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Firm technological trajectory as a driver of eco-innovation in young small and medium-sized enterprises

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ABSTRACT

Few studies have focused on green innovation in young small and medium-sized enterprises. Instead, research tends to focus on large companies with formal research and development departments, studying the influence of the firm's current technological strategy as well as the regulatory framework as a key driver of eco-innovation. This paper proposes that the combination of a firm's technological trajectory and its current research and development strategy are key determinants of eco-innovation. The authors investigate these relationships with panel data on 212 young firms in Spain, analysing their innovation strategy and behaviour during their first 10 years of activity. The results show that the firms cluster into four technological trajectories, but only "market-oriented innovators" engage significantly more in eco-innovation. These firms are characterized by a high use of formal appropriability mechanisms, market opportunity recognition arising from cooperation and high knowledge cumulativeness. This paper sheds light on whether and the extent to which a firm's technological trajectory is a driver of eco-innovation. It confirms that firms that search for opportunities and have a continuous collaboration with market players are more prone to develop eco-innovations. Additionally, it shows that path dependence occurs in the development of eco-innovations, in that a highly developed innovation capacity leads to additional green-innovation in the future. The findings indicate that young small firms need to develop innovation capabilities that also enable them to adopt advanced technology before striving to become greener. The paper concludes that policies designed to stimulate cooperative networking with other market players, an upgrading of technological capabilities, and the adoption of new technologies are all desirable because they contribute to improving the environmental impact of firms' innovations.

1. Introduction

In recent years, innovations are linked to the ecology more and more often (Przychodzen and Przychodzen, 2015). A firm's environmental orientation is the managerial recognition that its activities have an impact on the environment and that there is a need to minimize this impact (Mondéjar-Jiménez et al., 2015). One way firms can become greener is through eco-innovation that is, any form of innovation that aims to significantly and demonstrably address the goal of sustainable development by reducing detrimental effects on the environment or by enabling a more efficient and responsible use of natural resources and energy (European Commission, 2007). In today's business environment, companies have a greater awareness of the impact of their activities on the environment and are increasingly motivated by environmental concerns in their pursuit of innovation (Sáez-Martínez et al., 2014). However, research tends to focus on eco-innovation in large companies with formal research and development (R&D) departments while overlooking the role of small and medium-sized enterprises (SMEs) (Schiederig et al., 2012). This might be because SMEs are still rather reluctant to include environmental considerations in their practice (Revell and Rutherfoord, 2003). These smaller firms have found it difficult to convert green practices into competitive advantage and bottom-line enhancements in their financial performance. For example, in a study of the pulp and paper industry in Spain, Del Río (2005) finds that SMEs perceive the benefits of environmental management as lower than larger firms. However, more recent research shows that green initiatives among SMEs have begun to proliferate (Revell et al., 2010). A body of research on

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environmental management practices among SMEs is emerging, and significant progress has been made in the production of eco-friendly products during the last several years (Panainte et al., 2014). This literature had tended to focus on the influence of a firm's current technological strategy and the regulatory framework as the key drivers of eco-innovation. This approach obscures the effect of a firm's past choices and its prevailing technological trajectory on its eco-innovation investments and current decisions. Furthermore, there is a call for "further research to better understand the preconditions for successful sustainability efforts within firms" (Hoffman et al., 2012, p. 541). Additionally, Del Río et al. (2016, p. 2168) in their recent review of the empirical literature on eco-innovation, call for further analyses with panel data models, as they are "virtually absent." This paper responds to these calls and contributes to the literature by focussing on an understudied driver of eco-innovation for SMEs using panel data, their "technological trajectories." Recent literature reviews on the drivers and determinants to eco-innovation show this absence (Bossle et al., 2016; Díaz et al., 2015). Moreover, Del Río et al. (2016, p. 2169) claim that "although path dependency and innovation persistence have been main topics in the general innovation literature […] they remain largely unaddressed topics in the literature on firm-level drivers to eco-innovation with econometric methods." This paper fills this gap in the literature.

