

Review

Factors affecting on collaboration of industry with University

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It is well acknowledged that innovation has become a strategic source in creating sustainable competitive advantages for firms. Since innovation is increasingly related to a firm's ability to assimilate and exploit external knowledge, firms are facing challenges of accessing knowledge and sources of innovation. One of the sources for accessing external knowledge is the knowledge generated in universities. Therefore, the objective of this article is to review the literature on university-industry interactions and to identify the characteristics of firm which influence its ability in utilizing scientific knowledge transferred from universities. A number of factors are discussed which may influence the knowledge firms obtain from interactions with university researchers. They include: (1) Size; 2) Absorptive capacity; 3) R&D intensity; 4) Structure; 5) Strategy; 6) Culture; and 7) Trust. It is believed that this framework can provide a useful organizing scheme for understanding the existing literature on academic research, explaining the determinants on obtaining knowledge and guiding future studies on this issue.

Key words: Knowledge transfer, industry-university interactions, innovation.

INTRODUCTION

In knowledge-based economy, economic growth is increasingly dependent upon innovation and knowledge becomes one of the most important determinants of business success. Science is exerting an increasingly large influence on innovation, especially in fast-growing knowledge-intensive industries (Albino et al., 1999; Ramasamy et al., 2006; Murray and Peyrefitte, 2007; Arvanitis et al., 2008; Dinur et al., 2009; Herrera et al., 2010; Wonglimpiyarat, 2010). The extent and intensity of industry-science relationships are considered to be a major factor contributing to high innovation performance at the firm and industry levels (Arvanitis et al., 2008) and also the importance of learning alliances has been magnified as a fast and effective mechanism of firm's capability development (Daghfous, 2004). In a rapidly changing business environment, knowledge has become the most strategically important resource for firms to gain competitive advantages (Ding and Huang, 2010; Herrera

et al., 2010). It is said that advanced or radical innovations are drawn from new scientific knowledge generated in universities and research organizations (Tödtling et al., 2009). It is now well-accepted that establishing and sustaining competitive advantage depend upon effectively managing and integrating internal and external knowledge into operational activities in order to achieve superior performance and generate innovation (Chen and Huang, 2007; Tasseey, 2008; Fabrizio, 2009). Major sources of knowledge available for the firm are internal knowledge, customers and suppliers, competitors, universities and public research organizations (Ramasamy et al., 2006; Segarra-Blasco and Arauzo-Carod, 2008; Fabrizio, 2009) and, in the literature of innovation, universities and public research organizations have been identified as key knowledge sources for innovating firms, in particular in high-tech industries (Tödtling et al., 2009). As emphasized by Cockburn and Henderson (1998) and Zucker et al. (1994, 1998), "connectedness" to outside knowledge sources (particularly university's scientists) provides benefits in terms of accessing and exploiting external knowledge (Fabrizio, 2009). The resource-based theory of firms

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states that internal resources are binding; then it makes sense that a firm engages with external partners to have access to additional resources such as capital, technology and human capital. Industry–university cooperation has been considered as one type of R&D cooperation in these contexts. Most approaches have emphasized that firms and individual researchers take the resource-based view of the decision in order to participate in university–industry interactions (Boardman, 2009; Eom and Lee, 2010).

According to Geisler (1995), the more the universities and firms recognize their interdependence in terms of resources, the higher the possibility of establishing their partnerships (Dinur et al., 2009; Eom and Lee, 2010). Knowledge transfer from university to industry has become strategically important in many respects: it represents a source of funding for university research, a source of innovation for businesses and is a source of economic development for policy-makers (Hong, 2008; Grimpe and Fier, 2010; Muscio, 2010; Bishop et al., 2011). As Mansfield (1995, 1998) and Cockburn and Henderson (1998) argued, academic research greatly contributes to innovation in several industries (Hong, 2008; Grimpe and Fier, 2010; Macho-Stadler and Pérez-Castrillo, 2010; Muscio, 2010; Bishop et al., 2011).

This study contributes to the literature on university–business collaboration. It provides a detailed literature review of the knowledge transfer channels and factors which affect firms' gaining knowledge from interactions with universities. Since universities are regarded as key knowledge sources of firms for more advanced innovations, the factors influencing the firm's ability to access and absorb university knowledge are investigated. The main research question in this study is: what factors in the recipient firm can contribute to the firm's getting more knowledge from universities?

