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The role of process innovativeness in the development of environmental innovativeness capability

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ABSTRACT

Previous research suggests that innovation resources (i.e. internal and external Research & Development, acquisition of machinery, hardware, software, patents, and licenses) enhance environmental innovations. However, it is unknown how these resources should be deployed to develop environmental innovativeness capability. This research builds upon the resource management framework and proposes that environmental innovativeness capability is developed, at the firm level, through a two-sequenced bundling process. First, innovation resources are bundled into process innovativeness capability. Then, process innovativeness capability is extended to develop environmental innovativeness capability. The proposed model is tested with data collected through the 2008 *Community Innovation Survey* in Germany. The results confirm this two-sequenced bundling process. Specifically, results indicate that internal, external, hybrid innovation resources, and knowledge brought through Research & Development cooperation with suppliers are bundled into process innovativeness capability. Then, process innovativeness capability is extended and bundled with the knowledge brought through Research & Development cooperation with public research institutions into environmental innovativeness capability. These results are important because they provide a much-needed understanding on the development of firm level capabilities to undertake environmental innovations. Finally, this paper recommends managers to deploy their innovation resources to build capabilities on innovating processes, which in turn is the base for developing environmental innovativeness.

1. Introduction

Climate change has put pressure on managers to reduce their consumption of fossil-generated energy, and to eliminate waste and residuals along their production processes (Plambeck and Toktay, 2013). Consequently, firms need to adopt environmental technologies to substitute hazardous material, enhance energy efficiency, reduce water consumption, and change towards renewable sources of energy. However, firms usually lack the knowledge to cope with the ever increasing sustainability demands from multiple stakeholders (Horbach, 2008). Additionally, the required knowledge spans several domains, and is usually owned by organizations outside the industry, or in fields where firms have little familiarity (Ghisetti et al., 2015). Therefore, to adopt or develop environmental technologies, firms either have to find new ways to use their existing resources, or have to bring in new resources.

Environmental innovation is defined as *"the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the firm [or organization] and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives"* (Kemp and Pearson, 2007, p. 10). Researchers have identified three main antecedents of environmental innovation: (1) Pressure from the government (e.g. taxes and subsidies); (2) pressure from consumers and industry norms; and (3) innovation resources. Innovation resources are classified into internal R&D, external R&D, hybrid resources (i.e. acquisition of machinery, software, patents, and licenses), and R&D cooperation with stakeholders (Cainelli et al., 2015; De Marchi, 2012; Horbach, 2008; Kesidou and Demirel, 2012). Previous research on environmental innovation has built upon the resource-based view (RBV) to argue that innovation resources enable environmentally innovative firms to distinguish themselves from non-environmentally innovative firms

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(Bossle et al., 2016; Ghisetti and Pontoni, 2015). However, there is little research about how firms develop their environmental innovativeness capability.

Furthermore, environmental innovation entails other types of innovation such as process innovation. For instance, detergent manufacturers are replacing sodium tripolyphosphate with zeolite to reduce the harmful effect that wastewater has on rivers or lakes (Lafferty, 2015). In their intent to deliver environmentally friendly products, *Walmart,* a U.S. multinational retailer, offers organic cotton garments, and organic vegetables and fruits. To do so, they identified upstream suppliers, worked with their second tier suppliers, and allied with third parties to certify their organic practices at each link in their supply chain (Plambeck, 2012). Additionally, it is also suggested that process improvement practices, such as lean production and total quality management (TQM), facilitate the adoption and implementation of environmental technologies (King and Lenox, 2001; Piercy and Rich, 2015; Wiengarten and Pagell, 2012). Given these findings, this paper proposes that environmental innovativeness capability is developed through a two-sequenced bundling process of resources. First, firms deploy their innovation resources for developing process innovativeness capability. Then, firms extend their process innovativeness capability to develop the environmental innovativeness capability. Thus, this research explores the following research question: *Does process innovativeness capability mediates the relationship between innovation resources and environmental innovativeness capability?*

To explore this research question data collected by the 2008 Community Innovation Survey (CIS) is used. Results indicate that environmental innovativeness capability is the result of a two-sequenced bundling of innovation resources and process innovativeness capability. First, internal, external, hybrid innovation resources, and knowledge brought through R&D cooperation with suppliers are bundled into process innovativeness capability. Then, process innovativeness capability is extended and bundled with the knowledge brought through R&D cooperation with public research institutions into environmental innovativeness capability.

