5 South Korean SMEs and the quest for an innovation economy

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The dominant account in understanding the successful catch-up of the East Asian tigers has focused on state capacities for nurturing new industries by inducing private firms into areas they would otherwise not enter, investing in managerial and technological capabilities and enlarging their scale and scope. This process created large firms with substantial organizational capabilities, with the Korean *chaebol* as the exemplar (Amsden 1989; Amsden and Chu 2003; Evans 1995). Yet, while the developmental state created large-scale firms, it simultaneously retarded the development and growth of small and medium-sized enterprises (SMEs) by systematically funneling capital and business opportunities towards national champions, as Chapter 1 described in more detail.

Yet, the SME sector has become increasingly important for a country's future prospects. For a country to stay ahead, the state needs to develop a concrete set of ties with the private sector to induce growth of new firms (the so-called embedded thesis) and develop new and innovative industries. The transformation often requires decentralized and flexible state policies and flexible firms to respond and adapt to the rapidly changing global environment and to develop cutting-edge technological capacities continuously to stay ahead. Essentially, the new developmental project is about exploring state-society linkages that are conducive to innovation, such as "embedded autonomy" (Evans 1995), "governed interdependence" (Weiss 1998), or the "developmental network state" (Ó Riain 2004; Block 2008; Block and Keller 2011; Negoita and Block 2012). As Chapter 4 described, such linkages are particularly salient with respect to SMEs, which can lack the independent resources commanded by larger firms.

Korea is a case in point. Korea's response to globalization and competition from other latecomers has been to keep pace with the technology race by developing various innovation-driven regional clusters in the 2000s and cultivating SME entrepreneurship, going beyond the existing emphasis and dependence on *chaebol*-led innovation. The policies may have changed slightly in the past three administrations but the central thrust remains what has been called "balanced national development" and cultivating SMEs and networks among them to enhance learning and innovation. Essentially, the various regional innovation programs aim to bring closer collaborations among SMEs, universities, and government-funded research institutes (GRI) by housing them in innovation

complexes. A key question that motivates the research here is: Under what circumstances can a system of SMEs become competitive in exports, R&D, and investment in international rather than just domestic markets (see also Chapter 4)? Thus, in this chapter, I focus on the SME sectors that have potential both in innovation and in exports, given that export performance is vital to Korea's economic well-being. For these sectors, this chapter aims to provide an assessment of various regional innovation cluster and SME-based entrepreneurship initiatives.

This chapter is organized as follows: first, I will summarize the legacy of the Korean *chaebol*-dominant industrial system and contextualize Korea's current regional innovation clustering initiatives. Second, I will provide a preliminary assessment of the outcomes of these innovation clusters and the rationales behind them from my research. Third, a section will be devoted to discussing the transformation of the other well-known network-based economy, Taiwan, and its transformation in the SME-based machinery sectors to illustrate the alternative approach to the innovation quest. The comparison with the Taiwanese experience serves to illuminate the prospects and obstacles in moving from a *chaebol*-dominated economy to creating an innovation and network-based economy in Korea.

The Korean transition to an innovation economy: SME-based entrepreneurship and innovation clusters

Conventional wisdom attributes the underdevelopment of Korean SMEs to the government's overly strong support of the *chaebol* and pays only lip service to the SME constituents. However, there is ample evidence indicating that numerous programs to support SMEs were established in the 1980s and have accelerated since the 2000s, especially by the Ministry of Commerce, Industry, and Energy (MOCIE). Moreover, revitalizing SME-based entrepreneurship and SME innovation policies, as expressed in various regional innovation programs, occurred in the context of balanced national development and decentralization that aimed to delegate power to the regional government during the 2000s (Park and Koo 2013; Lee 2009; Hassink 2001). These initiatives, however, as I will demonstrate, have actually hindered the development of SME-based entrepreneurship. The following section will discuss the limitations of the state-led development legacy in which a similar pattern of state support has thrived in the quest for innovation economy in the past decade. I will first discuss the dynamics of these state initiatives and then use a detailed study of the Gyeonggi province's programs to illustrate the problems.

SME policy prior to the 1997 financial crisis

In the early 1980s, the government instituted a series of measures designed to curb the overdominance of the *chaebols* and the imbalanced development resulting from the heavy industrialization drive. Policies favoring the growth of SMEs

can be summed up in two areas: preferential financing for SMEs and the promotion of technology-driven sectors through systemization of the subcontracting program between assemblers and suppliers (Lim 1998). These measures aimed at revitalizing and strengthening SMEs, especially the suppliers of components to larger firms, but had mixed results. One might expect that the state might rely on the same mechanisms that led to their earlier success supporting the rise of the *chaebol*. Indeed, preferential financing programs helped chosen SMEs grow into mini-*chaebols*, instead of developing a vibrant parts sector as a whole. Second, the systemization of the subcontracting program, instead of helping the parts makers to develop, further locked them into overdependence on a single assembler and created vulnerability (Hsieh 2011).

