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Dynamics of R&D networked relationships and mergers and acquisitions in the smart card field

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ABSTRACT

This paper analyzes how the structure and the evolution of inter-firm agreements have shaped the development of the smart card industry. The aim is to establish a closer connection between the evolution of inter-firm agreements in the smart card industry and the patterns of change of technology and demand in this new high-tech industry. Based on a proprietary database covering both collaborative agreements and mergers and acquisitions (M&As) occurring in this industry over the period 1992–2006, we find that the evolution of technology and market demand shapes the dynamics of R&D networks and M&As are likely to change the industry structure. We also find that a small group of producers – first-movers – still control the industry and technological trajectories. Their position arises not for oligopolistic reasons of market structure, but for technological and organizational reasons.

1. Introduction

In the last three decades, the number of inter-firm agreements has been growing rapidly (Hagedoorn, 2002), particularly in high-technology fields, as they have proliferated in one industry after another. The smart card industry results from the cross-fertilization of technologies across several disciplines and, despite its youth, is one of the fields that have been marked by this trend. Over the last decade, the industry has witnessed an increasing number of inter-firm agreements, ranging from alliances to mergers and acquisitions (M&As). There are numerous reasons for these agreements such as joint R&D activities, promotion of standards, implementation of designs, deployment of new applications and penetration of new markets.

Recently, the use of inter-firm agreements has been an important means of understanding and examining the most dynamic changes taking place at the intersection of technologies, market structures and boundaries of firms in different industries. The exploitation of databases such as MERIT-CATI, CORE, LAREA/CEREM (1988), NCRA-RJV and SDC Platinum has clearly shown the evolution and major trends of these different organizational forms through extensive empirical studies (Hagedoorn et al., 2000; Hagedoorn, 2002; Caloghirou et al., 2003; De Man and Duysters, 2005; Moskalev and Swensen, 2007). While most of these have studied inter-firm agreements at a dyadic or firm level, few have adopted dynamic analysis; yet in specific industries, such as high-tech industries, relationships between firms shape networks of alliances. Seeing how networks evolve and change over time (Nohria, 1992), as well as examining the overall structure of inter-firm relationships (Wellman, 1988) should shed more light on the links between the evolution of inter-firm agreements and the patterns of change in these specific industries.

Moreover, the globalization and the intensification of competition in markets around the world, which has increasingly become based on innovation, has led to the use of not only cooperative agreements (or alliances), but also M&As. This is evident in the sharp increase in the number of M&As that have taken place over the past two decades, particularly in high-tech industries (Narula and Hagedoorn, 1999; De Man and Duysters, 2005). While there is a renewed salience of size considerations throughout M&A activity, new R&D, design and engineering capabilities are also relevant (Hitt et al., 1991; Chakrabarti et al., 1994; Cartwright and Schoenberg, 2006). These two modes of interaction between firms, which are

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increasingly overlapping, have become crucial features in structuring the process of innovation and competition in relation to technological and institutional changes. Therefore, they may lead to a better understanding of the linkages between innovation and the evolution of industries on the one hand, and innovation and market structure on the other.

In this respect, several works have studied the most dynamic changes in structures, markets, technologies and so on, spanning various industries. These studies have clearly shown how the analysis of the dynamics and the structure of inter-firm agreements can highlight several aspects about how industries are structured and how they change over time.

The subject of this article also falls within this domain. We focus on the smart card industry because it possesses a combination of features that few industries have known. First, the industry is knowledge-based, having emerged from the convergence of different types of technologies and demand and the resultant broader portfolio of competences. Second, it has rapidly become a worldwide oligopoly dominated by the same set of firms, exhibiting a dual market structure. Third, it is characterized by strong growth dynamics that have been supported by increasing returns to scale and rapid technological change, a considerable investment in innovative activities, a global geographical presence, and the unfolding of a broad range of applications serving many different uses. Fourth, it demonstrates the main characteristics of a network industry (Shy, 2001): complementarity,[1] compatibility, standards, and significant economies of scale on both the supply and demand side (network externalities). Finally, the industry serves a derived demand.

Thus, this paper analyzes how the structure and the evolution of inter-firm agreements have shaped the development of the smart card industry. The aim is to establish a closer connection between the evolution of inter-firm agreements and the patterns of change of technology and demand in the smart card industry by combining industry analysis and network analysis. To the best of our knowledge, the paper is also the first attempt to present a historical overview of trends and patterns in inter-firm agreement formation in the smart card industry.