These results contribute to the literature of environmental innovation by explaining how firms can develop the capability to environmentally innovate. Previous research has focused on the drivers of eco-innovations, and on the resources needed to undertake such innovations (Bossle et al., 2016; Cainelli et al., 2015; Ghisetti and Pontoni, 2015), but has fallen short in explaining how capabilities are built from these resources. This research addresses this void in the literature and offers guidelines and tools to managers on how to develop environmental innovativeness capability.

2. Literature review

The literature review is structured in three parts: firstly, a review of the antecedents of environmental innovation is provided; secondly, relevant literature on the concept of environmental innovativeness is reviewed and analyzed; finally, a literature review on the antecedents of environmental innovativeness is provided to develop the proposed hypotheses. Throughout the literature review, a differentiation between antecedents and conduits is made. Whilst antecedents refer to independent variables, which are variables with direct effects on a dependent variable; conduits refer to mediating variables that are variables through which independent variables have an indirect effect on dependent variables.

2.1. Antecedents of environmental innovation

Environmental innovation entails the development or adoption of new products, processes, services, or business methods that can result in the reduction of environmental risk, pollution or other negative implications for the environment (Kemp and Pearson, 2007); it has a double-externality issue that make it different from traditional innovation (De Marchi, 2012). Since there are loose regulations to internalize the cost of environmental harm, the first externality refers to the firms' incentives to keep old technologies. The second externality refers to the lower costs of adoption that late adopters have compared to early adopters. This difference in costs is explained by the positive spillover effect during the diffusion phase of the environmental innovation (Rennings, 2000). Consequently, firms have difficulties to appropriate economic value from environmental innovations. Therefore, in addition to the traditional drivers of innovation, technology push and market demand, governmental regulations also have to be considered when studying environmental innovations (Bossle et al., 2016; Ghisetti and Pontoni, 2015).

Technology push drivers refer to the resources and capabilities of the firm (e.g., organizational and technological capabilities) that enhance energy and material efficiency (Rennings, 2000). Previous studies have underscored four types of innovation resources that have a positive impact on environmental innovation: firstly, internal innovation resources or firm's internal R&D activities (Horbach, 2008; Horbach et al., 2013); secondly, external innovation resources or outsourced R&D activities (Cuerva et al., 2014; Horbach, 2008); thirdly, hybrid resources or resources that are external to the firm, but that can be purchased on the market (e.g. machinery, hardware, software, patents, and licenses) (Cainelli et al., 2015); and fourthly, R&D cooperation with stakeholders (e.g. suppliers, universities, and public research institutions) (Agrawal, 2001; Baba et al., 2009; De Marchi, 2012; Ghisetti et al., 2015).

Market pull drivers refer to consumer preferences, industry norms (e.g., codes of conduct), and new market characteristics that move firms to undertake environmental innovations (Kesidou and Demirel, 2012). For example, consumer demands for hybrid cars have increased in recent years. From 2014 to 2020, the growth rate of the global automotive market is expected to increase at a slower pace than the segment of hybrid vehicles (Future-Market-Insights, 2014). This shift in the preferences for cars has urged car manufacturers to adopt technologies that reduce their negative impact on the environment (e.g. through traction batteries). Empirical evidence about the effect of customer expectation on the adoption of environmental innovation has recently been accumulated. For instance, Kesidou and Demirel (2012) found that multiple UK firms have started eco-innovation initiates to satisfy the growing sustainability demands from customers and society. Cai and Zhou (2014) also observed similar changes among Chinese firms. Finally, Bossle et al. (2016) conducted a literature review and concluded that external factors such as customer preferences and requirements can enhance the adoption rate of eco-innovations.

Governmental regulation on environmental matters refers to policies that promote the increase of environmental awareness in the market, the reduction of pollution, and incentives for undertaking environmental innovation (Bossle et al., 2016). Previous research has classified governmental regulations into two categories: stringent policy, and incentives to innovate (Ghisetti and Pontoni, 2015). Stringent policy refers to the limit to emissions, environmental taxes, and sanctions associated with pollution incidents. On the other hand, incentives to innovate include subsidies, grants, and tax exemptions for the implementation and adoption of technologies that reduce the negative impact business activities on the environment. Yet, past research on environmental innovation suggests that stringent policies are more efficient drivers of environmental innovation than the incentives to innovate (Ghisetti and Pontoni, 2015).

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