In essence, the Korean path to technology learning and industrial development prior to the 1997 financial crisis was associated with policies of picking national champions where firm-specific policies (in the context of the nexus of the Korean state and large *chaebols*) prevailed. The legacies of past development strategies led to the underdevelopment of entrepreneurship and technological capabilities of Korean SMEs in several ways. First, state intervention tended to further concentrate production. Second, it emphasized volume and the assembly of finished goods, which broadly advantaged the *chaebol* over SMEs. Third, the approach of picking winners and providing firm-specific support policies undermined potential inter-firm collaborations, making SMEs prioritize the development of a vertical relationship with the state or with *chaebol* over horizontal cooperation with other SMEs. These factors largely explain the ambivalent outcomes of 1980s-era policies in developing the parts sector and cultivating SME-based entrepreneurship.

Post-1998 cluster-based SME policy

Since the early 2000s, Korea has aimed to respond to rapid global changes and to move away from investment-driven industrial policies and to diffusion-oriented and capability-building innovation ones by tapping into the idea of regional innovation systems. In light of the successful transformation of regions such as Silicon Valley, Baden-Württemberg in Germany, and Emilia Romagna in Italy to withstand global competition since the 1980s, many regions in advanced countries have set up science parks and innovative supporting agencies (Saxenian 1994; Herrigel 1996; Powell 1990; Lazerson 1995; Piore and Sabel 1984), instituting a cluster-oriented development agenda that aims to build connections among firms in the same geographic location. Clusters and networks are important for innovation on the basis of the assumption that social networking helps to transmit knowledge and information and is thus conducive to generating new ideas. Therefore, networks of social relations embedded in a geographical region are believed to be conducive to innovation, as geographical proximity tends to encourage face-to-face interaction, which strengthens inter-firm relationships and favors information exchange, learning, and knowledge production, the key to sustaining future economic growth and development (Saxenian and

Hsu 2001; Powell, Koput, and Smith-Doerr 1996; Smith-Doerr and Powell 2005; Castilla et al. 2000). Based on this idea, Korea has pushed for networking and the diffusion of ideas, as manifested in regional innovation clustering initiatives. Moreover, the clustering initiatives also involve connecting the private firms with research intensive agencies such as government research institutes (GRIs) and universities to generate value added in a more decentralized setting in the quest to a knowledge economy.

To realize the goal of balanced national development, regional innovation initiatives such as clustering polices were the new direction for regional development in Korea under Roh's administration (2003–2008) that strove to move beyond the prior dirigiste development approach and devolve powers onto regions. Hence, building industrial innovation clusters has been a dominant narrative in Korea over the last decade. For instance, existing industrial complex programs[1] (which focused mainly on production functions) were transferred to regional innovation clusters that were intended to construct an ecosystem with linkages among firms, universities, and GRIs that would be conducive to innovation.[2] The number of nationally designated industrial clusters has moved from the initiative stage of seven designated pilot innovative clusters in 2005 to 12 national designated complexes in 2007 to subsequently over 193 regional industrial complexes since 2010, under the industrial innovation cluster programs (ICCP) (Lee 2009; MKE and KICOX 2011, 9). The programs were further expanded to various types of hub and spoke clusters (referring to the ways in which different clusters are connected) and mini-clusters within the industrial complex from 2010, during the Lee administration (2008–2013).[3] Over 36,000 companies were chosen in the cluster programs by 2011 (MKE and KICOX 2011). In addition to the nationally devised regional innovation clustering programs, the regional strategic industries program encouraged and supported all 13 provincial regions for each region to select and promote its own strategic industries by establishing techno parks and specialized R&D zones (Kim, Lee, and Hwang 2014; Lee 2012).

In addition to MOCIE's clustering polices, the Ministry of Science and Technology (MOST) promoted research activities and boosted innovation and technology learning by constructing numerous R&D clusters. For example, chosen firms were granted R&D subsidies (on average one billion won) to set up research labs to collaborate with local universities and another four billion won for research projects every year. Consequently, the R&D clusters flourished; the number of recipient institutions went from 41 institutions covering six technology areas in 2004 to 103 institutions in 13 technology areas in 2007 (Lee 2012, 161).

All in all, as one interviewee put it, "clusters are booming business in Korea" (interview Park2, GSBC 2012). So, is Korea becoming a networked/clustered nation? Despite efforts to build bottom-up innovation clusters that were needed for the rapid innovation quest, the Korean experience suggests mixed outcomes for the initiatives. The reality is that Korean clusters do not necessarily generate the positive outcomes envisioned by the agglomeration theorists, nor are they a panacea to boosting national competitiveness and innovation capacities.