KNOWLEDGE TRANSFER

Knowledge, defined as the justified true belief, is the core of the knowledge-based theory, which builds upon the resource-based view. The knowledge-based theory views the firm as “a dynamic, evolving and quasi-autonomous system of knowledge production and application” (Blumenberg et al., 2009). This perspective contends that knowledge is the principal resource of firms and that production requires the integration of a broad range of knowledge (Blumenberg et al., 2009; Pertusa-Ortega et al., 2010). In particular, this argument is dealt with by Cohen and Levinthal (1990), who stressed that knowledge transfer is a critical factor for a firm and is necessary to rapidly respond to changes, innovate and achieve competitive success (Albino et al., 1999; Murray and Peyrefitte, 2007). Knowledge transfer is the process through which knowledge acquisition from a knowledge

transmitter is used as a knowledge receiver. Gilbert and Gordey-Hayes (1996) also considered that knowledge transfer is a dynamic process which involves acquisition, communication, application, acceptance and assimilation (Tsai, 2009). Dosi (1982) defined knowledge and technology transfer in the context of university–industry collaboration as follows: knowledge and technology transfer between academic institutions and business sectors is understood as any activity aimed at transferring knowledge or technology which may help either the company or academic institute – depending on the direction of transfer – in order to further pursue its activities (Arvanitis et al., 2008).

KNOWLEDGE TRANSFER CHANNELS

At the university level, there are formal and informal relations between institutions, firms and individuals (Segarra-Blasco and Arauzo-Carod, 2008; Grimpe and Fier, 2010). Different types of knowledge transfer processes require different forms of inter-organizational arrangements between university and industry in order to make the transmission and dissemination processes more effective (D'Este and Patel, 2007). As stated by Iansiti (1998), the concept of ‘technology integration’ in the knowledge management literature provides a theoretical framework for understanding the underlying rationale of academic engagement in a variety of interaction channels with industry (D'Este and Patel, 2007). Knowledge transfer between universities and industry takes place through a variety of mechanisms ranging from recruitment of university graduates to personnel exchanges, joint research, contract research, consulting, patents and publications, licensing, spin-off companies, industry-funded laboratories and other facilities and also informal contacts, such as meetings and conferences. Flows of tacit knowledge and informal contacts between industrialists and academics are relevant aspects of university–industry interactions (Weinberg and Mazey, 1988; D'Este and Patel, 2007; Arvanitis et al., 2008; Segarra-Blasco and Arauzo-Carod, 2008; Muscio, 2010).

Personal contacts can be established informally through casual meetings at conferences, workshops and networks with the academic community or through formal arrangements such as consultancy agreements, joint research projects and contract research. Close interaction between university and company personnel may enhance the problem solving capabilities of firms (Bishop et al., 2011). Mobility of personnel programs allow firms to gain an easy access to potentially highly valuable knowledge by contracting foreign researchers from public research centers and universities. These programs have a dual aim of stimulating firms' innovation effort by increasing inputs of the innovation process and

enhancing the efficiency of innovation activities by increasing the outputs of the innovation process (Herrera et al., 2010).

Science parks (also known as research parks) were first originated in western nations, such as the US and UK, and were often affiliated with academic or research institutions. These parks provide an environment for the mutually beneficial collaboration of research and development among tenants in the park and with academia in the case they are university-based. Such parks have been considered one model for promoting innovation, entrepreneurship, growth of knowledge-based companies and, in turn, economic growth within their regions (Phan et al., 2005; Vaidyanathan, 2008; Caldera and Debande, 2010; Ratinho and Henriques, 2010). Inspired by the success of California's Silicon Valley, many developing countries have established science parks as a vital strategy for promoting high-tech industries.

For example, Biotech-Information Technology (Bio-IT) park in India, Hsinchu Park Industrial Park in Taiwan (Grimpe and Fier, 2010). Other East Asian countries such as South Korea, Hong Kong and Malaysia have also started parks, which helps firms to exchange technological know-how, increase R&D efficiency and improve productivity of firms (Vaidyanathan, 2008). One other mechanism of technology transfer is to find a spin-off company that embodies a technology developed at a parent organization.

The term "spin-off" usually means a new company that arises from a parent organization (Carayannis et al., 1998; Clarysse et al., 2005). Roberts and Malone (1996), Steffensen et al. (1999) and Rogers et al. (2001) defined spinoffs as a mechanism in which technology transfers from parent R&D organization to a commercial organization.

They include government R&D laboratory, university, university's research center and private R&D organizations (O'Shea et al., 2008).

