The Routledge Companion to Innovation Management

Jin Chen, Alexander Brem, Eric Viardot, Poh Kam Wong

Perspectives on policies to promote convergence in innovation

Publication details
https://test.routledgehandbooks.com/doi/10.4324/9781315276670-15
Kong-rae Lee
Published online on: 26 Feb 2019

15

PERSPECTIVES ON POLICIES TO PROMOTE CONVERGENCE IN INNOVATION

Kong-rae Lee

Introduction

We have seen a myriad of new innovations, including smart cars, drones, 3D printing, smart phones, nanoparticles, Internet of Things (IoT), and biomaterials, emerging almost daily. People are surprised at the amazing functions of smart phones but they alternatively feel confused about the new jargon surrounding all the new technologies and functions. The Schumpeterian prediction (1976) that innovations will routinely emerge as a result of mass R&D activities undertaken in large organizations is now socially recognized in the modern industrial world.

Indeed, almost every class of business entity, including small venture firms, individual entrepreneurs, and medium and large firms, routinely innovates by applying their particular knowledge bases. As we have entered into the twenty-first century, this accelerating trend of innovation promises to continue to shake up and restructure the global economy with both negative and positive outcomes for individuals, business firms and other knowledge-creating organizations such as research institutes and universities.

Some scholars have begun to call this new innovation trajectory the fourth industrial revolution, with the first being water- and steam-powered mechanization, the second electricity-based mass production, and the third the industrial revolution centered on information and electronics technologies. The World Economic Forum (WEF) held in January 2016 in Davos, Switzerland, took *the Fourth Industrial Revolution* as the key discussion agenda. Whereas the third industrial revolution was characterized as the digitalization of the global world via information, communication and telecommunications technology, the fourth industrial revolution is characterized by a convergence of diverse technologies, creating new categories of products such as smart cars, drones, 3D printing, nano-bio and new generations of smarter phones.

The impact of the fourth industrial revolution on the economy and society is expected to be far greater than that of the third industrial revolution in terms of speed and scope. Some people are even scared of changes driven by such a revolution as they foresee negative impacts like job losses and widening disparity of income distribution, whereas many optimists insist that such changes will create plenty of leisure time, thereby enhancing human welfare and convenience.

Technological innovation has been traditionally featured as having a variety of characteristics, from simple learning through imitation to complex interactive learning for more advanced technologies. Modern innovations have had a strong tendency towards convergence, in which

information and communication technology (ICT) plays a central role across vast areas of industries, creating a bewildering variety of new products and services. Going beyond ICT, other technologies are also converging or being converged at varying degrees of speed and depth of integration, routinely generating new intellectual property rights issues.

The phenomenon of convergence in innovation is likely to further deepen and widen in the future due to an intense competition among firms in global markets. This applies especially to manufacturing firms in the East and Southeast Asian countries, which have been active in convergence innovation. They are in some respects leading the new global industrial revolution and bringing a center of world economic activities. In this trend, national and regional governments need to be highly keen on responding to the convergence phenomenon. They need various perspectives on policy making to promote convergence.

This chapter briefly summarizes past studies on the principles of convergence in innovation in the second section. In the next few sections, the chapter introduces various perspectives on policy making that promote convergence. The third section presents some policy perspectives at the micro level, including process, collective learning and types of converging, and networks and communications as sources of convergence. The fourth section discusses regional-level perspectives on convergence promoting policies such as scope of clustering, city innovation system, collaboration and globalization of R&D. The fifth section presents such country-level perspectives as institutions, culture and human factors.

Past studies on the principles of convergence in innovation

There has been a group of research topics such as how individuals and firms learn and diffuse knowledge as origins of convergence in innovation, how to navigate the processes of convergence and case investigations into industries and countries so as to discover facts or events happening in reality. The results of the past investigations on convergence and their implications can be briefly summarized as follows.

