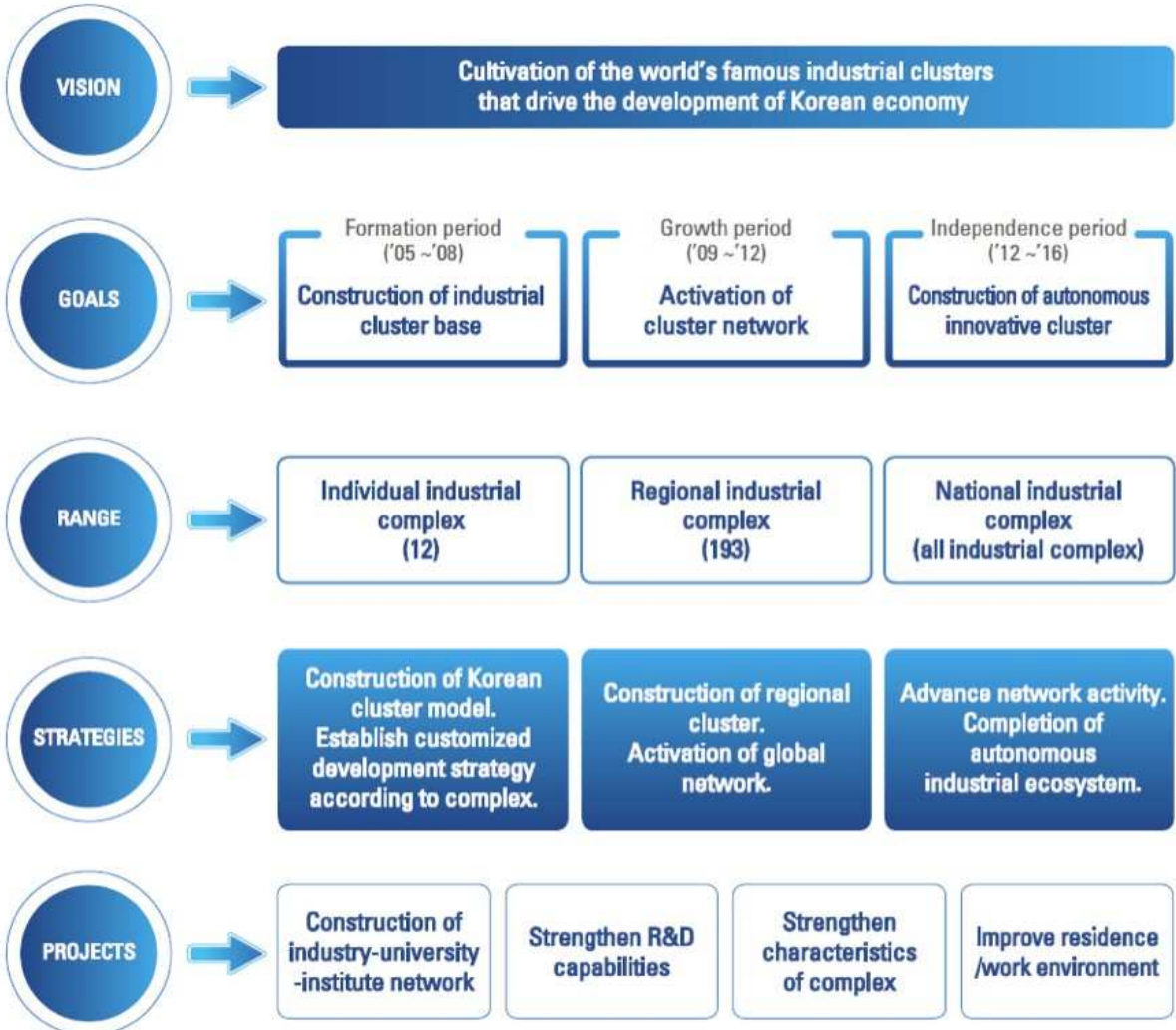
The initial concept of industrial complexes was a simple physical agglomeration of firms and factories in some designated areas. Firms and employees had a few networking activities within those complexes. With the advent of the knowledge-based economy, these complexes gradually lost their competitiveness because of their lack of R&D capabilities, insufficient knowledge-based services, difficulty in attracting high-quality workers, and so on. Therefore, various government policies were pursued to upgrade competitiveness and to reinforce the innovation capabilities of industrial complexes from the late 1990s.

With the progress of the Participatory Government in the early 2000s, a variety of projects related to industrial clusters were promoted. Some of these projects were led by the government, and others were led by the private sector. Policies, such as promoting regional strategic industries and nurturing hub universities for industrial collaboration, were implemented nationwide as previously discussed. Meanwhile, some projects, such as the nurturing Daeduk R&D Special District, building Osong Bio-Health Science Park, and High-Tech IT Complex at Sangam, Seoul (KICOX, 2011), were focused on building the core capabilities of particular regions. Moreover, other clusters led by private sectors developed during this period, including Samsung Electronics' Semiconductor Digital Valley in Suwon, Gyeonggi and LG's LCD Cluster in Paju, Gyeonggi.

