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Information technology and organizational learning in knowledge alliances and networks: Evidence from U.S. pharmaceutical industry

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ABSTRACT

Recent years have witnessed a change in firms' innovation patterns, from closed to open, in which information technology (IT) has played an important role. This paper aims to open up the black box of IT-enabled absorptive capacity by theorizing and testing the role of IT in two organizational learning processes, which are either interactive with partners in the knowledge alliance or non-interactive with others in the knowledge network. In particular, we formulate a model explaining how a firm's IT investment moderates its organizational learning processes in knowledge alliances and networks, which sheds light on the role of IT as an enabler of absorptive capacity. Using a panel data set from the U.S. pharmaceutical industry, the results show the moderating role of IT in strengthening the organizational learning processes from knowledge alliance experience to coinvented knowledge and from knowledge network centrality to assimilated knowledge, which, in turn, improve firm competitiveness.

1. Introduction

With the advances in information technology, access to external knowledge across firm boundaries is now a key source of innovation [22,56,98]. Innovation activities have thus moved from closed to open forms, with various stakeholders directly or indirectly exchanging knowledge in shared physical or social contexts [18,32]. The growing literature on innovation has raised the interest of firms in tapping into external resources, and researchers have also begun to examine innovation dynamics from inter-organizational and network-based perspectives [39,44,60, 82,107]. Such studies focus on outside-in knowledge flows and show that firms have to develop their *absorptive capacity* to learn from external sources of knowledge [48,65,104].

In Cohen and Levinthal's [22] original concept, absorptive capacity is defined as a firm's ability to assimilate and utilize external knowledge for commercial ends and thus a new way to view organizational learning and innovation. The subsequent absorptive capacity literature has drawn on a process-oriented perspective and conceptualized absorptive capacity as a set of different organizational learning processes [60,61,66,115]. Consistent with the prior literature, *this study defines absorptive capacity as the externally oriented organizational learning processes of a firm that are carried out to obtain and create knowledge across its boundaries* [22,100,112]. In these externally oriented organizational learning processes, visible knowledge alliances with partners and invisible knowledge networks among firms have been recognized as important external knowledge sources that can aid innovation (e.g., [48,104]).

The recent IS literature increasingly suggests that one of the most critical enablers of absorptive capacity is information technology (IT; [53,86]), and IT is also seen as a catalyst of organizational learning [103] and innovation [19,6,33,34,56, 98,113]. Although the notion of IT-enabled absorptive capacity has been widely used in IS research, the understanding of how IT enables absorptive capacity with regard to various different externally oriented organizational learning processes is still limited. In other words, little is known about what happens inside the black box of IT-enabled absorptive capacity.

The current study aims to fill this gap in the literature by explaining how IT strengthens the externally oriented organizational learning processes in knowledge alliances and networks and thus how it can enhance a firm's absorptive capacity. The research

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question addressed in this paper is how IT facilitates organizational learning processes in knowledge alliances and networks, two contexts that have been highlighted in the literature. These two contexts represent organizational learning processes that are interactive with visible alliance partners (e.g., [60]) or interactive with other firms in an invisible network of knowledge flows (e.g., [104,2]). Because no prior study in the literature attempts to simultaneously consider the organizational learning processes that occur in knowledge alliances and networks, this work aims to provide a more holistic picture by taking into account both of these contexts simultaneously.

We formulate a conceptual model that connects knowledge alliance experience and knowledge network centrality to the corresponding organizational learning outcomes as coinvented knowledge and assimilated knowledge, respectively. IT investment is theorized as a key moderator that enhances these organizational learning processes. Our model differs from prior studies by reconceptualizing alliance-based, interactive, network-based, non-interactive, externally oriented organizational learning processes as a firm's absorptive capacity. Furthermore, the model highlights IT's role as an enabler of absorptive capacity by facilitating these processes. By doing so, this work is able to offer a novel understanding to the IS literature as to what IT-enabled absorptive capacity is and how IT enables absorptive capacity.

Compared to the extant IS literature, this paper contributes an insightful theory of IT-enabled absorptive capacity by theorizing the role of IT in alliance- and network-based organizational learning processes. These processes lead to coinvented knowledge based on prior successful experiences of knowledge exchange in alliances, or the knowledge that is assimilated from the intangible networks among firms in an industry. Given that recent studies in the pharmaceutical industry reflect the importance of alliances and open innovation due to the distributed nature of knowledge [17,20,23,83], we focus on empirically testing our theory based on a sample of firms from the U.S. pharmaceutical industry.