University spinoffs are an important subset of spinoff firms because they are an economically powerful group of high-technology companies. Among them, there are several-billion-dollar public corporations including Cirrus Logic, Google, Genentech and Chiron (Grandi and Grimaldi, 2005; O'Shea et al., 2008; Macho-Stadler and Pérez-Castrillo, 2010; Müller, 2010; Rasmussen and Borch, 2010). Joint R&D projects involve the recipient firm and university. Cohen and Levinthal (1989) found empirical evidence that R&D not only generates new information for the firm, but also enhances its ability to assimilate and exploit the existing information.

They argued that R&D provides a spillover benefit, which consists of enhancing the firm's ability to learn from external sources of knowledge and, subsequently, its ability to create new knowledge (Daghfous, 2004; Johnson, 2008).

FACTORS

According to a comprehensive survey of the literature on the university–industry linkage by Agrawal (2001), there is a small but growing volume of research on the characteristics of firms, which influences their ability to utilize scientific knowledge transferred from universities (Kodama, 2008).

Internal characteristics of the organization provide critical sources for success. Specifically, both Gold et al. (2001) and Lee and Choi (2003) examined aspects of organizational culture, structure and technology that were directly related to knowledge management (Zheng et al., 2010). Gopalakrishnan and Santoro (2004) examined factors, such as strategy, structure, culture and trust, in an organization's context which affect knowledge and technology transfer. Gupta and Govindarajan (2000) and Lane and Lubatkin (1998) found that absorptive capacity facilitated knowledge transfer (Duanmu and Fai, 2007).

Size

Firm size is one of the most obvious variables representing the firm-level resources, which affects firms' decision regarding R&D cooperation with external factors (Fontana et al., 2006; Segarra-Blasco and Arauzo-Carod, 2008; Eom and Lee, 2010). Large firms can cooperate with partners more effectively than small firms because big firms have more resources to help them in establishing the relationships with partners.

However, there are few studies that argue the opposite: small firms tend to be more eager for external cooperation than large firms, as they face lack of internal resources, especially financial, R&D capacity or facility (Fontana et al., 2006; Eom and Lee, 2010). Tether (2002) found that large firms might be more attractive for the partners than the smaller ones. Segarra et al. (2008) observed that small and innovative firms in Spanish manufacturing and service industries find it very difficult to find R&D partners (Segarra-Blasco and Arauzo-Carod, 2008).

Fritsch (2001) empirically investigated the propensity to engage in cooperation and found that this is positively influenced by firm size and R&D intensity (Tödtling et al., 2009). Beise and Stahl (1999) found the significantly positive effect of firm size, measured by the number of employees, on the generation of innovations which could not have been developed without the public research done by universities. Laursen and Salter (2003) found a significantly positive effect of the number of employees on the degree of knowledge use created at universities. In short, four out of six studies that incorporate variables on size have found some pieces of positive evidence for the relationship between firm size and university-industry interactions (Azagra-Caro, 2007).

Absorptive capacity

Cohen and Levinthal (1989, 1990) introduced the concept of 'absorptive capacity', which refers to the firm's ability to identify, assimilate and apply (for commercial ends) the knowledge which is external to the firm (Kodama, 2008; Bishop et al., 2011). Firm's absorptive capacity has a relevant impact on the ability of firms, in order to cooperate with external organizations (Nieto and Quevedo, 2005; Segarra-Blasco and Arauzo-Carod, 2008). Zahra and George (2002) considered the multifaceted nature for absorptive capacity and proposed that it is comprised of 'potential' and 'realized' capacities. The former includes knowledge acquisition and assimilation capabilities and the latter include knowledge transformation and exploitation (Bishop et al., 2011). Empirical evidence shows that absorptive capacity of the firms, enables an efficient technology transfer between universities and firms (Kodama, 2008). Davenport and Prusak (2000) argued that the knowledge transfer process consists of transmission and absorption, culminating in a behavioral change by the recipient. They considered lack of absorptive capacity in the recipient as a friction, which slows or prevents transfer (Daghfous, 2004).

In their 1990 paper, Cohen and Levinthal stated that absorptive capacity can be generated in a variety of ways. While they argued that absorptive capacity can be seen as a byproduct of a firm's R&D investment, they acknowledged also that manufacturing experience can provide the firm with the necessary background, in order to both recognize and implement new methods (Bishop et al., 2011). Also, the capacity to evaluate and use external know-how is largely a function of prior related knowledge. This prior related knowledge confers ability to the recipient firm so as to recognize the value of new knowledge or information, assimilate it and apply it to commercial ends (Daghfous, 2004; Nieto and Quevedo, 2005). Some authors have noted that such prior knowledge can arise as the by-product of doing R&D activities in the firm itself (Nieto and Quevedo, 2005). For instance, Shane (2000) found that prior knowledge of entrepreneurs plays a significant role in the number of opportunities that they discover following a technological change. Kim (1998) argued that the success of organizational learning depends on the firm's absorptive capacity, which itself is determined by the firm's prior related knowledge (Daghfous, 2004).