The term 'convergence' indicates that technological convergence can be defined as a horizontal integration of diverse technologies.[1] Horizontal integration means absorption of diverse fields of technological knowledge for the purpose of creating new functions or products, which often broadens the scope of their technological specialization by interacting with user firms.[2] This phenomenon of technological convergence similarly occurred between machinery industries and electronic industries in 1970 and among a variety of industries, including chemicals, foods, machine tools, and pharmaceuticals (Lee, Kong-rae, and Hwang, Jung-tae, 2005).

Technology convergence increasingly appears in the modern innovation scene. The article on "Technological change in the machine tool industry, 1840–1910" by Rosenberg (1963) explains that, at the end of the nineteenth century, all machines confronted a similar collection of technological problems in dealing with such matters as power transmission, control devices, feed mechanisms, friction reduction and a broad array of problems connected with the properties of metals. These problems became common in the production of a wide range of commodities. They seemed apparently unrelated from the perspective of the nature of the final products. The uses, however, of the final products were very closely related on a technological basis. Rosenberg called this phenomenon technological convergence and argued that the intensive degree of specialization that developed in the second half of the nineteenth century owed its existence to a combination of this technological convergence.

Similar to technological convergence, the term 'technological fusion' has been adopted by some innovation scholars (Kodama, 1986, 1994, 1991; Lee, Kong-Rae, 2005, 2007). Kodama (1986) argued that there are two fundamental types of innovation: one is the technological

breakthrough, and the other is technology fusion. According to Kodama, breakthrough innovations are associated with strong leadership in a particular technology, and technology fusion becomes possible through concerted efforts by several different industries. He empirically observed a phenomenon of technology fusion that first occurred between machinery industries and electronic industries in 1970, and later among a variety of industries including chemicals, foods, and pharmaceuticals in 1974.

Recently there has been growing trends of innovation studies on the convergence phenomenon, particularly at the micro level. The processes of convergence begin with individuals so that exploring the processes at the personal level has been of important concern. Lee, Kong-rae (2017b) argues that it starts when a researcher with a cognitive map interacts with another researcher holding another cognitive map. He further states that individuals behave differently in terms of their modes of learning and evolve one after another. Technological learning for convergence has gone beyond the simple mode of learning by doing to the extent of learning by porting via learning by using or learning by integration, producing a synergistic impact on innovation.

In the process of convergence, collective learning can be regarded as an important element for making these processes successful. This is because the interaction between individuals evolves into a collective learning that creates new knowledge and provides a clue for creating an innovation. Under active learning, the applications of a given technology are so diverse that the convergence to create new functions, products or services becomes possible. Managing convergence in innovation is mainly concerned with this collective learning at the firm level (Lee, Kong-rae, 2017b). In particular, large firms are faced with many hardships that have become obstacles in pursuing convergence. To create convergence in innovation, they have to cope with anxiety caused by changes from convergence, objectives and visions for changes, and images that follow changes (Yun, Jong-Yong, and Kim, Changsu, 2017).

To explore the process of convergence, Kim, Euiseok (2014) analyzed the convergence in the innovations of printing and electronic technologies and found that there is a continuous disequilibrium between converging technologies, which are divided into two types: reference technology and matching technology. Two types of converging technologies tend to innovate at differing degrees of speed in such a manner that when one technology (reference technology) is innovated and generates a disequilibrium, the other technology – called matching technology – necessarily innovates to match or adjust an optimal balance between the functions of the two technologies. He stated that the process of tuning involving mutual matching and minute adjustment across disparate technologies to achieve a target performance is one of the most critical attributes in convergence.

As seen in Figure 15.1, Technology A1 and Technology B2 converge to create Technology C1, which is a new innovation creating new functions, new products or new processes. Technology A can be a reference technology or matching technology to match or adjust an optimal balance between the functions of the two technologies. In that sense, both Technology A and Technology B may have a certain degree of tuning capability in the process of matching or adjusting an optimal balance. Tuning capability may imply technological opportunity to make an innovation of an individual technology or a converged innovation of the two technologies involved.