The various innovation clustering initiatives by the Korean local and national governments ended up creating clusters that have no synergy effect. In the following, I will draw on existing research and my own research on the case study of Gyeonggi Province's regional innovation programs to illustrate the inherent problems.

Limits of state-led regional innovation initiatives: generating homogenous institutions across regions

To start with, these so-called regional initiatives actually consist of nationally devised and implemented policies. Despite emphasis on decentralization in the SME-oriented innovation policy, programs such as techno parks and research consortiums remained strongly national, as provinces had only the role of co-financing the initiatives created by the central government (Hassink 2004). Instead of empowering regions, these initiatives generated homogenous institutions that did not respond to local demands. For instance, the nationally designated techno parks were too homogenous in terms of their aims and targeted groups instead of linking well to the endogenous characteristics of the regions where they were situated (Hassink 2001, 1388). In other cases, over 20 regional bio-clusters were designated by MOCIE as a result of the bio-industry promotion policy, but most were for low-tech and low value-added regional agricultural and marine products (Lee 2009, 363). A researcher involved in evaluating clustering projects remarked, "I think that the regional clustering program was not so successful because I think we selected too many clusters. In order to succeed, you know the economies of scale are very critical" (Interview B Lee 2012). Another interviewee's remark also captures the problem: "The regional initiatives actually replicated mini national bureaucracies across all provinces but they lacked appropriate manpower to execute the programs. As a result, resources were dissipated" (Interview Jung 2015).

The immediate consequences of these nationally devised regional policies actually generated competition among these actors (i.e., regional governments) to seek more power and resources from the central government, which "resulted in a glut of institutions," as Lee describes it (2009, 362). The experience of Gyeonggi Province's regional innovation programs is a case in point. Gyeonggi Province is considered to have the densest innovation support infrastructure of all the provinces in Korea. It holds high R&D potential in various statistical measures, in terms of number of R&D workers, number of jobs in the high technology sector, and numerous independent, innovative SMEs in the electronics and machinery sectors (Hassink 2004, 163). As a strong manufacturing base, Gyeonggi Province has the largest Science and Technology (S&T) budget among all Korean provinces (Chung 1999). Yet, a lion's share of the budget was devoted to co-financing these nationally devised clustering initiatives (Hassink 2004) or generating policies that ran parallel to the national programs. For instance, the province set up its own intermediary agencies, such as the GSBC (Gyeonggi Small and Medium Business Center) and the Gyeonggi Institute of Science and Technology Promotion (GSTEP) to work with SMEs in high-tech sectors. The services consisted of varieties of small business incubation, start-up programs, and R&D support to promote technology and innovation in Gyeonggi Province (Interview info).

When the programs are examined in detail, however, the regional initiatives of Gyeonggi Province share similarities to their equivalent national counterparts, such as SBC (Small and Medium Business Corporation), SMBA (Small and Medium Business Administration), and STEPI (Science and Technology Policy Institute), the national agencies that assist SMEs and promote science and technological development. For instance, as stated on the GSTEP website, one of its primary orientations is to support industrial cluster innovation programs in Gyeonggi Province.[4] It aims to strengthen cooperation among industries, academia, and research industries within strategically targeted industries, and it developed 14 IICC (Industry Innovation Cluster Committees) operating institutions within Gyeonggi Province (Interview W Lee 2012). In many ways, these programs were parallel to aspects of the national Industrial Complex Cluster Program (ICCP), such as the hub and spoke and mini-clusters.

The GSBC, established in 1996, promotes business start-ups, provides technology and marketing support to individual firms that connect SMEs with international buyers and organizes trade delegations and trade fairs. Interviews with the relevant personnel at GSBC and SBC and studying their official documents suggest that GSBC, SBC, and SMBA (the latter two have branches in Gyeonggi Province) provide similar support programs to SMEs in Gyeonggi Province.

In addition to generating an excessive number of institutions, there is a lack of inter-organizational coordination and exchange among these regional cluster initiatives, which contradicts the idea that regional clustering would encourage the kind of coordination and information exchange seen in the European experience (Hassink 2004). On a visit I made to SBC Gyeonggi Branch, which is located in the same complex as GSBC, when I asked the interviewees at SBC Gyeonggi Branch about their relationship with GSBC and the services they provided, an interviewee replied, "Actually we do not have much relationship with GSBC. Because it's a regional government performance organization, and we are the national government performance organization, ..." The interviewee further acknowledged that GSBC and SBC are competing organizations (Interviewee SBC 2012). Another interviewee at GSBC (a policy analyst) raised the question of an ongoing debate about whether SBC or GSBC should be the medium for the clustering programs (Interview GSBC 2012c).

