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What drives technology convergence? Exploring the influence of technological and resource allocation contexts

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ABSTRACT

Although many studies emphasize the importance of technology convergence, comparatively few ask, "What drives technology convergence?". This study empirically demonstrates how technological and resource allocation contexts nourish technology convergence. We use the data from government-supported R&D projects in Korea and measure convergent patents as ones with multi-assigned R&D domains. The results show that earlier stage of technology life cycle, lower technology readiness level, longer R&D timespan, or smaller R&D budget lead to the creation of technology convergence. The results justify the policy supports for technology convergence and highlight the paradoxical relationship between the affluence of R&D resources and technology convergence.

Introduction

Following the Renaissance, scientific and technological knowledge developed within their respective domains (Roco and Bainbridge, 2002). However, as socio-economic and managerial problems grew more complex, knowledge based on a single discipline was found to be insufficient to resolve them (Brew, 2008). In addition, rapid globalization and intensified technological development

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induced research and development (R&D) entities to derive various competitive advantages in emerging industries (Curran and Leker, 2011).

In this context, strategic decisions on converging technologies and associated products can critically influence the competitiveness of both enterprises and nations (Curran and Leker, 2011). Converging technologies lay the groundwork for a wide variety of technical solutions by unlocking the potential of radically novel technological developments (Roco and Bainbridge, 2002; Kim et al., 2009; Nordmann, 2004; Wolbring, 2008). Therefore, converging technologies are expected to lead and dominate next-generation technological innovations (Athreye and Keeble, 2000), as crossing disciplinary boundaries by convergence makes it possible for researchers to develop intellectual breakthroughs (Morillo et al., 2003). This aspect of convergence can contribute to the increase in innovation capabilities of research and development (R&D) entities.

Accordingly, a number of scholars have emphasized the importance of convergence and interdisciplinary research (Stone et al., 2009); R&D managers and researchers also strongly perceive its importance.[1] Since the 1980s, a certain number of corporate strategic plans have involved considerations of convergence (Lind, 2004; Bröring et al., 2006), and more than 80% of surveyed Spanish researchers have used knowledge and techniques from other techno-scientific domains (Sanz-Menéndez et al., 2001). Furthermore, more than half the knowledge in academic journals is of an interdisciplinary nature (Morillo et al., 2003).

In fact, perceiving the importance of opportunities arising from convergence, developed countries' governments have established initiatives to promote such convergence, especially in technology. For example, the National Science Foundation (NSF) in the United States has shown noteworthy interest in the convergence of nano-, bio-, information, and cognitive (NBIC) technologies (Roco and Bainbridge, 2002) and is taking action to facilitate such endeavors (Wolbring, 2008). Likewise, the European Commission has executed similar policies vis-à-vis technology convergence (Nordmann, 2004). Policymakers in South Korea and Japan have initiated plans analogous with those in the United States and the European Union (Kim et al., 2009).

However, it has not been fully clarified in what contexts R&D entities combine knowledge from different fields or what conditions promote technology convergence. By and large, technological and demand uncertainties are theoretically speculated as the determinant of technology convergence (Bores et al., 2003). More specifically, taking a heuristic approach (Llerena and Meyer-Krahmer, 2003; Bainbridge, 2006), researchers elucidate the social barriers to mingling among the R&D entities of different techno-scientific domains (Stokols et al., 2008). Conspicuously, some empirical research demonstrates a propensity on the part of individual researchers to participate in interdisciplinary research (Carayol and Thi, 2005) and investigates the correlation between the structures of convergence in R&D and standardization (Gauch and Blind, 2014). However, few studies empirically demonstrate what drives technology convergence.

This study demonstrates the influences of technological and resource allocation contexts on technology convergence among distinct macro-level techno-scientific domains. While the efficacy of programs that encourage technology convergence is in serious doubt (Metzger and Zare, 1999), identifying in what contexts convergence occurs and investigating its facilitation may broaden our understanding of convergence, perhaps helping form policy and managerial decisions in ways conducive to fostering technology convergence. Moreover, since technology convergence is a key driver of market/industry convergence (Hacklin, 2008), the deepened understanding created by this study may help us envision the forthcoming future of convergence in commercial markets and industrial activities.

This study makes distinctive contributions. It offers novel empirical evidence of the influences of technological and resource allocation contexts on convergence. Thus far, because of difficulty obtaining relevant preference data (Hacklin, 2008), previous empirical studies focus on identification of convergence and trend-watch in particular concentrating on industry convergence (Curran et al., 2010; Curran and Leker, 2011; Karvonen and Kässi, 2013; Preschitschek et al., 2012). However, while they do not empirically demonstrate hypotheses on the drivers of convergence, surveys show the

[1] Although "interdisciplinary research/interdisciplinarity" and "convergence" are both phenomena in which heterogeneous knowledge or fields are combined, they are only roughly synonymous. We review the differences between the two in Section "Definition of "technology convergence"".