Multiple past studies have also found out that different types of convergence emerge, depending upon firm-specific learning modes and growth strategies (Kodama, Nakata, and Shibata, 2017; Darr, 2017; Kim, Jang-Hyun, and Lee, 2017). The inside-out type of convergence in innovation arises when firms try to utilize their core competence for exploiting business opportunities in other market areas, while the outside-in type prevails when firms are in a booming period

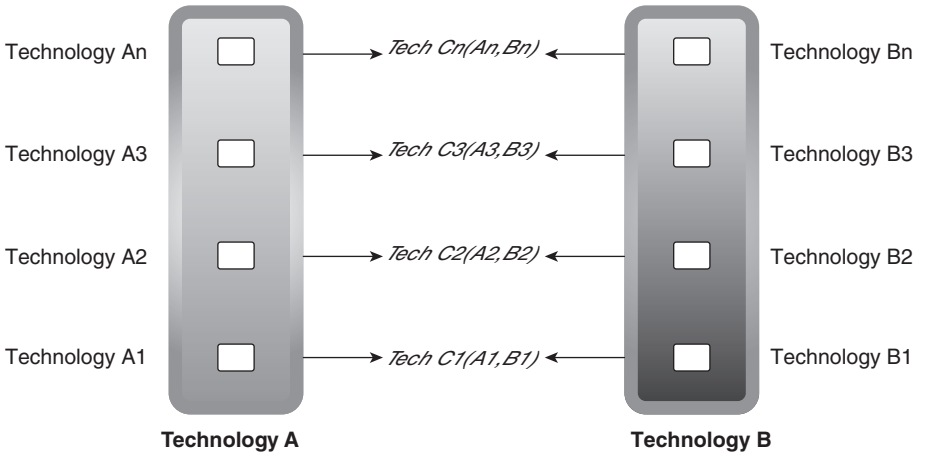

Figure 15.1 Process of convergence between Technology A and Technology B
Source: Lee Kong-rae (2017a)

as they diligently integrate outside technologies into their core competence fields in order to solve their technological problems (Lee, Joseph, and Jeong, 2015).

Regarding sources of convergence, it was argued that networks and communications matter in pursuing convergence since they are likely to be means to diffuse converged knowledge throughout the organizations and societies (Barnett, 2017). He insisted that individuals come up with new innovations through various networks with cognitive processes and communications. Knowledge, information and innovations spread within and between organizations through digital media, such as e-mail and other social network services (SNSs), and are adopted in much the same way as they are from an external source. Networks and communications facilitate and accommodate individual needs, tastes or personal situations, but they also allow dis-adoption due to the dissatisfaction with the innovation or substitution by a newer innovation that better meets the individual's needs or desires, leading to more convergence.

Diversity has also been treated as an important source of convergence in innovation. Steinmueller (2017) stated that diversity is an important enabling factor in navigating convergence in innovation. Diversity presents major steps in creating convergence and often involves generating a space of freedom and opportunities. It is proposed in the context of Asian countries; a transformational change from the legacy of the catching up and competitiveness agenda to the pursuit of diversification has become an important agenda for promoting convergence. In this respect, a strategy of greater diversification remains an option for Asian countries as a response to the risk associated with the current dominance of the catching-up industries and the uneven intersectoral performance.

On the other dimension, a geographic factor in the clustering of firms and professionals appears to be an important element to facilitate convergence in innovation. Wong (2017) found out that a city innovation system matters because it creates a path to convergence. As in the case of Kuala Lumpur and Cyberjaya of Malaysia, a railway company initially assimilated rail technology to attain capability in operation and maintenance (Wong, Chan-Yuan, 2017). As time went by, a group of firms in the railroad industry clustered and learned together, upgrading their level of technology. As a result, convergence in the innovation of companies became evident

throughout the period of the 2000s. The knowledge ties among firms clustering in a large city have considerably enabled the emergence of convergence in innovation.

