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Network embeddedness and new product development in the biopharmaceutical industry: The moderating role of open innovation flow

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ABSTRACT

This paper explores the role of centrality and structural holes positions on the likelihood to develop new products and the moderating role of the open innovation flow, a measure of the net knowledge flow crossing the firm's boundaries, on the aforementioned relation. We argue that network positions provide the information content to the firm, whilst open innovation flow describes how the firm uses such content, thus the combination of these two concepts has a significant impact on new product development. We test the theoretical framework on a large sample of 544 public companies and data from 1758 agreements among 1890 bio-pharmaceutical firms through the period 2006–2010. Our results show that being centrally located in the network positively affects the new product development process, while having a structural holes position has no effect on the aforementioned performance. However, the interaction of the two network positions with the open innovation flow has a positive impact on the likelihood to develop new products.

1. Introduction

Social capital (SC) scholars highlight how structural network embeddedness influences the ability of the firm to develop innovations such as patents (Ahuja, 2000; Schilling and Phelps, 2007; Phelps, 2010), significant improved products/services (Pèrez-Luño et al., 2011) and new product awards (Soh, 2003). Open innovation (OI) scholars (Chesbrough, 2003) evidence how the incoming flow of knowledge provided through inbound OI practices (West and Bogers, 2013), such as in-licensing, acquisition of R&D services and technologies, influences the firm's innovation performance such as patent development (Sampson, 2007), patent citations (Li and Tang, 2010) and new product development (Un et al., 2010).

By analyzing the aforementioned contributes two interesting issues emerge. First, while OI scholars enhance our understanding of how openness improves new product development, to the best of our knowledge, SC literature has not examined specifically whether and how structural network embeddedness, i.e. the firm's network position, is able to improve the ability of the firm to develop new products. This omission is glaring, especially in the bio-pharmaceutical industry, where developing new products allows achieving monopoly rents for several years ahead.

Second, a more relevant issue concerns the relation between the information asset provided by the network position and the use of such resources provided by the direction of the knowledge flow that the firm builds through OI practices. Indeed, while SC scholars point out the information dimension of network embeddedness by evidencing how information volume, diversity and richness, provided by different network positions, can enhance firm's performance, they fall short on tackling the potential benefits springing out from the actual use of such information in term of knowledge flow creation or dissipation (Koka and Prescott, 2002, 2008). On the other hand, OI scholars evidence the effect of an inflow of knowledge, provided by inbound practices, on innovation performance, however they ignore the role of firm's structural position as a source of information asset, enhancing the developing of the knowledge flow. Thus, the second contribute of this research is understanding how the direction of the knowledge flow across the organizational boundaries provided by OI practices is able to enhance (or deteriorate) the positive effect that some network positions have on innovation performance. The importance of such contributes to the literature is recently highlighted by an editorial of a special issue on OI research where the authors affirm: "While research on strategic alliances has profited greatly from a network perspective, the link between open innovation and social capital is underdeveloped" (West et al., 2014: 809).

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In order to accomplish these aims, we define a measure of the net knowledge flow crossing the firm boundaries. We define *open innovation flow* as the attitude of a firm of balancing inflow of knowledge and outflow of knowledge through the prevalence of inbound and outbound practices; it is positive when inflow of knowledge is greater than outflow of knowledge and vice versa. Thus, the open innovation flow provides insights on how the firm uses the information content provided by its network position to enhance (or deteriorate) its capacity to develop new products. We build a theoretical framework and we test it within the bio-pharmaceutical context. We gather data on a network of inter-firm relations among bio-pharmaceutical firms through 2006 to 2010 using information from the *BioWorld* database. We construct the network characteristics by collecting a total amount of 1758 agreements among 1890 bio-pharmaceutical firms in the period 2006–2010. We collect data on patents, new products and firm attributes for a sample of 544 public companies belonging to the aforementioned network using multiple sources of other data.

Our results show that, although structural embeddedness positions (centrality and structural holes) have a direct positive influence in the process of new product development, the effect is significantly amplified when a net positive knowledge flow is involved.

The paper is organized as it follows. In section two, we develop the theoretical framework. Then, we describe the development of the dataset and explain the estimation models. Next, the empirical findings are presented. Finally, the paper concludes with a discussion of the theoretical and managerial implications of the study, some limitations of the research and suggestions for future research directions.