Not only did supporting institutions not interact with each other, my interviews with and visits to various Gyeonggi Province clustering support agencies, such as GSBC and the well-regarded Pangyo Techno Valley initiative,[5] revealed that many synergies have been realized despite the amount of resources that have been invested. Pangyo Techno Valley is considered one of the most successful cluster initiatives among them all, for the revenue the firms located inside the techno park generated exceeds 70 trillion won (about $60 billion US) annually. This amount accounts for over 20 percent of the annual gross domestic product

(GDP) of the Gyeonggi Province, the largest Korean province, and is equivalent to the GDP of Busan Region (interview Pangyo 2015; *Korean Herald*, 2016/04/07).[6] Even with such a stellar performance, policy-makers acknowledged that there seemed to be little networking among firms (Interviews GSBC 2012c; W Lee 2012; Pangyo Valley 2012; 2015; GSTEP 2015). There are factors independent of clustering initiatives that may have resulted in the rapid growth of Pangyo Techno Valley; they include its close geographical proximity to Metropolitan Seoul, which attracts Korean conglomerates and multinationals (MNCs) (Interview Jung 2015).

Most interviewees acknowledged that varieties of clustering programs did not generate the kind of networking and synergies that policy-makers had envisioned. Firms located inside these innovation clusters and in GSBC incubation programs did not interact very much, contrary to what the initiatives and theories had predicted. The remark from a GSBC interviewee illustrates the reasons behind the lack of interaction in the clustering initiatives and the dilemma they faced:

> Firms come to the industrial cluster to take advantage of government incentives as opposed to working with each other. The government induces companies to form clusters with supporting money and research funds.... The real question here is whether the government should be the one constructing clusters.
>
> (Interview GSBC 2012c)

In short, despite the attempts to develop bottom-up innovation initiatives, the Korean innovation system remains national in its characteristics. For one, the top-down approach has generated homogenous and excessive innovation support agencies that provide services that do not respond to regional demands. At the same time, most provinces remain dependent on the financial support of the national government to manage these programs, and lack the capacity to coordinate either these national initiatives or the local and regional initiatives. Second, the top-down regional innovation initiatives create horizontal coordination problems. For the provinces that have more manpower and resources, such as Gyeonggi province, the regional support agencies actually overlap with the support infrastructure of the national agencies, such as SMBA and SBC. Thus, support programs are fragmented and often redundant as opposed to being complementary. The case study of Gyeonggi province's SME supporting programs illustrates inter-agency and inter-firm competition instead of cooperation. Third, the specific scheme of R&D subsidies and incentives created by the government induces firms to come to the clusters to take advantage of government perks but not to do networking. Horizontal coordination and collaboration among firms remain far from being realized. Consequently, the state-led regional innovation policies have led to rent-seeking instead of innovation-seeking behavior on the part of agencies and firms and to competition among regions and firms to receive endorsement and support.

Constructing ties with university, industry, and public research institutes

The varieties of regional innovation cluster programs connect the private sector, especially the SMEs, with research-oriented actors, such as universities and GRIs, for R&D. The emphasis on regional universities and GRIs for local R&D can be distinguished from the past industrial complex program that mainly served to house manufacturers and suppliers in a geographical compound. Most interviewees involved in clustering evaluation and planning concurred that Korean cluster programs are about connecting universities with *individual firms* (emphasis added, Interview KOSBI 2012): "The main mission of techno parks is to provide some kind of linkages between R&D experts and SMEs" (Interview B Lee 2012) and "They have universities focusing on technology development in the clusters" (Interview GSBC2 2012).

The Korean vision of connecting different actors is about developing customized support by bridging individual SMEs with different resources they can tap into to succeed in the global market. Various supporting programs under the Creative Economies Project of the current Park administration illustrate this kind of customized winner takes all support.[7] For example, *Business Korea* reports the extensive supports received by a marine bio company that succeeded in breaking into the US market:

> This company built a factory with a cloud fund of 80 million won from 43 investors after it developed cosmetic products using fishery byproducts with support from the Jeonnam Creative Economy Center. Marine Techno Co. is now receiving various support including small and medium innovation, laws, financial consulting and other professional areas beyond simple funding from the Creative Economy Center.
>
> (*Business Korea*, May 3, 2016)[8]

In a site visit to Pangyo Creative Economy Center, similar kinds of support were mentioned as being offered to chosen start-ups (interview Pangyo 2015).[9]

