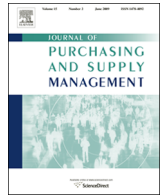




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Supply chain of innovation and new product development



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ABSTRACT

This paper conceptualizes the supply chain of innovation of a company as its supply chain not related to physical goods exchanges but to R&D commodities exchanges. R&D commodities, being the outcomes of research activities, are for example patents, technologies, research services, studies, projects, etc. Specifically, we focus on the relationship between the activities of purchasing/selling R&D commodities and the propensity of the firm to develop new products; we examine how the position of the firm within its innovation network moderates this relationship. The empirical setting of the research consists of a cross-sectional dataset of 544 biopharmaceutical companies that have signed 1772 R&D agreements in the years 2006–2010. We find firstly, evidence of the supply chain of innovation (as a natural evolution of the well-acknowledged dual-market model of the biopharmaceutical industry). Secondly, we find that the relational embeddedness, coming from innovation network, influences the effect of purchasing and selling R&D commodities on new product development. Supporting our theoretical predictions, this paper offers contributions to the scientific literature on supply chain relationships in new product development.

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1. Introduction

The movement of firms towards opening their new product development (NPD) process, for example by involving and integrating with suppliers, has rapidly increased since the 1990s (Harland, 1996). For this reason the operations and supply chain management academic community, in the last two decades, has deeply investigated collaboration models in NPD, such as supplier involvement (Johnsen, 2009) and customer integration (Flynn et al., 2010).

However, besides collaborating with suppliers and customers during the NPD process, companies did also start using external competencies and exploiting internal knowledge in the form of R&D commodities by directly purchasing and selling them from and to external parties. External parties include universities, research centers, other companies, but also suppliers and buyers (Pilkington, 1999). R&D commodities are R&D products or activities that can be purchased and/or commercialized, such as R&D services, projects, patents, technologies and licenses.

While the operations management literature has put much effort in exploring the effects of collaboration with traditional

suppliers and buyers on NPD performance, much less attention has been paid to analyse the effect on NPD of purchasing and selling R&D commodities to and from external parties. However, a lot of empirical works have demonstrated that these more and more adopted practices strongly influences the innovation performance of the firm (Mazzola et al., 2012; West et al., 2014). For this reason, when designing the NPD process, managers should take into account precise considerations about the consequences of R&D purchasing and selling on the outcome of this process.

To fill this gap, in this paper we explore the relationship between R&D purchasing/selling activities and the firm's NPD, and we conceptualize the *Supply Chain of Innovation* (SCOI), as the supply chain not related to the material flow but to the R&D commodities flow. We, indeed, observe that the propensity of a company towards purchasing and selling of R&D brings the company to position itself along the SCOI. Positioning downstream makes the company closer to the final market, and thus it will be stimulated more than others to develop new marketable products. Conversely, positioning upstream makes it closer to the R&D market, and thus the company will be stimulated more than others to develop and sell R&D commodities instead of end-consumer products. In other words, in this paper we use the SCOI lens to understand and interpret the consequences of R&D purchasing and selling in terms of NPD performance.

Actually, besides being positioned within the SCOI, the company is also surrounded and embedded in a more complex web of

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inter-firm relationships (Wu, 2008). Each company, indeed, not just buys and sells R&D commodities in order to acquire or exploit knowledge, but also signs alliances and other bilateral agreements with other companies for similar purposes. From the complex network of relationships surrounding each company, the company itself can benefit in terms of resources and information acquisition (Granovetter, 1992). Specifically, following the recent expansion in research incorporating different strategic management perspectives in the field of operations and supply chain management (Mol, 2003; Krause et al., 2007; Meehan and Bryde, 2014), we absorb social capital view in studying the effect of “being part of a network” on the NPD process. We consider that the quality of the information that a company gains from its network depends on its *relational embeddedness* in the network, i.e. the quality of relationships that the ego firm builds with its partners (Granovetter, 1992; Uzzi, 1996; Meehan and Bryde, 2014). There is a wide consensus among researchers that the firm’s embeddedness and its position in a network of relations matter for its NPD (Soh, 2003; Pérez-Luño et al., 2011; Mazzola et al., 2015). For this reason, in this paper we also explore whether relational embeddedness enhances or reduces the effect of R&D purchasing and selling on NPD.

The empirical setting of this study consists of the total set of agreements signed by biotech companies listed in *BioWorld* database 2006–2010, where biotech company means both pure biotechnological, and biopharmaceutical. We use this setting in order to find evidence of the existence of the SCoI and of the phenomenon of firms’ positioning along it. Indeed, the advent of biotechnology as a new paradigm changed the shape of the classical pharmaceutical industry into a dual market structure (Pisano, 1991; Chiesa and Toletti, 2004; Narayana et al., 2014). Biotech firms are focusing on producing and commercializing different R&D commodities, and thus are positioning themselves along the SCoI.