Among these nationwide policies, the "Industrial Complex Cluster Program: ICCP" was a pivotal one for industrial clusters. The ICCP was first initiated in 2004 as one of the balanced national development policies of the Participatory Government. The key concept of this

program is converting industrial complexes into innovation clusters. This program aims to build indigenous innovation clusters of industry–university–research institution networks and to establish an industrial ecosystem (MKE and KICOX, 2011). It is divided into three periods: the formation period from 2005 to 2008, the growth period from 2009 to 2012, and the independence period from 2012 to 2016 (Figure 3). The action plan for the creation of innovation clusters from existing industrial complexes was reported as a national project in 2004 and was approved and promoted for the ICCP in seven pilot complexes in April 2005. The seven pilot complexes were Banwol-Sihwa (parts and materials), Wonju (medical equipment), Gumi (electronics), Ulsan (automobiles), Changwon (machinery), Gwangju (photonics), and Gunsan (machinery, automobile components). Five additional industrial complexes were designated to the ICCP in 2007: Namdong (machine parts), Ochang (electronics and information), Seongseo (mechatronics), Noksan (shipbuilding equipment), and Daebul (shipbuilding). The ICCP was evaluated as effective in vitalizing industry–university–research institution networks and in reinforcing the R&D capability of the complexes (MKE and KICOX, 2010).

Figure 3. Industrial Complex Cluster Program Outline



Source: MKE and KICOX, 2011.

4.2. Pan Regional Cluster Program in the Lee Myung-bak Government

When the Lee Myung-bak Government was established in 2008, the core unit of regional development plans was changed into the Regional Economic Area (REA), which was similar to the Mega region. The nation was divided into the 5+2 REA, namely, the areas of Seoul Metropolitan, Chungcheong, Honam, Daegyeong, and Dongnam, plus the Kangwon and Jeju areas (Figure 4). Therefore, the ICCP was reformed along with the policy line launching of the “Pan Regional Cluster Program” in 2010, which was the 5+2 pan regional cluster project according to the REA. This policy was meant to spread out the accomplishments of the existing cluster-related programs to other industrial complexes nationwide via the REA units. In other words, the policy connected general industrial complexes and agro-industrial complexes to hub industrial complexes with the aim of using innovative resources and expanding activities outside the complex (MKE and KICOX, 2010). Therefore, the focus of the project was changed from individual industrial complexes to hub-spoke type regional clusters with 25 hub complexes and 168 connected complexes. This process expanded stage by stage, starting from the individual hub complexes, to the neighboring connected complexes, to the pan regional cluster by the REA, and finally to the inter-REA nationwide.

Figure 4. Regional Economic Area and Major Hub Regional Clusters in Lee Myung-bak Government



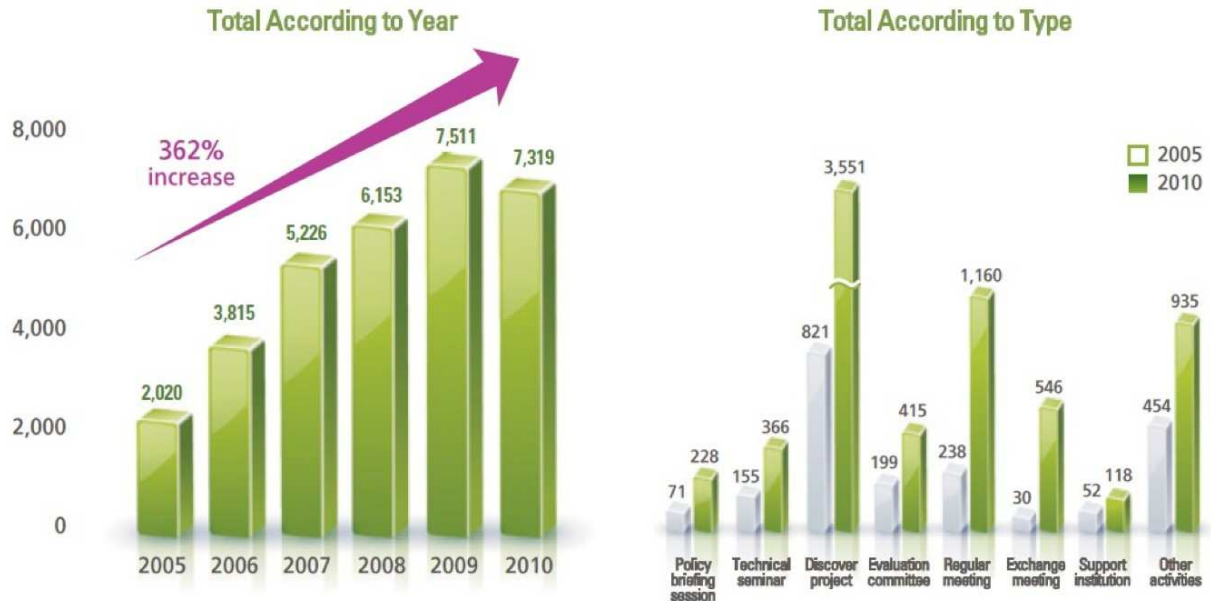
Source: MKE and KICOX, 2011.