The paper is organized as follows. In Section 2, we present the theoretical background. Next, we give an overview of the history and economics of the smart card industry. Using a database[2] containing more than 960 agreements, we present and explain the growth patterns in collaboration since 1992. Then, we analyze the R&D network dynamics of the smart card field over the period 1992–2006. This is followed by a discussion of the structure of R&D alliances within the smart card industry network. Our objective is to investigate dynamic changes induced by technological conditions in the inter-firm R&D agreements network. In parallel, we also discuss the role of M&As in the evolution of the industry. We conclude with the findings of the analysis.

2. Theoretical background

Interest in networks has increased greatly over the last decade, since the recognition that the interaction among actors deeply affects innovation and industry evolution (McKelvey et al., 2004; Malerba, 2006). These actors work towards a common objective and form relationships among themselves in order to generate, diffuse and use the advances of new knowledge. The evolution of relationships into networks stresses both the impact of technological change and the dynamics of market demand (Bonaccorsi and Giuri, 2001). Yet the notion of networking may capture the global, national and local dimensions as well as their interactions (Freeman, 1988; Carlsson et al., 2002; Lundvall et al., 2002). It takes into account the variety of actors and networks that simultaneously have to align to create industrial change (von Tunzelmann, 2004). Thus, the nature of interactions among actors and the network of their relationships should play a crucial role in the outcome of innovation processes and the performance of the industry.

While the growing stream of research on networks has been carried out in various ways, the analysis of the structure of networks in industries using social network analysis remains an important area of research. Along these lines studies have appraised dynamic changes in network structures for several of the high-tech industries such as aero-engines (Bonaccorsi and Giuri, 2001), automobiles (Dyer, 1996), biotechnology (Powell et al., 1996; Arora and Gambardella, 1998; Orsenigo et al., 2001), bio-pharmaceuticals (Riccaboni et al., 2003; Powell et al., 2005; Hagedoorn and Roijakkers, 2006), computers (Cloodt et al., 2006), information and communication technologies (Hagedoorn and Schakenraad, 1992; Langlois and Robertson, 1995), semiconductors (Duysters and Vanhaverbeke, 1996; Stuart and Podolny, 2000), and steel (Rowley et al., 2000). These studies have clearly found that the evolution of networks results from the interdependence between actors, and that the structure of networks differs from one industry to another (Kogut, 2000). It was also recognized that the nature of knowledge, demand, industrial setting and institutions affects the evolution of networks (Malerba, 2006).

Knowledge is a key driver for the evolution of industries and the formation of inter-firm agreements. New industries that emerge from the convergence of different types of technologies and demand involve diverse actors with different knowledge, competences and specializations. Therefore, firms form close relationships with other companies to access complementary resources, knowledge and competencies, and generate innovation collectively. Further, rapid technological changes and uncertain environments encourage firms to tie alliances and to rely on network relationships (Powell et al., 2005).

Thus, the process of innovation relies on interdisciplinarity, a knowledge base and learning processes (Nelson, 1994; Metcalfe, 1998; Loasby, 1999; David, 2000; Foray, 2004). On the one hand, it explicitly identifies interdependencies and illustrates the complexity of interactions between its various elements (Kline and Rosenberg, 1986). And on the other hand, it gives rise to a knowledge-based networked oligopoly, resulting from the formation of networks of firms interacting in a specific economic/industry area, rather than individual companies emerging within and/or across industry segments (Mytelka and Delapierre, 1999). The vertical and horizontal boundaries of the firm will be affected by continuous changes in order to acquire new sources of competitive advantages (Dosi et al., 2007). Additionally, the structure of demand can play an important role in the formation and evolution of both vertical and horizontal network alliances and in explaining vertical and horizontal boundary changes.

In such a context, the new knowledge-based oligopolies are dynamic. They are defined in terms of knowledge or competence flows and seek to organize, manage and monitor change. Furthermore, they are intent on shaping the future boundaries of an industry and the technological trajectories (Dosi, 1982), standards and the rules of competition within them, which themselves are a source of dynamic entry barriers. Therefore, new actors, with specific and complementary knowledge or assets, can enter the oligopolies and consequently move and reshape oligopolies' actors. Thus, innovation plays an important role in transforming specific industries and reshaping competition between newcom-

[1] According to Shy (2001), *complementarity* means that consumers in complementary goods markets are shopping for systems (e.g. computers and software, music players and CD titles); in our case smart card terminals or readers, software, etc.

[2] Empirical data for this article has been drawn from our proprietary database SCIFA (Smart Card Inter-Firm Agreements).