2. The supply chain of innovation

The supply chain management literature has deeply investigated the role of collaborating with suppliers and buyers in the NPD process. For example, Twigg (1998) examines the relationships between a vehicle manufacturer and six key suppliers which contribute to the final design of products; the author terms ‘design chain’ the interaction of design information between each supplier and customer. In fact, several collaboration modes with suppliers and customers in NPD have been analyzed: supplier innovation generation (Jean et al., 2012); early supplier involvement (Koufteros et al., 2005; Johnsen, 2009); supplier involvement and investment (Song et al., 2011); supplier integration (Petersen et al., 2005; Ettl and Pavlou, 2006; Swink et al., 2007); supplier development (Krause et al., 2007); and customer involvement (Flynn et al., 2010).

To achieve the same objectives of collaboration for NPD, in the last ten years companies started purchasing and selling R&D commodities in many industries: for example, this behavior has been identified as one of the main trends in the biopharmaceutical industry (Chiesa and Toletti, 2004; Birch, 2008). This phenomenon lets us argue that, mostly in high-tech industries, a new kind of supply chain is emerging: namely, the supply chain of innovation (SCoI). We define the SCoI of a company as the supply chain not related to the material flow but to the innovation flow. Physical goods are replaced by patents and the material flow supply chain is replaced by the innovation-flow supply chain.

To make our research context clear, it is essential to specify the difference between material-flow supply chain (SCoM) and innovation-flow supply chain (SCoI).

According to Christopher (1992) a SCoM is a chain (or network) of organizations that are involved in the different transformation processes that add value to one specific product and that bring it to the hand of the ultimate consumer. For instance ‘[...] a shirt manufacturer is a part of a supply chain that extends upstream through the weavers of fabrics to the manufacturers of fibers, and downstream through distributors and retailers to the final consumer’ (Christopher, 1992, p. 12). And indeed, it is usually referred to as the supply chain of a product.

Contrarily, the SCoI is a chain (or network) of organizations involved in the innovation process and not in the transformation (manufacturing) process. For this reason, it is better to conceptualize the SCoI as a chain which is not product-centered, but company-centered. It is the network of businesses including buyers (and buyers’ buyers) and suppliers (and suppliers’ suppliers) involved in the innovation process of a given company, the focal company. This definition is also in line with one of the major uses of the term ‘supply chain management’ as indicated by (Harland, 1996, p. 64): ‘There are four main uses of the term ‘supply chain management’: [...] Thirdly, the management of a chain of businesses including a supplier, a supplier’s suppliers, a customer and a customer’s customer, and so on’.

To illustrate an example of SCoI, consider the following buyer–supplier relationships that Amgen, a large biopharmaceutical company, was recently involved in. We found that Amgen licensed-out 13 molecules to Takeda Pharmaceutical Co. Ltd. Conversely, Amgen has licensed-in the ‘Cabily’ patent family from Genentech Inc., which in turn has purchased research services on multiple drug targets from Sareum Holdings. Of course, these supply chain relationships do not necessarily refer to the same molecule, but they refer to R&D purchasing and selling related to Amgen (independently from specific molecule) with its suppliers and buyers. We also found many other companies (biotech, biopharmaceutical, big-pharma, universities, clinical research organizations, etc.) that were involved in the supply chain of Amgen.

To make clear the difference between the SCoM and the SCoI we summarize the main characteristics of these two types of supply chain in Table 1.

The typical actors involved in the SCoM are suppliers, manufacturers, distributors, and others, which buy from each other (or sell to) physical goods. The objects of each commercial transaction are raw or semi-manufactured parts and components that, thus, flow from upstream to downstream along the supply chain. Contrarily, the actors in the SCoI are research centers or high tech companies which exchange R&D commodities. A supplier in the SCoM, for example, could be a high-tech company with a large body of knowledge (and patent stock) which also sells its R&D commodities to its customers. From the customer side, a company could buy both physical materials and R&D commodities from the same supplier.

The R&D commodity (e.g. a research service, project, patent, technology, or license) is the object of the commercial transaction and the terms ‘supplier’ or ‘buyer’ are meant as provider or user of an R&D commodity. The final product (meant as final result) of the SCoM is the product on the hand of the customer. The final product of the SCoI is, instead, the final outcome of the innovation process, for example a new developed product which has not been industrialized yet.

The typical buyer–supplier relationships in the SCoM are transactional, unless products are co-produced and/or co-distributed. However, while the main goal of the SCoM is transforming raw materials into finished products, its actors are also involved in the new product development process. To this purpose, bilateral agreements (supplier involvement, customer integration, etc.) among firms are necessary to support innovative activities as they can facilitate complex coordination beyond what

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