With this shift of the ICCP, existing projects also had to change directions. The major directional changes were focused on simplifying existing projects, launching new pan

regional projects, strengthening regional autonomy, differentiating support size, and reducing the numbers of large and medium-sized projects (MKE and KICOX, 2010).

The ICCP mainly involved building an innovation system through networking among regional actors, such as companies, universities, research institutions, and local governments (MKE and KICOX, 2010). For the period between 2005 and 2010, which covered the formation period and half of the growth period of the ICCP, various networking activities, such as technical seminars and support for project discovery, increased by 362% (Figure 5). These networking activities were evaluated as effective in contributing to the consensus building for cooperation among innovative actors.

Figure 5. Change of Network Activities in the ICCP



Source: MKE and KICOX, 2011.

Although the name of the program and the action plan was slightly changed, the program for building up industry–university–research institution networks has been steadily maintained since 2005. The main goal of this program is to vitalize networks, and its main target is to initiate a project to cope with the common difficulties of companies with mini-clusters at the center (MKE and KICOX, 2010). The program has offered intensive support to field projects in various areas, including general management, R&D, funding, labor force, and marketing. Over 50% of the ICCP budget has been invested in this program. In the Lee Myung-bak Government, supporting industry–university–research institution networking and collaboration was also one of the important cluster policies. However, after 2010, operating industry–university–research institution alliance (mini-cluster) somewhat changed to operating pan regional industry–university–research institution alliance, along with the policy related to the REA. Moreover, various projects to support companies was restructured and merged as part of the Company Growth Promotion Project, complete with a detailed action plan that included the commercialization of manufacturing technology, support for product manufacturing, total marketing, tailored education and training, and customized comprehensive support.

In the process of building networks and implementing the ICCP, a mini-cluster has played a pivotal role. A mini-cluster is an industry–university–research institution alliance that is built according to industrial or technical fields; such an alliance continuously develops mutual cooperation, joint learning, and information sharing (MKE and KICOX, 2011). It is based on the participation of innovative actors in the region, such as large firms, SMEs, universities, research institutions, supporting organizations, and local government units. The role of the mini-cluster highlights the strength of the ICCP, as it promotes projects through a customized

bottom-up approach instead of the usual top-down manner of other previous policies. During mini-cluster network activities, such as forums, technical innovation seminars, workshops, and specific meetings, members of a mini-cluster can discover the demands and difficulties of companies. They can select projects through the evaluation committee and search for various solutions, such as those that involve innovative institution network, coordinator connection, self-solving in the complex, implementing governmental policy project connection, or composition of separate teams. With the follow-up management of reported cases of performance and collection of royalties, the members can decide the termination or continuation of the project.

In the 12 hub complexes, three to seven mini-clusters are grouped by industry or technology. The number of mini-clusters increased from 49 in 2005 (first year of the ICCP) to 55 in 2010. In addition, the number of participating actors increased from 2,706 to 5,413. The average member in one mini-cluster nearly doubled from 55.2 to 98.4 during the same period (MKE and KICOX, 2010).

In addition to the existing program for building networks, new projects suitable for the Pan Regional Cluster Program were launched in 2010. Two of them focused on the establishment of pan regional clusters and on the enhancement of global competitiveness. The objective of the establishment of pan regional clusters was to build an expanded regional industry–university–research institution network by the REA. Through the construction of this network, a synergy of cluster programs and innovations was expected. The enhancement of global competitiveness was related to the global networking for improving the global capability of companies, including vitalizing overseas networks, promoting the utilization of overseas technology, and nurturing global talents implemented by hub complexes. Moreover, the Operation Biz-Doctors Center project started in 2011 was an actual site-based coaching and consulting for growth in overall management areas of SMEs over the four pilot complexes (i.e., Banwol-Sihwa, Gumi, Gwangju, and Changwon) (MKE and KICOX, 2011).