Additionally, Cohen and Levinthal (1990) argued that absorptive capacity can be developed by deliberate efforts in order to benefit from personnel exchange and training. In particular, Cohen and Levinthal (1990) suggested that when a firm wishes to acquire and use knowledge that is unrelated to its current knowledge base, deliberate efforts are required for creating absorptive capacity (Bishop et al., 2011).

R&D intensity

As a firm-level variable, R&D intensity also matters as one possible proxy for the absorptive capacity of a firm (Fontana et al., 2006; Eom and Lee, 2010). Firms that invest in R&D are likely to absorb the information developed outside the firm (Segarra-Blasco and Arauzo-Carod, 2008). Other studies have incorporated the level of R&D expenditure and/or R&D intensity. Firms that invest heavily in R&D are likely to possess a high technological capability allowing them to absorb the knowledge developed outside the firm (Fontana et al., 2006). Firms whose R&D capacities are large enough to absorb external knowledge are expected to seek such linkages easily and more actively. However, the opposite situation may occur as well; these capable firms may want to try to substitute in-house efforts for the external cooperation (Eom and Lee, 2010).

In line with other studies, Bishop et al. (2011) explored the role of the firm's commitment to R&D in order to determine the types of firms that are particularly likely to benefit from university interactions. The measures typically used for studying the firm's commitment to R&D are R&D intensity or the presence of an R&D lab. Laursen and Salter (2003) found a significantly positive effect of the ratio of R&D expenditure on the degree of knowledge use created at universities. Moreover, Hanel and St. Pierre (2006) found that, in knowledge-based industries and in firms with their own in-house R&D efforts, there is a higher probability of collaboration with universities (Azagra-Caro, 2007).

Structure

Organizational structure plays a key role in knowledge management regarding the development, transfer and use of knowledge, because it can facilitate the coordination of all the elements inside the organization so that it can fulfill its objectives (Gopalakrishnan and Santoro, 2004; Pertusa-Ortega et al., 2010). Firms must design structures and systems which facilitate the flow of knowledge so that the organization can create, accumulate, integrate and disseminate and, hence manage, this resource effectively (Pertusa-Ortega et al., 2010; Liao et al., 2011). Organizational structure is usually categorized to three elements of formalization, centralization and complexity (Gopalakrishnan and Santoro, 2004; Chen and Huang, 2007; Liao et al., 2011). The term 'formalization' refers to the degree to which jobs within the organization are standardized and the extent to which employee behavior is guided by formal rules, standard policies and procedures (Chen and Huang, 2007; Liao et al., 2011).

Formalization facilitates inter-functional transfer of explicit and codified knowledge by means of rules that

ease the circulation of the knowledge produced among different parts of the organization and nurture them with new ideas and different viewpoints. Formalization also reduces ambiguity (Pertusa-Ortega et al., 2010). Some authors have considered the rules that restrict the creation of knowledge because of limiting the chances for organization members to communicate and interact with one another; and the range of new ideas seems to suffer when strict formal rules dominate an organization (Pertusa-Ortega et al., 2010). According to Robbins (1990) and Fredrickson (1986), complexity refers to the degree of differentiation that exists within an organization. The three dimensions that usually indicate the level of structural complexity are horizontal, vertical and spatial differentiation. Vertical differentiation refers to the number of hierarchical levels in the organization; spatial differentiation is the degree to which the location of an organization's offices, plants and personnel are geographically dispersed and horizontal differentiation has to do with the degree of differentiation between—generally interrelated—units based on the nature of the tasks performed by members, their education or training (Pertusa-Ortega et al., 2010; Liao et al., 2011).

A low degree of centralization of the decision-making process can complement and enhance the knowledge performance that may result from formalization and complexity.

Centralization refers to the degree to which the right to make decisions and evaluate activities is concentrated while decentralization of decision-making is a consequence of the distribution of authority among different structural components. Decentralization fosters the incorporation of a greater number of individuals and organizational levels into the process of strategic reflection (Pertusa-Ortega et al., 2010; Liao et al., 2011).

