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Developing ecological index for identifying roles of ICT industries in mobile ecosystems: The inter-industry analysis approach

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ABSTRACT

With the convergence of information and communication technology (ICT) industries in the mobile communication sectors, new actors have started emerging such as mobile contents and media service industries. The traditional distribution of power in ICT industries of mobile communication sectors has significantly changed based on relations with the new actors. Recently, the concept of a "mobile ecosystem" which embraces this environmental shift is highlighted. The traditional industries such as hardware and network-based firms and new ICT industries such as software and service-based firms grow up simultaneously creating the mobile ecosystem. In this respect, this study aims to explore ecological indexes for identifying roles of ICT industries in the mobile ecosystem. To be specific, the ecological indexes are proposed to take new roles and position of ICT industries in the perspective of ecosystem into account. For this, the inter-industry analysis, which includes the physical flows between industries, is mainly used since the ecosystem is operated by streamlining physical flows. First, the mobile ecosystem is structured by using physical input-output flows and industrial relationships. Second, to explore roles of ICT industries in the mobile ecosystem, four ecological indexes have been developed and combined based on the result of inter-industry analysis: productivity, size, spillover effect, and coverage. As a result, we identified six roles for ICT industries and their relationships: commodity, landlord, controller, keystone, facilitator, and dominator. Regarding these ecological roles and relationships in ICT industries, strategic and policy implications are also suggested to improve the health of the mobile ecosystem.

1. Introduction

With the increasing use of information and communication technologies (ICTs) in mobile societies worldwide, ICTs have started evolving very fast and have become extremely critical in the mobile communications sectors (Dekleva et al., 2007). Various ICTs have begun to converge in the mobile communications sector; therefore, along with the integration of mobile

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devices, networks, and content services, cooperation amongst the ICT sectors has increased significantly (Jing and Xiong-Jian, 2011; Basole et al., 2015a). This convergence between ICT industries has led to the creation of a new business environment of ICT industries in the mobile communications sector.

In recent years, the key drivers for this change have been the newly developed smartphones, open mobile operating systems (OS), and the mobile application market. For example, the integration of products and services, such as the iPhone, iOS, and the App Store of Apple, has produced a new business environment for mobile network operators, device manufacturers, and content providers (Basole, 2009; West and Mace, 2010; Kim, 2011). By releasing the Google phone, its Android OS, and the Android Market together, Google has also become a big player in the mobile communications sector (Holzer and Ondrus, 2011). This technical and social change results in the blurring of boundaries of the mobile communications industries (Suh and Kim, 2015). In such an open mobile environment, ICT industries in the mobile communications sector have become more complex, and resources are being shared across those industries. New ICT industries have been created as a result of new technologies or products. In response, the concept of "mobile ecosystems" has emerged in both academia and practice to explain the growth of this complex structure and the interactions between firms or industries in the mobile communications sector (Basole, 2009; Feijoo et al., 2009; Gueguen and Isckia, 2011). In the mobile ecosystem, new actors and new relations are emerging and the traditional distribution of power is changing substantially.

Both theoretically and methodologically, the motivation for this study of the mobile ecosystem is different from most previous studies that have focused on ICT industries in mobile communications sectors. First, prior studies have been conducted from various perspectives such as firm strategies (Adner, 2006; Bores et al., 2003), national policy making incurred by ICT co-evolution (Lee et al., 2009), evolutionary economics (Hacklin, 2008), and the value chain network (Pil and Holweg, 2006). However, there are limited studies done from the ecosystem perspective. The ecosystem dimension has gained importance in the mobile communications sector because numerous firms and businesses have evolved and constructed large business networks (Basole, 2009; Jing and Xiong-Jian, 2011; Li, 2009). This complex and large mobile communications sector is being viewed as the mobile ecosystem in which numerous different species (i.e., ICT industries) coexist. The ICT industries influence one another and are affected by various external forces (Iansiti and Levien, 2004; Basole, 2009). The core of the ecosystem thinking is to provide a broader view and a familiar ecological terminology for studying the interacting organism in the socio-economy (Moore, 1993; Basole, 2009; Peltoniemi, 2006; Fransman, 2010). Using ecological relationships and roles of ICT industries, we find considerable ways of structuring and maintaining a healthy mobile ecosystem. Nevertheless, research on ecosystem-based views for the mobile business and industry is still in its early phase of development. The relationships and roles in the ecosystem are not specifically defined and explored. Thus, this study intends to facilitate in-depth understanding on the structure of the mobile ecosystem and to identify ICT roles from the perspectives of the ecosystem.

Second, from the methodological background, previous research has tended to deal with the mobile ecosystem based on qualitative analysis performed at the conceptual level (Jing and Xiong-Jian, 2011). More attention is given to an individual industry or firm, such as the network industry or the mobile device industry. In addition to case studies, quantitative analysis has been conducted based on patent data in the view of big data analytics, such as the United States Patent and Trademark Office (USPTO), United States Patent Classification (USPC), and Standard Industrial Classification (SIC) systems (Lee et al., 2009, 2016; Li, 2009). The analysis has also included the sector participation of enterprises using mergers and acquisitions (M&A) and collaborative data (Basole, 2009; Gueguen and Isckia, 2011). Nonetheless, these are limited studies on inter-firm analysis or inter-technology analysis at a micro level. Micro-level analysis cannot explain the whole structure of interactions and relationships between industries. It is also difficult to derive managerial and policy implications for a country or industry. However, because ICT industries have converged in the mobile ecosystem (Hacklin et al., 2009; Karhu et al., 2014), it is essential to analyze the physical resource flows across a range of industries. Therefore, the industry-level quantitative analysis for drawing an overall picture of a mobile ecosystem has remained largely unexplored and unexploited.

For the industry-level quantitative analysis of mobile ecosystem, inter-industry analysis is a useful mathematical method since it can deal with resource distributions at the industry level (Leontief, 1941). Using the input-output table, the relatedness and interconnectedness among sectors can be explored (Xing et al., 2011). More specifically, inter-industry analysis is particularly relevant for adopting ecosystem perspectives because the input-output table shows a concrete economic structure that has both physical input and output flows across sectors (Miller and Blair, 1985). Input-output analysis has three strengths for this study. First, the input and output degrees of resource flows and spillover effects of ICT industries in a mobile ecosystem can be examined. Second, the relationships among ICT industries can be quantitatively explored. Finally, with the analysis results above, ecological roles of ICT industries from the ecosystem perspective can be characterized.

Consequently, the major contribution of this paper is to structure mobile ecosystems based on relationships between ICT industries and to identify their ecological roles in their mobile ecosystems using inter-industry analysis. The ecological indexes and roles represent the useful analogy to understand the structure and condition of systems. Compared to other indexes, the managerial and policy implications are easily identified from the roles which is similar with real ecosystems. The advantages and disadvantages of ecological roles can be taken into account through the metaphor of animals (such as predator-prey relations) or plants. An analysis of the results can facilitate resource flow and make the mobile ecosystem symbiotically healthier. To be specific, practical and policy implications are provided by applying inter-industry analysis into a Korean mobile ecosystem, understanding ecological relationships and roles of each industry. The case of Korea can provide significant meaning for ecosystem studies because the ICT is a major field of Korea. Annually, Korea allocates a large budget for ICT industries, approximately 4 billion dollars. Also, there are many global ICT firms such as *Samsung*, *LG*, *SKT*, *Kakao*, and *NHN*. In particular, in addition to hardware manufacturer, contents service firms are considered a major player in recent