In addition to the integrated and comprehensive one-stop support programs by Creative Economy Innovation Centers, different government agencies, at both the national and regional levels, offer similar most-promising innovative SME program awards to individual SMEs, such as SMBA's global hidden champion programs, KICOX's global leading companies program, and regional programs such as GSBC's entrepreneurial incubation programs (Interview GSBC Park 2012). To give a few examples: The global leading companies program by the Korean Industrial Complex Corporation (KICOX), the national agency in overseeing innovation cluster programs, aspires to take all measures to help the selected promising firms (as poster children of KICOX) to become global leading firms.[10] According to the news release by KICOX, the winners will receive customized growth support in overall business activities from building factories to overseas expansion, including industrial complex location support and personal

company doctor consulting, to a collective company growth support platform project operated by KICOX with an exclusive platform manager and any other support and services the companies might need that were not included in the program. Catering to the program will be as exhaustive as possible with the help of networks of related organizations. Moreover, the selected companies will receive All-In-One financial support services from financial institutions (i.e., Shin-A Bank), including prime interest loans and support for technological evaluation fees, direct investment, and overseas expansion.[11]

At the regional level, close scrutiny of the aforementioned mini-cluster programs, in which innovation clusters are organized through the alliances of industry (consisting of large firms and SMEs), universities, and research institutions according to the specific industry or technology field, also reveals limited impacts of constructing cross-cutting ties, despite their acclaimed success compared with all other clustering initiatives. For instance, the GSTEP interviewee pointed out that the mini-cluster for an intelligent electronics device (a robotic cleaning machine) seemed to work well compared with other mini-clusters, but he also acknowledged that it was a privately initiated cluster (Interview W Lee 2012). Another success story of a mini-cluster is an electronic/intelligent rice cooker that has already gained a foothold in the international market (Interview W Lee 2012). But the growth of these two cases was merely captured by an individual firm in the industry and did not cascade to other firms.

Other government R&D clustering and support programs show similar findings regarding the building capability of individual firms rather than any development of collaboration and diffusion. The current progress concurs with a previous study that revealed a fragmented consortium structure as Korean firms hesitated to cooperate with one another (Sakakibara and Cho 2002, 656) despite continued efforts from the government to foster innovation programs by connecting the private sector with GRIs and universities. The earlier research findings suggest that 78 out of 190 consortiums had two participants; also, many companies were included, as universities and national research institutes count as consortium participants (ibid., 685). Evaluating the programs after a decade-long effort of decentralization and constructing cross-cutting ties among different actors, my research findings suggest that these clusters and R&D cluster programs have continued to generate "infrastructure" support for individual firms as opposed to creating a "system" that supports a network of firms. For instance, in evaluating the R&D clustering programs, most interviewees acknowledged not having witnessed a substantial synergy effect as of 2015. They noted difficulties in getting people together to form a research consortium (Interview W Lee 2012). In particular, consortiums led by universities were not successful, in spite of what the plan had predicted.

As comprehensive and ambitious as these support programs are for nurturing world-class Korean SMEs, these measures are most likely to be successful in growing individual firms, without any spillover effects. An interviewee who was involved in evaluating innovative SME applications pointed to the inherent problems of the initiatives:

> Firms are more interested in getting the government resources to solve their own problems as opposed to working with each other in an R&D consortium. Collaboration is that not good; they compete to work with public research institutes in order to get R&D subsidies and solve their own problems.
>
> (Interview Song 2012)

In fact, of all the regional innovation initiatives, most interviewees thought that the program that worked best was the techno doctor program for solving the specific problems of individual firms (Interviews, B Lee 2012; GSBC Park 2012; Oh 2012). For instance, the GSBC connected individual experts, either retired engineers or researchers with individual firms, to help solve problems (Interview GSBC Park 2012).

To sum up: to date, research suggests that the Korean regional innovation initiatives generate customized capability building programs for individual chosen firms. They do not, however, generate the kind of institutional embeddedness and thickness that the network and agglomeration literature has emphasized. The clusters often lack interconnected companies and associated institutions. The Korean initiatives provide the hardware, but the software to run the system is missing. Nor have there been coherent visions on what the software should be.[12] Second, the notion of growing world-class individual firms, instead of a network of firms with collaboration among them, has continued to prevail in Korea's quest for an innovation economy. Thus, innovation clusters in the Korean context are about competition to be the chosen one as opposed to generating inter-firm cooperation and spillover effects. In what follows, I will discuss the Taiwanese experience so as to substantiate my argument with an alternative view of SME-based innovation and network relations.

The quest for innovation and export diversification: Taiwan as a comparison case[13]

The distinctive feature of Taiwan's post-war export-led development is decentralized industrialization: First, the SME-based production system encompasses an extensive division of labor, in which firms complement each other in the production process. They cluster in geographical locales. Extensive subcontracting is also exercised within the parts sector. The various components within a part are subcontracted to small factories that specialize in manufacturing that particular part. Second, the SME production network consists of numerous independent parts makers and processing specialists that focus on intermediate inputs and do not make the final product. Third, production networks are decentralized, in that they are open and non-dependent networks in which suppliers and specialist firms are usually not tied to particular assemblers or suppliers; they can supply to several firms within the industry or sell to other industries. Lastly, what distinguishes Taiwan's SMEs from their counterparts in other countries, such as Japan, the United States, France, and Korea (see Chapter 4), is that

Taiwan's SMEs are in charge of export activities. In particular, parts makers and specialist firms actively participate in the global production network as independent specialist subcontractors and compete directly in the world market, rather than being completely dependent on domestic assemblers.