Strategy

Organizational strategy refers to “a plan for interaction with competitive environments to achieve organizational goals”. Organizational strategy has been a central theme in the strategy literature and is closely related to organizational performance. Organizational strategy can then be perceived as the organization's plan for creating and deploying knowledge assets.

Knowledge management partially carries the influence of strategy through defining what strategic knowledge is, coordinating critical knowledge transfers and guiding key knowledge exploitation efforts which could result in enhanced effectiveness (Zheng et al., 2010). Gopalakrishnan and Santoro (2004) defined strategy as referring to the actions that firms pursue in order to improve their overall competitive position and, in this case, strategy is the firm's pursuit of knowledge transfer and/or technology transfer.

Culture

Organizational culture is a complex construct consisting of shared assumptions, values and norms. It is a source of sustained competitive advantage and empirical research shows a positive relationship between organizational culture and knowledge management (Gopalakrishnan and Santoro, 2004; Zheng et al., 2010). It is a key factor for organizational effectiveness and exerts its influence through shaping the behavior of organizational members (Zheng et al., 2010). Knowledge management practices capturing the process of how new external and internal information is absorbed, digested, positioned and integrated into an organizational memory. The whole process is conditioned by organizational culture because the values and behavioral norms held by organizational members serve as a filter in the sense-making and meaning-construction processes (Gopalakrishnan and Santoro, 2004; Zheng et al., 2010). The success of knowledge management is positively associated with the degree to which the organizational culture is generally supportive of learning, change and innovation (Yakhlef, 2007).

Trust

Various scholars have advocated trust as a necessary ingredient for the effectiveness of intra- and inter-firm collaborative efforts, since it facilitates learning and innovation (Gopalakrishnan and Santoro, 2004; Santoro and Saporito, 2006; Vaccaro et al., 2010). Cooperation relations are based on trust, a shared understanding of problems and objectives, and acceptance of common rules and behavioral norms (Santoro and Saporito, 2006; Tödtling et al., 2009). Previous studies have demonstrated that lack of trust in collaborations can deter efficient knowledge exchanges (Vaccaro et al., 2010). Trust within or between organizations is often conceptualized as a confident expectation and goodwill that a focal organization places in the partner organization. The literature on organizational trust in exchange relationships suggests that trust exists when one party has confidence in an exchange partner's reliability and integrity (Li, 2005).

Trust is defined in the literature as the “willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” (Santoro and Gopalakrishnan, 2000; Gopalakrishnan and Santoro, 2004). Gopalakrishnan and Santoro (2004) argued that organizational trust plays a role in knowledge transfer and technology transfer activities. They offered two reasons to illuminate how trust reduces this vulnerability and facilitates technology transfer and knowledge transfer

activities. First, when collaborating organizations build trust, they develop confidence in their partner's abilities and expected behavior. Trust also serves as a control mechanism that helps govern economic transactions between the firm and its university partner. When a high level of trust exists, the firm has more confidence in the university research center's abilities and motives and is more willing to share its ideas, feelings and goals with the center.

DISCUSSION

Innovation literature repeatedly emphasizes the positive impacts of university–industry interactions on firms' innovative performance. Knowledge and the capability to create and utilize knowledge are important sources of a firm's sustainable competitive advantage. So, it needs to support a variety of knowledge transfer channels which are more appropriate to the needs of the industry. Globalization, fast changing technology and increasing competitive have made effective knowledge transfer central to a firm's success. The increased emphasis on knowledge- and technology-transfer across university–industry institutional boundaries have led to the creation and implementation of a variety of transfer-oriented mechanisms including publications, mobility personnel, meetings, R&D cooperative research, science parks and spin-offs. Furthermore, the intensity and efficiency of the interactions between the chief actors involved in the generation and dissemination of knowledge facilitates knowledge transfer. It also considers a critical role for healthy and adaptable relations between university and industry leading to the rapid development in the growth and shaping of new industries. Using various kinds of mechanisms, instead of a unique one, is more likely to prepare the required capabilities for bridging the gap between scientific research and its application in industry. Furthermore, to increase an effective knowledge transfer, university researchers and firms need to know the factors affecting the firm's ability in accessing knowledge from university. Also, industry, as a consumer and user of knowledge, should have the ability to comprehend, interpret, evaluate and attract academic knowledge according to its requirements. So, the present study explored many factors associated with knowledge transfer from universities to firms. A broad range of firm-level characteristics were accounted for which could help explain private companies' interactions with university; thus insightful recommendations were provided for improving the process.

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