The empirical results based on a panel data set from the U.S. pharmaceutical industry reveal that IT plays a significant moderating role in strengthening the organizational learning processes that occur in knowledge alliances and networks. The findings further show that these organizational learning processes enabled by IT can improve firm competitiveness by generating learning outcomes such as coinvented and assimilated knowledge. Therefore, simply getting access to external resources in a knowledge alliance or network does not automatically lead to desirable innovation outcomes, unless a firm is able to leverage its strategic resources, such as IT investments, to facilitate organizational learning. IT-enabled absorptive capacity can thus lead to more effective organizational learning processes; thus, it is critical for innovation and the creation of a competitive advantage.

The rest of paper is organized as follows. Section 2 reviews the relevant literature and summarizes the theoretical background. The hypotheses and conceptual model are presented in Section 3. Data and measures are introduced in Section 4, and Section 5 then reports the empirical results. The main findings are discussed in Section 6, and the conclusion and implications are presented in Section 7.

2. Theoretical background

2.1. Open innovation and absorptive capacity theory

Since Schumpeter [92] first proposed that innovation is a path to economic growth, the conventional definition of innovation has been widely investigated in the hope of establishing a sequential model based on the characteristics of closed innovation activities within an organization. However, with innovation activities dynamically evolving, the innovation process has advanced from a sequential, closed form to an open process. In this open process, various specialized participants absorb, emit and exchange knowledge inputs in shared physical or social contexts [32,102]. As researchers have begun to understand innovation activities as a series of knowledge exchanges and spillovers [51,58,105], a more dynamic conception of innovation is required to capture how knowledge can be acquired from external sources, such as knowledge alliances and networks [3,48,73,104].

A number of studies have been conducted regarding the growing relevance of external sources of innovation rather than a reliance on internal R&D, resulting in the notion of "open innovation" [15,16]. Open innovation describes the situation in which many innovative firms have shifted to an open model for their activities, using a wide range of external knowledge sources to help them achieve their goals. It highlights the use of purposive inflows and outflows of knowledge to accelerate innovation. This paradigm thus proposes that firms in an open innovation process should aim to acquire and use external knowledge.

Open innovation can shed light on absorptive capacity theory, which emphasizes externally oriented organizational learning [108]. Research on organizational learning has existed at least since the work of Cyert and March [29] and Cangelosi and Dill [14], and the literature has grown dramatically in recent years. Organizational learning occurs when the organization exploits internal experience or assimilates external knowledge. Because open innovation is essentially externally oriented learning processes that occur by reusing and recombining existing elements of knowledge [69,75], absorptive capacity theory is a powerful lens through which to understand how a focal firm can generate innovation and build competitiveness by working with external partners or assimilating knowledge spillovers. Because firms do not automatically appropriate the value of open innovation, their absorptive capacity becomes critical in enabling them to benefit from external sources of knowledge [91]. Therefore, the degree to which a firm can obtain desirable outcomes from its open innovation activities depends on how it carries out externally oriented organizational learning processes and thus on its absorptive capacity. For instance, Powell et al. [82] claim that the development of absorptive capacity by pharmaceutical firms, with regard to how they manage organizational learning in knowledge alliances, is an important source of innovation in this industry.

2.2. Absorptive capacity as externally oriented organizational learning

In Cohen and Levinthal's [22] original work, absorptive capacity is defined as a firm's ability to recognize the value of external information, assimilate it, and apply it to commercial ends. They thus propose absorptive capacity theory as a new way to understand the learning and innovation carried out by organizations. Subsequent scholars have drawn on a process-oriented perspective and conceptualized absorptive capacity as different externally oriented organizational learning processes [60,61,66,115]. This study pays attention to two particular externally oriented organizational learning processes, rooted in visible knowledge alliances and the invisible knowledge networks among firms.

Past studies proposed that externally oriented organizational learning is an assimilating and transforming process [27], which is based on the degree of "interaction" among firms within a specific industry [109,5]. These works suggest that externally oriented organizational learning occurs in a context composed of the organization itself and the environment in which it is embedded. As a result, two types of externally oriented organizational learning processes are commonly seen, those that entail direct interaction with others in a formal knowledge alliance and those without