Lastly, intra-industry convergence appeared to be prevailing in contemporary industrial innovation. It has been intensely arising particularly between science-based firms and scale-intensive firms. According to Lee, Kong-rae, 2017b, the specialized suppliers sector showed the highest degree of intra-industry convergence in innovation, implying that it has been the focal point of convergence, integrating forward and backward industries. From the cross-country comparison among China, Japan, Korea and Taiwan, no major differences in the characteristics of convergence in industrial innovation between countries were discovered, implying that the inherent industrial and technological characteristics may play a critical role in convergence activities, regardless of country-specific features (Lee, Kong-rae, 2017b).

As such, the phenomenon of convergence has been observed in many innovations not only in the twentieth century but also today. That is, the convergence between many user sectors and machining technology explored by Rosenberg (1963) is still going on. It is perceived that convergence is a universal phenomenon happening in all technological fields and industrial areas (Rafols and Meyer, 2006; OECD, 1993; Roco and Bainbridge, 2002).

Micro-level perspectives on policies to promote convergence

Diverse viewpoints are required to explore convergence phenomena in innovation. Policies concerned with convergence are generally directed at promoting scientific and technological activities conducive to convergence in innovation so as to increase economic growth and people's welfare. Policies here indicate innovation policies to encourage convergence in innovation. Policy implications at the micro level can be drawn from such perspectives as process, user–supplier and R&D. These perspectives provide better insights for local and central governments in pursuing convergence in innovation.

Looking into the process in which convergence arises and moves seems to be critical for making the right policies to promote it. Learning, particularly collective learning, is vital in managing the processes of convergence at the organizational level. Firms that pursue convergence require policy tools to make institutions well adapted for effective learning. Training and rewarding talented project leaders capable of managing R&D projects will be critical. They are to be well equipped with knowledge and leadership to manage the processes of convergence in order to deal with conflicts or problems arising from the knowledge gap among research personnel and those from the different stages of the process.

In addition to training and rewarding talented project leaders, firms need to have policy tools to play a gate-keeping function. Building up and maintaining linkages between inside and outside organizations through various search activities, forums, regular seminars and so on is a way of facilitating diverse collective learning such as internalization, externalization, socialization and combination and thus managing convergence processes well (Nonaka, 1994).

On the other hand, the user–supplier relationship is one of the key elements to facilitate convergence. The user–supplier interaction is designed to incorporate diverse users' and suppliers' knowledge into the process of convergence in innovation. It emphasizes the downstream side of the innovation process, like early integration of the users' and suppliers' role at the organizational level. The importance of user–supplier interaction has been much emphasized in innovation studies as a source of successful innovation (Lee, Yun, and Jeong, 2015; Lee, 1998; Lundvall, 1988; Sugiura, 1994). It is likely to become even more important in convergence.

Government and corporate policies intended to promote convergence should seriously take users' ideas and viewpoints in addition to those of suppliers. Government-led projects are usually

ignorant of user-side ideas so that their results are neither innovative nor sufficient to fulfill originally designed purposes. Therefore, the role of lead users and user–supplier interaction should be considered from the very beginning of a policy designing process and be implemented for the purpose of achieving policy targets.

During the process of convergence in innovation, R&D is a good, powerful instrument for targeting specific convergence in innovation. Planning R&D projects with convergence nature or targets is an effective way of making convergence innovation, assuming that it will be followed by actual implementation. Scientists and engineers generally tend to focus on issues of their own disciplines in conducting R&D. Thus, the portion of R&D projects with a convergence nature is likely to be limited if allowed to run autonomously. One way to promote convergence R&D is to intentionally plan for it.

A substantial portion of government R&D projects and programs today have the characteristics of convergence. This is because they have not only an interdisciplinary nature, but also their objectives require convergence of diverse types of knowledge. Social and technological problems to be solved by governments in reality are so complicated and complex that they need the convergence of diverse knowledge, and so do R&D projects. Government officials in charge of R&D planning therefore need to obtain in-depth knowledge on convergence in innovation.

