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The changing pattern of industrial technology linkage structure of Korea: Did the ICT industry play a role in the 1980s and 1990s?☆

Moon-Soo Kim [a,*], Yongtae Park [b]

[a] School of Industrial & Management Engineering, Hankuk University of Foreign Studies, San 89, Wangsan-ri, Mohyeon-myun, Yongin-si, Kyongki-do 449-791, Republic of Korea
[b] Department of Industrial Engineering, Seoul National University, San 56-1, Shillim-Dong Gwanak-Gu Seoul, Republic of Korea

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ABSTRACT

The notion of the knowledge-based economy highlights the strategic importance of inter-industrial knowledge flows. Among others, the crucial role of information and communications technology (ICT) industry is emphasized. The pattern whereby technological knowledge is created, accumulated and disseminated through the interactive learning among industries can be portrayed as a network. Based on the network theory, this empirical study analyses, from the dynamic perspective, inter-industrial technological knowledge structure of Korean industries during the reference period of early 1980s to mid-1990s. Overall, the density of the network increased over time, implying that the knowledge network has expanded and intensified. The role of the ICT industry in the global network has also increased but needs to be further strengthened, especially informatization of non-ICT industries by the outflow of ICT industrial knowledge in the future. The findings in turn render some important policy implications that should be addressed in developing technology policy.

1. Introduction

With the advent of knowledge-based economy, technological knowledge is recognized as the driver of economic growth and social change. Technological knowledge is generated and disseminated through transmission channels and interaction mechanisms among various actors, creating technological innovations and eventually exerting a crucial impact on the productivity of socio-economic systems [1–3]. Particularly, the diffusion of information and communications technology (ICT) is emerging and being accelerated now. ICT not only activates and exchanges knowledge, but also encourages relationships among participating agents. In developing countries like Korea, therefore, ICT knowledge diffusion is very important to diffuse knowledge across other industries and to boost innovative activities in the ICT industry itself as well as in others.

We consider the technology diffusion between industries as inter-industrial knowledge flows, which denote the transfer of technological knowledge from one industry to another through research spillovers, human mobility or equipment adoption. In order to understand the structure of the industrial knowledge flows and its changing pattern over time, inter-industrial knowledge flows can be easily represented as a network. Furthermore, by using network analysis, we can identify industries that play a greater role in generating inter-industrial knowledge flows, and pay particular attention to the role and the importance of ICT.

Previous network analyses on the relationships among industrial sectors are not abundant. Imai and Baba [4] investigated the basic characteristics and information structure of cross-border industrial networks and inter-firm alliances and proposed a typology of international networks. Leoncini et al. [5] compared the Italian and German flow structures by using the notion of national technological systems. Porter [6] highlighted the strategic importance of regional network in terms of factor conditions,

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* Corresponding author. Tel.: +82 31 330 4979; fax: +82 31 330 4093.
E-mail address: kms@hufs.ac.kr (M.-S. Kim).

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market structure and user–supplier relationship. Von Hippel [7] examined the collaboration between producers and users to identify the critical role of users in the innovation process.

Most previous research has coped with innovations either at the national level, at the firm level or the entire industrial relationship, leaving the intermediary industry-level as missing link. Some notable exceptions are Kim and Park [8], who analysed the characteristics and changing pattern of inter-industrial knowledge flows in the Korean manufacturing industries during the 1980s as well as Leoncini and Montresor [9] who examine the automobile technological systems of four European countries. To our knowledge, although there are considerable studies concerning increase in production and productivity resulting of economy from the development of ICT, the relationship between the whole industrial structure and the ICT sector has not been dealt with even though the emergence of the techno-economic paradigm and information age require a better understanding of the knowledge network and the relationship between ICT and traditional industries.