In *Capitalism, Socialism and Democracy,* Schumpeter (1942) views technological change as a gradual process of technological accumulation. This vision pinpoints a large degree of path dependence, such that companies are on individual trajectories in terms of their accumulated competencies and experiences, which are difficult to change (Frenz and Prevezer, 2012). We suggest that having a particular technological trajectory affects search routines that characterize innovation and, therefore, some firms are more prone to an environmental orientation than others. We propose a contingent framework for explaining eco-innovation that integrates both internal (e.g. the prevailing technological trajectory of each firm and its R&D strategy) and external (e.g. industry) drivers. The primary research questions are as follows:

1. *Does the technological trajectory of a firm drive eco-innovation*?
2. *Which features characterize the technological trajectory of young SMEs*?

To answer these questions we focus on start-up firms, and follow their innovation decisions and technological trajectory through their first 10 years of activity to determine the effect of this trajectory on the environmental orientation of their innovations. We argue that previous decisions, investments and behaviour can explain current environmental orientation. Therefore, we propose that there is a "past determinism" that influences a firm's current eco-innovation orientation.

We structure the remainder of this paper as follows: In the next section, we review the literature and develop the hypotheses. The following section describes the data, the methods we employed, and the results. In the final section, we discuss the empirical results and conclude with implications for policy makers, academics and practitioners.

2. Theoretical framework: technological trajectories and eco-innovation

Eco-innovation involves economic and natural-resource benefits (Levidow et al., 2016). It can be defined as "the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources used (including energy use) compared to relevant alternatives" (Kemp and Pearson, 2007, p. 7). The literature has used different theoretical frameworks to explain a firm's intention to eco-innovate. It is widely accepted that technology push, market pull, and the regulatory push–pull effect are the main drivers of eco-innovation (Horbach et al., 2012; Rennings and Rammer, 2011). New eco-friendly technologies can be incorporated through technology push factors whereas environmentally friendly products can be included through market pull factors (Rennings, 2000). Recent research also analyse the impact and the role of stakeholders into eco-innovation practices (Tyl et al., 2015).

From a dynamic capabilities perspective (Teece et al., 1997), certain firm capabilities may be required to successfully implement environmental management. Horbach et al. (2012) contend that internal R&D, high investment intensity, and improvements in a company's innovative capacity are important drivers of eco-innovations that make firms economically successful. This might be because the "availability of greater technical knowledge within a company moderates its vulnerability in the face of the demands of new environmental regulations" (Canon de Francia et al., 2007, p. 307). A firm's ability to eco-innovate is traditionally linked to the role of resources and capabilities and to the pool of knowledge available within the company (Doran and Ryan, 2014). However, several studies have identified the positive effects of incorporating external knowledge, and compared with other innovations "eco-innovation activities seem to require more external sources of knowledge and information" (Horbach et al., 2013, p. 523).

Nelson and Winter (1982) assert that a certain degree of path dependence is established in search routines that characterize innovation and technology within the firms. In this context, Winter (1984) introduces the term "technological regime," which reflects the particular characteristics associated with industries. As a result, firms become clustered in technological regimes that influence, at least partially, their innovation processes. Pavitt's (1984) taxonomy of sectoral patterns of technological change is one of the first and most cited classifications of firms according to different determinants of innovation. These technological regimes act as contingency factors that influence innovation processes in industries and in incumbent firms (Castellacci, 2007). Technological regimes are defined in terms of at least three dimensions: (1) appropriability conditions; (2) opportunity conditions, either (a) technological or (b) from the market-based; and (3) cumulativeness conditions (Malerba and Orsenigo, 1993). These three dimensions define the knowledge and learning environment in which firms operate and develop their innovation activities. The literature on technological regimes identifies and measures appropriability, opportunity and cumulativeness conditions at the industry level. Our approach is similar, but at the firm level.

Pavitt (1984) argues that the technologies firms use are individual and built up from their own manufacturing processes, and are usually modified and adopted from other firms and from the science base. This concept of "technological accumulation" indicates that firms are on unique technological paths or trajectories with their own acquisition of skills and capacities (Cantwell, 1989). "Although firms in an industry will be drawing on a similar set of original developments in a technology, they will each adapt the technology to their own ends differently and integrate it with their existing production methods" (Frenz and Prevezer, 2012, p. 305). Thus, companies become entrenched in an individual trajectory in

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