One direct consequence of such decentralized industrialization is that inter-industry linkages are high. The ability of the Taiwanese parts makers to engage directly in the export market and connect to different production networks means having access to novel information flows by connecting to different clusters. An immediate outcome of the free flow of information among industries permits the parts sector to pursue improvement and innovations at the intermediate input level, which can be applied to many situations, instead of at the stage of the end product. In turn, cross-industry learning often leads to adaptation of new materials and new manufacturing technologies through recombination of ideas. Therefore, cross-industry linkages and the organizational principles of the SME network production system provide a strong basis of learning and innovation in Taiwanese SMEs' transition to higher value-added production.

While the dominant understanding of Taiwan's industrial ascent has focused on the success of the information technology sector (IT), various industries in Taiwan's machinery sector, mostly SMEs, have also continued to move up the value chain and be strong exporters in the global market. Clusters continued to thrive in Taiwan in addition to internationalization of production, contrary to the predicted "hollowing out" of SME-based industries (Hsieh 2014). In what follows, I will present examples of how the SME-network system has continued to have an impact on the state-industry linkages in Taiwan's quest for innovation. The rise of Taiwan's metal and machinery sector involves an unacknowledged but widely practiced model of loosely coupled Taiwanese para-state agencies coordinating with a series of SMEs to establish the quality and technical capacities needed to succeed in the global market. Attention is focused on the para-state institutions that serve as the institutionalized linkages between the state and the system of SMEs, including various industry-specific R&D centers and the Metal Industries Research Development Center (MIRDC).

To start: Industry-specific R&D centers that work with the parts sector have been crucial in sustaining the technological capabilities of these parts makers. Having access to industry-specific R&D centers in Taiwan means that SMEs, especially parts makers, can tap into the external economies provided by these public research agencies in areas where an individual SME is unlikely to be able to function effectively on its own. Instead of focusing on capability building of individual SMEs, these collective problem-solving services, such as testing and standards compliance, alleviate the burdens of SMEs by reducing entry barriers for export and R&D. For instance, industry-specific R&D centers have been instrumental in building internationally accredited testing facilities in the machinery sector. In the case of the auto-parts industry, to be accepted as AM suppliers, they need to pass the testing requirement for entering the EU and US markets. In other cases, changes in EU regulations and EU industrial standards have affected the manufacturing methods of machine tools and components.

Yet an individual SME is not likely to meet these requirements on its own. The supporting industry R&D centers disseminate information on changing regulations in the export markets and the respective implications for changes in manufacturing and possible solutions. Moreover, testing facilities have been important for product development for SMEs and for troubleshooting (Interviews ARTC2013; PMC 2011; MIRDC 2013; MPF 2013; BRL 2011). The result is export diversification by SMEs in the machinery and transportation sectors. For instance, in the past decade, about half the total exports went to the top five destinations in the aggregated transportation industries, while over one-third of the total exports went to destinations outside the top 10 countries. In the machinery sector, over 50 percent of the total export value went to countries outside the top 10 export destinations, while the top five export destinations received less than 50 percent of the total exports (Hsieh 2014).

These public institutions are crucial for sustaining SME production networks. They coordinate the decentralized networks by developing the supply chains and matching different production networks. Their technology extension services focus on the development aspect of R&D: enhancing local spillover effects, integration, and developing technical capabilities of the entire supply chain as opposed to growing the capabilities of individual firms or transferring crucial technology to individual chosen firms, as discussed in the Korean experience. For instance, Taiwan used to be the number one exporter of fasteners, with SME-based industry clustered in southern Taiwan. Despite losing advantages to other lower wage countries, the cluster has survived and many companies have moved from low-end standardized fasteners for construction to a higher grade for auto parts suppliers and the aerospace industry. The transition involves working with the whole supply chain for fasteners and tapping into the decentralized network for collective upgrading. The MIRDC was crucial in coordinating the upgrading process by introducing new technologies and working with machine tool firms and the fastener parts makers to develop the required equipment for the new precision manufacturing technology. In turn, the technology could be widely extended as the equipment can be built domestically. The upgrading has cascaded not just within the fastener manufacturers but to a wide range of auxiliary specialists and equipment manufacturers (Hsieh 2014).