Last but not least are the human factors determining successful convergence. Human factors include training; general education of people; leaders and their leadership; networks; communications; cooperation and conflict resolution between people; and the credibility, creativity and braveness of people to achieve something complex and complicated. In particular, a university education at the graduate school level needs to be emphasized for making policies to encourage convergence. Through proper education, future professionals are to be well harmonized with each other with respect to diversity and with readiness to carry out convergence projects. The previously mentioned qualities of people conducive to convergence should be cultivated in the education system over a long period. Communications and cooperation among people, both at intra- and interorganizational levels, are critically important for convergence, so they need to be culturally encouraged and strengthened. They are also likely to be amicably accelerated by capable leaders and encourage organizational culture.

Regional-level perspectives on policies to promote convergence

Convergence in innovation can be more clearly observed at the regional level. Diverse players in innovation within a specific region can be easily identified, and so can their innovation activities. This means local government may be able to effectively moderate, facilitate, support and intervene in their innovation activities by using even a small scale of resources. In this regard, regional innovation policies are more effective and efficient than national innovation policies. However, regional governments, especially those with a low level of financial self-reliance, hardly overcome problems arising from a lack of manpower and other resources.

As a way to overcome the limitation of resources at the regional level, innovation policies at the city level can be taken into account. Previous research findings reveal that city and sectoral innovation systems matter in encouraging convergence (Wong, 2017; Pavitt, 1984; Tidd, Bssant, and Pavitt, 2001). Wong's research results (2017) provide a policy implication that such knowledge-creating agents as research institutes, corporate R&D centers, universities, etc., should be geographically clustered as much as possible in city regions to overcome a lack of resources.

Past innovation studies with a cluster approach did not clearly show what scope of geographical area needs to be taken into account in locating knowledge-creating organizations. It is

believed that a well-functioning city innovation system effectively creates a path to convergence in innovation. This argument implies that a large city can be a location in clustering them for successful convergence in innovation. This point also needs to be considered when firms globalize their R&D, for instance, sourcing diverse knowledge by locating R&D centers in talented regions.

Collaboration between companies and universities at the city level must be an important element in promoting convergence in innovation. It has been frequently pointed out that both entities are reluctant to collaborate mainly because of cultural differences (Lee, Kong-rae, and Seong, Tae-gyeong, 2009). Companies primarily pursue commercial development and try to achieve relative values of corporate culture, while universities traditionally do early-stage research so as to have a related academic culture. These cultural differences can be overcome by carefully designed policies at the city level. Some universities see their role being extended from teaching and conducting pure research to taking on social challenges and contributing to regional development. Companies also increasingly began to recognize a need to attract the best and brightest talent for meaningful work and social utility (Lutchen, 2018).

Country-level perspectives on policies to promote convergence

At the country level, central government is obviously a core player in developing policies to promote convergence in innovation. It should encourage cooperation among individuals, firms, research institutes and universities. Taking a process perspective means carefully managing each stage of convergence processes. A careful consideration of people and organizations during the convergence processes leads to more frequent cooperation and exchange of knowledge among them, as well as their convergence activities. Governments have so far emphasized competition rather than cooperation among R&D personnel and organizations, which has obviously increased R&D productivity, but they have failed to encourage cooperation for the purpose of generating meaningful innovation. Designing such policies for encouraging cooperation requires more policy research, resources and creative ideas, which requires extra space, time, allowance, margin, etc.

A perspective on the institutional dimension is likely to be also important in making good policies associated with promotion, compensation, protection and co-exploitation of convergence in innovation. A set of institutions enabling people to create or configure convergence that fits into the unique culture of the country or the organization should be identified, formulated and established by policies (Schumpeter, 1976; Tidd, Bssant, and Pavitt, 2001).

Creating convergence in innovation depends greatly upon how many experienced and talented project leaders capable of managing diverse projects are available. Therefore, firms need to have competitive institutions that can select and train such capable project leaders. Not only leaders but also members of organizations and societies require credibility, creativity and braveness to achieve a higher level of convergence innovation. In this regard, the existence of a national innovation system equipped with institutions to nurture human attributes of such leaders is important for fostering convergence in innovation (Lee, Kong-rae, 2017b). Governments should orient their policies towards this end by designing and building up various institutions conducive to convergence in innovation.