The structure of the article is as follows. Section 2 provides the background of this study to extract the importance of inter-industrial knowledge structure and its change based on ICT industry of Korea in the reference period, through reviewing country-specific ICT effects on the industries and ICT-related policy background of Korea in the 1980s and mid-1990s. In Section 3, we measure the inter-industrial knowledge flows and introduce network analysis methodology. Section 4 includes data with a reference period from 1983 to 1995 in Korea. In Section 5, we examine the dynamism and characteristics within the ICT industry under the light of network analysis, and the inter-industrial technological knowledge structure between the ICT industry and other industries. Finally, we conclude in Section 6 with the several policy implications and further studies.

2. Study background

Korea's 1960s and 1970s strategy was largely associated with duplicative imitations, producing on large scale knockoffs or clones of mature foreign products, imitative goods with their own or original equipment manufacturers' brand names at significantly lower prices. Korea's 1980s and 1990s industrialization increasingly involves creative imitations; especially several industries such as ICT industries like semiconductor, electronics are stretching their R&D activities to transform themselves into innovators [10]. And under the motive 'the industrialization have felled behind, but informatization precedes' Korean government had supported and developed the ICT, as a strategic industry of nation, to catch up economic gap from the advanced countries. Especially since the newly established Ministry of Information and Communications (MIC) in 1994, the several programs on building the infra for high-speed communication network had been continuously and successfully carried out [11].

In the 1980s to mid-1990s the creative imitations or technological innovation of ICT as well as the consistent industry policy on ICT had been the driving force of the rapid growth of ICT industry and related one since the mid-1990s. The total production of ICT industry was 15.2 billion dollars in 1990 but increased to 141.7 billion dollars in 2000; the value-added of that was from 33.7 billion dollars in 1996 to 67.2 billion dollars in 2000 which increased 18.9% per year and led 12.9% of Korean GDP. Furthermore, the growth contribution of ICT industry to Korean economy increased from 4.5% in 1990 to 50.4% in 2000 [12]. The ICT has carried out an important role to tow the overall economy; especially it has been a breakthrough for easing the currency crisis of Korea in the year 1997.

The production and productivity effects of ICT on other industries and economy have been observed and empirically examined in many other countries such as New Zealand [13], Finland [14], UK [15], Italy [16], several OECD and Asian countries [17], etc. The OECD [18] has more emphasized that ICT has been, furthermore, an important driver of growth and productivity in its member countries. Recent improvements in growth and productivity performance in the US and many other OECD countries have been linked to the expansion of the production of ICT goods and to the use of ICT to enhance efficiency and innovation.

The recently several studies on the case of Korea, however, have issued that such a positive relation between ICT and economic growth, especially increase of other industries' productivity, should be carefully reassessed. According to Kang and Hong [19] and Kim [20], although ICT industry which has been invested a lot of Korean domestic capital and labors since the 1990s has positively affected the growth of GDP, this has not resulted by increase of total factor productivity (TFP). And Kim and Oh [21] analysed also empirically that ICT industry was not positively linked to the productivity of Korean manufacturing industries based on the data of the years 1995 and 1998. They concluded that the Korean economy seems not to be yet of an ICT friendly structure which improves industries' production technology in accordance with the development of ICT.

Schreyer [22] mentioned that there are several channels for improving the productivity by ICT. First, technological progress in the production of ICT goods directly raises TFP of ICT-producing industries. Second, falling prices of ICT capital relative to other types of capital or labor encourage firms to substitute the former for the latter. In this way, an increase in investment in ICT capital contributes to labor productivity growth in ICT-using industries through capital deepening effects, i.e., more capital per worker leads to an increase in labor productivity. Lastly, ICT may generate beneficial externalities in the form of spillovers through efficiency gains in the production process, and through the accumulation of intangible organizational capital accompanying investment in ICT capital [23,24]. Such positive externalities, or spillover effects, can accelerate TFP growth and boost technological innovation in ICT-using industries. The negative results on relation between ICT and other industries' productivity in Korea seem to be based on not well operating those channels, particularly spillover effects of ICT to boost other industries' innovation.

Therefore in order to increase productivity and stimulate technological innovation of other industries by ICT, the effectively technological knowledge flows of ICT across industries are believed a prerequisite. And the industrial structure carries out an important role, which is a main political target, as an effective mechanism to diffuse more quickly and easily the technologies