Public technology support agencies also play an orchestrating role in bridging different networks and resources. In the context of a decentralized industrial structure, technology adaptation and breakthroughs often occur at the level of intermediate input (meaning the parts sector) and work upward and downward along the supply chain to create backward linkages. Here, the public technology support agencies connect SMEs from different production networks and facilitate the cross-industry fertilization in which innovations and breakthroughs occur through recombination of existing means. This is in direct contrast to the Korean experience where the state connects varieties of agencies and resources to individual firms. For instance, with the emergence of electronic applications on auto components, an increasing number of IT component makers are entering the field of automobile components by collaborating with auto parts makers.

Here, the Automotive Industry Research and Testing Center (ARTC) connected firms in the IT industry with auto parts component makers to pursue and orchestrate the development of such applications (Interview ARTC 2013).

In short, these initiatives, while not consuming large R&D expenditures, have been successful in sustaining clusters, building technological capacities, alleviating SMEs' R&D burden, and averting risks. As the Taiwan experience illustrates, public support institutions are connected to the decentralized industrial system by addressing collective needs and helping parts makers insert themselves into global production networks and succeed in the global market. This includes efforts to sustain networks that are neither conventionally acknowledged nor understood: encouraging skill formation; introducing new manufacturing technologies and disseminating information, thus lowering the entry barriers for SMEs; and matching different production chains for recombining ideas to construct cross-sectoral ties. These partnerships between the lower-rank R&D centers and SMEs affect the subsequent form of technological learning in the SMEs where each actor (including state agencies) is connected in multiple directions. There, the actors' concerns have been to develop industries that will tap into external economies, as opposed to facilitating growth of individual firms. By not picking winners, these initiatives have preserved horizontal inter-firm collaborations, encouraged inter-sector exchange, and recombined resources among different networks, which is conducive to innovation and technology diffusion, as can be seen in the industrial upgrading experience of the machinery sector.

Conclusions

The comparison between the Korean and Taiwanese experiences demonstrates two approaches to industrial transformation with completely different notions of clustering and ways of constructing cross-cutting ties in facilitating innovation. Despite emphasis on demand-responsive policies with numerous nationally devised regional clustering initiatives in Korea, the empirical case studies presented suggest a firm-growth approach has continued to prevail by connecting individual firms to varieties of support agencies so that they will grow and compete globally. The incentive instrument has continued to rely on financial subsidies to individual chosen firms (in the form of R&D subsidies and grants) to promote R&D activities. Korean state-led decentralized innovation policies, rather than breeding entrepreneurships and the diffusion of ideas, generate bureaucratic sprawl and intensify competition among firms. This winner-picking approach to clustering actually undermines potential collaboration and networking among firms, contrary to the expectations of theorists and practitioners regarding such clusters. Learning remains inside the firms. This finding reaffirms the argument that characterizes Korea's high technology development as development without inter-firm networking (Sohn and Kenney 2007).

On the other hand, the Taiwanese case demonstrates more horizontal and decentralized connections among firms and between firms and public research

institutes, where each actor is connected in multiple directions. Learning takes place not only within the firm but also by working with other networks of firms. The lessons that can be learned from the Taiwanese SMEs call attention to an alternative path to network-based innovation for latecomers. The specific ways in which the Taiwanese state has connected with the decentralized industrial system have helped to preserve horizontal collaboration among firms and to form a broad-based entrepreneurship in the upgrading quest. This was done through varieties of lower-ranked industrial R&D centers and public research institutes that build external economies, solve collective problems, and extend technology to develop local supply chains to ensure cross-industry spillover effects.

In line with the analysis, my hunch is that the Korean model will grow individual leading national and global champions, whereas the Taiwanese path will grow groups of hidden champions that complement each other in climbing up the global value chains. To succeed in the next stage of the innovation quest, the question that concerns the Korean model will continue to be how to identify best-practice SMEs and an ecosystem that could nurture individual promising actors regardless of the national or regional support systems. The question that dominates the Taiwanese model will continue to be how to sustain the territorial-rooted clusters and nourish a system that comprises a network of firms complementing each other and tapping into external economies in the face of internationalization.