The cultural perspective is also a necessary element in making policies to promote convergence. Culture concerns the development of a mind-set such as the creation of community values and social norms, building trust relationship among stakeholders, decision-making of collective agents, and so on. Whether or not organizations or science and technology communities

have a culture to adapt to diversity is likely to be critical in promoting convergence in innovation. An autonomous environment is definitely required in R&D communities for convergence to take place, as it helps generate creative ideas.

Likewise, democratic leadership, democratic culture and democratic decision-making rather than authoritative ones are likely to create more convergence. In this respect, people should enjoy freedom as much as possible, both in organizations and communities, unless they exert a negative influence. A liberal working environment should also be respected and regulations should be minimized. A democratic political system is likely to have a higher possibility of developing such a culture than any other regime.

Conclusion

One of the most important features of the current wave of industrialization is the convergence phenomena of different categories or processes of innovation. The concept of 'convergence innovation' put forward helps explain how many diverse knowledge fields are being combined in order to create not only new products but also new functions, processes or services. How can we understand, analyze and interpret modern convergence in innovation? This is not a trivial question. It goes to the very heart of understanding the so-called fourth industrial revolution.

However, until now, we have not had research necessary to understand the processes involved in convergence or its impact on firms, organizations, industries and nations. Moreover, confusion arises when pursuing convergence among policy makers, organizational leaders and business people. They sometimes devise conflictual measures or deepen problems that arise from the conventional ways of doing things. This is because their lack of understanding of the principles of convergence in innovation. Innovation scholars are responsible for solving this situation as they explore the truth in the convergence phenomena today.

There should be more studies so as to create more discussions and new theories, perhaps finally reaching a synthesis on convergence in innovation. It requires bringing together a range of new studies on convergence in innovation so that policy perspectives can be drawn not only for innovation scholars but also for policy makers to promote convergence in innovation. I believe sometime later hypotheses related to convergence will be established as theories, be embedded in innovation theories and contribute to overcoming the problems of the modern capitalist economy through convergence innovation.

The previously mentioned micro-, regional- and country-level perspectives in this chapter provide a clue to developing innovation policies and expanding them across various aspects of convergence. Innovation studies focused on convergence need to refine their research framework and incorporate various perspectives in the future. In-depth research on these perspectives will provide useful insights into the exploration and exploitation of future convergence studies. The suggestions represent useful insights for governments interested in pursuing convergence for the purpose of promoting social welfare and economic growth.

Notes

1 The term 'horizontal integration' in this chapter is not same as that explained by Teece (1976), who used the term as an organizational integration over value chains.
2 Iansiti (1998) stated that technology integration is made up of a set of problem-solving activities that are performed to match a new element of technical knowledge to the complex architecture of established competences.

References

Barnett, G. A. (2017). Innovation and network. In Kong-rae Lee (Ed.), *Managing convergence in innovation*. London: Routledge, Chap 3, pp. 38–50.

Darr, A. (2017). Convergence of service and technical skills: the case of ERP implementation in Israel. In Lee, Kong-rae (Ed.), *Convergence innovation in Asian industries*. New York: Routledge, pp. 40–57.

Iansiti, M. (1998). *Technology integration*. Boston, MA: Harvard Business School Press.

Kim, Euiseok (2014). *Evolutionary patterns and dynamics of technological convergence: the case of printed electronics*, PhD Dissertation, Daejeon: KAIST.

Kim, Jang-Hyun and Lee, Jinsuk (2017). A semantic network analysis of technological innovation in dentistry: a case of CAD/CAM. In Lee, Kong-Rae (Ed.), *Convergence innovation in Asian industries*. New York: Routledge.

Kodama, F. (1986). Inter-disciplinary research: Japanese innovation in mechatronics technology. *Science and Public Policy*, 13(1), 44–51.