5. Conclusion and future policy implications for the 21st century

This paper examined the overall trend of industrial development policies focused on the regional innovation strategies and cluster policies. The policies for industrial and regional development have evolved continuously toward innovation and cluster development despite policy changes by different governments. Although Korea overcame the financial crisis of 1997 in a short period of time and has persisted in the recent global financial crisis, the country has confronted diverse problems with the increase of unemployment rate and disparity of growth between giant firms and SMEs in the trend of globalization, knowledge-based information society, and climate change. In addition, population aging is progressing rapidly in Korea. Low birth rates and aging Korean population, along with other global trends, will require policies beyond those that cover industrial cluster and RIS. Future policy issues should be aimed not only toward a balanced national development but also toward the provision of jobs and a new growth engine for sustainable development. Some policy issues can be broadly considered in the aspects of sustainability and brain circulation.

First, diverse sustainable development programs for industrial cluster development should be established and practiced urgently. Sustainability should be considered in three aspects: environmental, economic, and social sustainability (Park, 2002). With the issue of climate change, most of the countries in the world are now concerned about environmental sustainability. Environmental sustainability is defined by pollution indicators, rules and procedures to control waste, institutions for managing natural resources, and behavior of citizens toward the environment. Diverse programs and plans are now being developed in

Korea for the low-carbon, green-growth policy. For environmental sustainability, strategies for financing environmental change as well as for networking for development and transferring of environmental technology should be considered alongside the strategies for the generation of a green industry. Economic sustainability is related to the market, macroeconomic and financial systems, infrastructure development, industrial efficiency, and so on. For economic sustainability in Korea, global competitiveness should be enhanced through the development of efficient national innovation systems and creative economic regions. Social sustainability is defined by institutions as a state that promotes human rights, educational and training opportunities, and confidence toward the judiciary system and government. For social sustainability, social conflicts between diverse social groups should be reduced and harmonized social relations should be promoted. Education, training, and retraining programs for the socially marginalized groups of the regional population should be provided for the welfare of the poor and multi-cultural families. To provide an equal opportunity for higher education and to raise the social status of the poor, diverse cooperative programs involving the universities, business firms, and local government units can be provided. The three aspects of economic, environmental, and social sustainability should be considered as an interlinked and unified force for the long-term sustainable growth. Considering all these three aspects of sustainability, the integration of ICT into the energy system, along with the development of new and renewable energy, should be carefully considered. Intelligent electronic grid systems should be established for energy efficiency and for the creation of new jobs for young generations. In the short term, intelligent energy grid systems and energy management systems can be initially introduced to the industrial cluster. Afterwards, the nationwide development of intelligent energy grid systems should be supported for the generation of a new growth engine and jobs in the future.

Second, *brain circulation* by attracting talented persons to the provincial regions is critical for the development of the regional innovation systems and for the clustering in the creative economic region of the non-Capital region (Park, 2011). To attract these talents to the non-Capital areas, a regional environment promoting interaction among all the economic actors in the region and a living environment where creative people and scientists can take root in provincial regions should be provided. A mere relocation policy of R&D centers and firms is not enough for the improvement of the innovation potential of the peripheral regions. Brain drains of the past, which represent the out-migration of talented people toward Seoul and foreign countries, should be transformed into brain circulation, wherein talented people are encouraged to live in the provincial areas. Fostering qualified high schools in the provincial areas and providing good living and service environments are required in the non-Capital regions to attract and retain talented people. Specifically, university–industry collaborative networks should be strengthened in the provincial region, and at least one best high school in each province should be nurtured. In addition, considering the possible dramatic changes of the Korean society because of low birth rates and population aging, a new system should be established to encourage talented people in the provincial regions to assist in the country’s development. Considering the location of the longevity areas in the provincial regions, “retired brains” could be attracted to the provincial regions to contribute to the local development by providing diverse programs for regional development. Retired experts can be recruited for consulting activities for local SMEs and for local retraining programs as teachers. The utilization of retired experts is an efficient and inexpensive way to enhance the competitiveness of the local labor market and to promote brain circulation for the regional development of an aging society. Attracting retired brains to the non-Capital regions can contribute to the enhancement of the regional innovation capacities and can solve problems including the shortage of qualified manpower in the provincial regions.

Aside from the two major policy directions mentioned above, globalization trend should be considered in every policy and strategy regarding innovation systems and industrial cluster policies. Accumulating intangible assets in the provincial regions should also be considered for a successful regional development through the revitalization of the industrial clusters in the provincial areas. The accumulation of some intangible assets in a given region enables the provincial regions to attract FDIs. Thus, the externalities through the knowledge spillover from the firms can influence the accumulation of regional intangible assets, resulting in a positive relationship between the firm and the region in a knowledge-based economy (Artis, Miguelez, and Moreno, 2012; Park, 2012). Considering the differences in regional characteristics and regional assets, policies devoted to the generation of regional intangible assets should consider the specifications of the region.

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