Notes

1 For a review of the old industrial complex/cluster program, see Lee (2001).
2 The MOCIE (Ministry of Commerce, Industry, and Energy) was responsible for regional innovation initiatives during Roh's administration. Subsequently, a large part of MOCIE became the Ministry of Knowledge Economy (MKE) during Lee's administration (2008–2013).
3 A mini-cluster is the industry-academia-research labs alliance composed according to an industry/technical field that aims to develop mutual cooperation, joint-learning, and sharing of information continuously among innovative agents in the region, including companies (both large firms and SMEs, universities, research institutes, and support institutions) (MKE and KICOX 2011, 12).
4 For detailed information on the goals of GSTEP, see the organization's website at www.gstep.re.kr/eng/html/research/gstep_business_02.asp.
5 Pangyo Techno Valley claims to have become Korea's Silicon Valley, aiming to attract global companies and local innovative companies in IT and biotech industries and to encourage start-ups. GSTEP oversees the project. See the Pangyo website for further details: www.pangyotechnovalley.org/eng/html/introduce/index.asp.
6 Kim Young-won, "Shaping Korean start-up scene: Gyeonggi science technology center serves as bridge between start-ups and tech heavyweights," *The Korean Herald*, April 7, 2016, www.koreaherald.com/view.php?ud=20160407000692. Accessed October 14, 2016.
7 Simon Mundy, "South Korea aims for creative economy to end reliance on *chaebol*: Government rolls out funding and infrastructure to aid start-ups and revitalize SME sector," *Financial Times*, June 24, 2015, www.ft.com/content/9203e38c-0dab-11e5-9a65-00144feabdc0. Accessed April 6, 2016.

8 Huh Sung-soo, "Creative Economy: New Paradigm of Economic Policy Creates Visible Results Centered on Creative Innovation Centers," *Business Korea*, May 3, 2016, www.businesskorea.co.kr/english/features/cover-stories/14582-creative-economy-new-paradigm-economic-policy-creates-visible-results. Accessed October 12, 2016.

9 A total of 18 creative economy and innovation centers (창조경제혁신센터) were created in which central and local governments work in conjunction with *chaebols* to create an ecosystem to nurture and support the expansion of SMEs across regions, with particular emphasis on start-ups. Each *chaebol* is assigned to an innovation center according to its expertise. For a brief summary of the program, see Choi Yang-hee, "Creative Economy: springboard for Korea's leap forward," *Korea Times*, September 29, 2015, www.koreatimes.co.kr/www/news/biz/2015/09/123_187696.html. Accessed April 6, 2016.

10 Lee Song-hoon, "Driving Creative Economy: KICOX Pledges to Make Korean Industry Base of Creative Economy," *Business Korea*, January 6, 2016, www.businesskorea.co.kr/english/news/industry/13473-driving-creative-economy-kicox-pledges-make-korean-industry-base-creative. Accessed October 13, 2016.

11 The news was posted by one of the companies selected in 2014, Dunhwa Entec Co., a manufacturer of heat-exchanger for the marine, petro-chemical, and power generation industry, as an indication for their technology prowess. www.dh.co.kr/English/pr/news01.asp?act=view&encData=skey%E3%80%8D%E3%80%8Csstr%E3%80%8D%E3%80%8Ccate%E3%80%8D%E3%80%8Cpage%E3%80%8D1%E3%80%8Cidx%E3%80%8D3689.

12 The question of what the software should be is often raised in the agency's self-evaluation. See Yim et al. (2010).

13 The following section develops from Hsieh (2014).

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6 College major and female labor supply

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There is little doubt that the male-centric nature of Korean society and corporate culture contributes to the strategic and operational shortcomings of the *chaebol* and SMEs alike, as described by the first five chapters of this volume. A male-centric culture is deeply rooted in Korean society, as shown by various measures such as the sex ratio imbalance at birth through the 1990s, rigid gender roles, and low female representation in leadership positions. According to World Values Survey data, from 2010 to 2014, 54.1 percent of Koreans agreed that "when jobs are scarce, men should have more right to a job than women," compared with 7.6 percent of Americans.[1] In regard to leadership positions, 41.3 percent of Koreans agreed that "on the whole, men make better business executives than woman do," compared with 11.6 percent of Americans.[2] This perception of gender roles might be reflected in the low percentage of females in leadership positions. For example, only 13 out of 1,787 firms listed on the Korean stock exchange have female CEOs (0.7 percent, CEO Score 2013). Relatedly, only 15.7 percent of parliamentarians are female, placing Korea the sixth lowest among OECD countries (OECD 2013).[3]

Although there is evidence that such gender stereotypes are receding in the Korean mindset (see Chapter 1), they continue to be major obstacles for women to remain in the workplace, let alone rise up the professional ladder.[4] In Korea, the female labor market participation rate was only 55.6 percent in 2013, making it one of the bottom five OECD countries (OECD 2016). As described in Panel A of Figure 6.1, the female labor market participation rate in Korea has increased over the past years, except for 1998, when the Asian financial crisis hit the economy, and 2008, when the 2008 economic downturn starting in the USA affected the economic conditions. Korea, however, still shows a sizable deficit of female labor market participants relative to other OECD countries. In Panel B of Figure 6.1, we plot the fraction of female employees among the working-age female population, as an alternative measure of female representation in the labor market, which shows a consistently lower level than the OECD average between 1990 and 2013. Furthermore, Korea was ranked the worst among OECD countries in 2015 in terms of the glass-ceiling index for women and work (see *The Economist* 2016). The under-representation of women in the labor force is concerning particularly because women's educational attainment had