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Electrifying the automotive industry: The geography and governance of R&D collaboration

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ABSTRACT

The automotive industry is subject to various pressures that may result in a transition to more eco-friendly technologies. Electrified vehicles represent a potential means to shift road transport onto a new technological path. However, incumbent automakers face several challenges related to vehicle electrification. One challenge is that vehicle electrification requires competences different to those associated with the internal combustion engine. Automakers can access competences and knowledge that can benefit innovation via collaborative R&Dwith external organisations. This paper uses patent and bibliometric data to examine geographical and organisational aspects of R&D collaboration in the automotive industry. We distinguish between two modes of organisation for R&D collaborations between automakers and external partners (hierarchies and networks) and compare R&D collaborations for electric vehicle technologies with traditional R&D partnerships. We show that automakers collaborate with foreign partners when they are linked viahierarchies and are embedded in local R&D networks with academic partners.

1. Introduction

The global automotive industry is unsustainable in many respects, and is subject to various pressures that may force road transport onto a new technological path. First, the recent economic

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downturn caused substantial losses in sales for numerous automakers (Dooley et al., 2010). Governments were forced to intervene with recovery packages to save jobs, the most notable being the salvation of General Motors by the US Obama administration. Second, the global reconfiguration of the automotive industry that followed the rapid economic development of Asian economies has resulted in the emergence of new markets (Abrenica, 1998; Humphrey and Memedovic, 2003) and new automotive companies in India and China that are competing with previously incumbent automakers. Third, increased global demand for automobility has driven fuel prices upwards and refocused attention to the fact that oil is a finite and geopolitically sensitive resource (Wells, 2010). Fourth, the conflation of these factors with ecological issues such as global warming has resulted in environmental legislation that forces automakers to improve vehicles' fuel efficiency and utilise alternative technologies and fuels.

Several automakers have developed electrified road vehicles in response to these 'megatrends' (Conrady, 2012). Electric vehicles have regained popularity in the last two decades and vehicles with various configurations of internal combustion engines (ICE) and electric motors have been developed. Toyota was an early mover in the electrification upswing with the Prius, first sold in 1997 (Magnusson and Berggren, 2001). Since the late 1990s other automakers have introduced hybrid and fully electric cars, buses and trucks. Hydrogen fuel cells represent another alternative for electrification.

Staying abreast of this trend poses challenges for automakers. One challenge is that electrification requires knowledge and competences that are notably different from those inherent to the ICE (Aggeri et al., 2009). Integrating electric motors, batteries and regenerative braking systems into vehicles means that automakers must develop more complex control systems to control and monitor electrical subsystems and components, and requires competences in fields such as electronics and computing. Connecting electric vehicles to the electricity grid via charging stations or 'slide-in' technology requires developments in ICT and utilises competences from electric power engineering. In other words, the potential for a transition to electrified vehicles means that automakers must draw on knowledge and skills that are beyond their traditional competence bases. Hence automakers may find it useful to seek out external partners with competences that can assist in an electromobility transition. The strategic alliance between Renault and Nissan, for instance, aims in part to develop 'zero-emission' transportation (Nissan, 2012). The alliance encompasses R&D collaboration on various key technologies for electrification, realised via joint venture activities such as the Automotive Energy Supply Corporation, which aims to develop and mass-produce lithium-ion batteries. The alliance is designed to help develop and access competences relevant for innovation and boost competitive advantage.

These types of partnerships represent credible ways of boosting innovation. Generally speaking, the generation of new ideas and knowledge for innovation is increasingly recognised as an outcome of creative interactions between actors with complementary knowledge bases and competences (Gilsing et al., 2008). Hence innovation management scholars tend to advocate open innovation strategies that blend external sources of innovation with company-level competences and assets (Chesbrough, 2006). The benefits of collaborations between companies and external partners are widely known. Companies can gain access to key markets, technologies, competences and skills that are useful for innovation (Mariti and Smiley, 1983; Lynn, 1988; Eisenhardt and Schoonhoven, 1996; Powell et al., 1996; Hagedoorn and Duysters, 2002). Through collaboration, companies can become better equipped to boost their competitive advantage, especially where increasing product complexity makes it difficult to maintain a workforce with the human capital necessary for innovation (Porter and Fuller, 1986; Hagedoorn and Schakenraad, 1990). Furthermore, R&D collaboration is important when industries undergo transitions to new technologies, especially where market incumbents do not possess the requisite competences and skills.

However, there are various factors that can inhibit R&D collaboration, including the structure and dynamics of competitive markets, a lack of social capital, cultural differences between skilled practitioners and even the types of knowledge shared between partners (Polanyi, 1967; Powell et al., 1996; Lundvall et al., 2002). Together these elements can inhibit the forces of globalisation as regards R&D collaboration, which is in some instances more suited to a local geographical scale (Martin and Moodysson, 2011).