2. Conceptual development and hypotheses

2.1. Structural network embeddedness and new product development

As structural network embeddedness (Granovetter, 1992; Moran, 2005) we mean the "impersonal configuration of linkage between network actors" (Nahapiet and Ghoshal, 1998: 244) such as the presence or absence of ties, connectivity, centrality and hierarchy. SC scholars associate structural embeddedness with the extent of information a firm can obtain from its network of relations (Koka and Prescott, 2002, 2008). According to this view, structural embeddedness is analyzed along two network features. The first is *centrality* (Borgatti et al., 2002; Koka and Prescott, 2008); having a central network position provides the ego firm with information *volume*, i.e. a dimension emphasizing the quantity of information that a firm can access and acquire through its position in the network of inter-firm ties (Koka and Prescott, 2002).

The second feature – *structural holes* – highlights the brokerage opportunities created by an open social structure (Burt, 1992). Structural holes are open and not densely tied network structures that provide the ego firm with entrepreneurial opportunities, i.e. the possibility to act as bridges between the different parts of the network (Koka and Prescott, 2008). Thus, by occupying a structural holes position a firm access to information *diversity*, i.e. the variety and to a somewhat lesser extent quantity of information that a firm can access through its relationships (Koka and Prescott, 2002).

From the seminal work of Uzzi (1996), several scholars have tried to understand how structural network embeddedness influences organization's performance. Through an in-depth review of SC empirical studies, we examine scientific papers that have empirically investigated the role of the network embeddedness in explaining innovation and organizational performance. Table 1 summarizes the results of the literature review. From the literature analysis, we found several scholars that evaluate the impact of network embeddedness on economic-financial performance of the firm (Koka and Prescott, 2002; Bae and Gargiulo, 2004; Zaheer and Bell, 2005; Maurer and Ebers, 2006; Shipilov, 2006; Acquaah, 2007; Goerzen, 2007; Shipilov and Li, 2008; Wu, 2008; Malik, 2012) and some other scholars dealing with innovation performance (Ahuja, 2000; Soh, 2003; Salman and Saives, 2005; Schilling and Phelps, 2007; Gilsing et al., 2008; Padula, 2008; Pieters et al., 2009; Vanhaverbeke et al., 2009; Phelps, 2010; Pèrez-Luño

Table 1
Literature review on SC and firm performance.

Authors	Performance measures	Operationalization
Acquaah (2007)	Organizational performance	Sales and revenues, net income, return on assets, return on sales, growth in productivity
Ahuja (2000)	Innovation output	Number of successful patent applications
Bae and Gargiulo (2004)	Organizational profitability	Return on investment, return on asset
Gilsing et al. (2008)	Explorative innovation performance	Number of patents
Goerzen (2007)	Economic performance	Operating return on sale, return on asset, operating return on capital
Karamanos (2012)	Innovation performance	Number of patents
Koka and Prescott (2002)	Firm performance	Sales per employees
Pèrez-Luño et al. (2011)	Radical innovation	Five-item scale regarding new or significant improved products/services
Malik (2012)	Firm performance	Return on revenue
Maurer and Ebers (2006)	Firm performance	Revenue and employment growth, patenting rate
Molina-Morales et al. (2010)	Innovation performance	Innovation in processes and products
Padula (2008)	Rates of innovation	Number of successful patent applications
Phelps (2010)	Degree of exploratory innovation	Number of patent citations
Pieters et al. (2009)	Innovative performance	Weighted patent counts
Salman and Saives (2005)	Innovation performance	Number of patents
Schilling and Phelps (2007)	Knowledge creation	Number of successful patent applications
Shipilov and Li (2008)	Firm's market performance	Revenue-generation abilities
Shipilov (2006)	Firm performance	Market share
Soh (2003)	New product performance	Number of new product awards
Vanhaverbeke et al. (2009)	Exploitative/explorative technology innovation	Weighted patent counts
Vanhaverbeke et al. (2012)	Core/non core technology	Number of patent citations
Wu (2008)	Firm competitiveness	Three items scale regarding firm's competitors, products/services quality, reaction to market demand
Zaheer and Bell (2005)	Firm performance	Market share

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