Kodama, F. (1991). *Analyzing Japanese high technologies: the techno paradigm shift*. London: Pinter Publishers.

Kodama, F. (1994). *Emerging patterns of innovation*. Boston, MA: Harvard University Press.

Kodama, F., Nakata, Y. and Shibata, T. (2017). Changes in modes of technological learning. In Lee, Kong-Rae (Ed.), *Managing convergence in innovation*. New York: Routledge.

Lee, Kong-Rae (1998). *The sources of capital goods innovation – the roles of user firms in Japan and Korea*. London: Harwood Academic Publishers.

Lee, K-R. (2007). Patterns and processes of contemporary technology fusion: the case of intelligent robots. *Asian Journal of Technology Innovation*, 15(2), 45–65.

Lee, Kong-Rae (Ed.) (2017a). *Convergence innovation in Asian industries*. New York: Routledge.

Lee, Kong-Rae (Ed.) (2017b). *Managing convergence in innovation*. New York: Routledge.

Lee, Kong-Rae and Hwang, Jung-Tae (2005). *A study on innovation system with multi-technology fusion* (in Korean). Seoul: STEPI Policy Study 2005–17.

Lee, Kong-Rae and Seong, Tae-Gyeong (2009). *University-industry collaboration for activating convergence innovation* (in Korean). Seoul: STEPI Policy Report.

Lee, K-R., Joseph, Y. J. and Jeong, E-S. (2015). Convergence innovation of the textile machinery industry in Korea. *Asian Journal of Technology Innovation*, 23(s.1), 58–73.

Lundvall, B. A. (1988). Innovation as an interactive process: from user-producer interaction to the national system of innovation. In Dosi et al. (Eds.), *Technical change and economic theory*. London and New York: Pinter Publishers.

Lutchen, K. R. (2018). Why companies and universities should forge long-term collaborations. *Harvard Business Review*, January 24, 1–10.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organizational Science*, 5(1), 14–37.

OECD (1993). *Technology fusion: a path to innovation, the case of optoelectronics*. Paris: OECD.

Pavitt, K. (1984). Sectoral patterns of technical change: towards a taxonomy and a theory. *Research Policy*, 13(6), 343–373.

Rafols, I. and Meyer, M. (2006). *Knowledge-sourcing strategies for cross-disciplinarity in bionanotechnology*. Brighton: SPRU Electronic Working Paper Series: 152.

Roco, M. C. and Bainbridge, W. S. (2002). *Converging technologies for improving human performance*. Arlington, VA: NSF.

Rosenberg, N. (1963). Technological change in the machine tool industry, 1840–1910. *Journal of Economic History*, 23(4), 414–446.

Schumpeter. (1976). *Capitalism, socialism and democracy*. London: George Allen & Unwin.

Steinmueller, W. E. (2017). Convergence and diversity in Korea: moving from catching up to forging ahead. In Lee, Kong-Rae (Ed.), *Managing convergence in innovation*. New York: Routledge, pp. 71–82.

Sugiura, K. (1994). *Technological role of machinery users in economic development: the case of the textile machinery industry in Japan and Korea*. PhD Dissertation, Brighton: University of Sussex.

Teece, D. J. (1976). *Vertical integration and vertical divestiture in the US petroleum industry*. Stanford Institute for Energy Studies, Working Paper No. 300.

Tidd, J., Bssant, J. and Pavitt, K. (2001). *Managing innovation-integrating technological, market and organizational change* (2nd ed.). Chischester: John Wiley & Sons Ltd.

Wong, Chan-Yuan (2017). Convergence innovation in city innovation system: railway technology case in Malaysia. In Lee, Kong-Rae (Ed.), *Managing convergence in innovation*. New York: Routledge.

Yun, Jong-Yong and Kim, Changsu (2017). Convergence innovation in the management of large firms: Samsung Electronics. In Lee, Kong-Rae (Ed.), *Managing convergence innovation*. London: Routledge, pp. 55–70.