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The effect of external and internal factors on firms' product innovation

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Abstract

In this article we analyse the effect of factors external and internal to the firm, on product innovation novelty, and how this effect varies by industry. We estimate three econometric models to determine the individual effects of these factors, their joint explanatory power and the effects of interactions among them. The analysis is based on a sample of 6094 manufacturing firms, taken from the Spanish Survey of Technological Innovation 2000. The results indicate that the firm's technological competences, derived from in-house R&D, are the main determinant of product innovation. They also suggest that in the presence of high levels of such competences, the technological opportunities deriving from non-industry agents become less important as determinants of innovation. We show that the determinants of innovation vary depending on the industrial sector and the degree of novelty of the product developed.

Keywords: Innovation outputs; Absorptive capacity; Technological opportunities; Appropriability conditions

1. Introduction

Identification of the determinants of technological innovation in the firm is a popular topic in the empirical literature on innovation. It has been generally studied either from an industrial economy perspective or from a business management perspective.

Studies in the field of industrial economy start from the hypothesis that the level of innovation in the firm can be explained in terms of the structural characteristics of the industry in which it competes, and that it is possible to find general patterns of technological change associated with specific industries or, failing this, with broad industry categories (Souitaris, 2002a). This involves studying the effect of industry characteristics, such as market opportunities (Dougherty, 1990; Levin, 1981; Schmookler, 1966), technological opportunities (Geroski, 1990; Levin et al., 1985) and appropriability conditions (Levin et al., 1987; Mansfield, 1981, 1986). A particular focus has been on the size of the firm and the structure of the market as possible determinants of innovation. The results of these studies are ambiguous. Some validate the classical Schumpeterian hypothesis that links a monopolistic market structure and larger firm size with

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better innovative performance, while others contradict it.[1]

Studies in the field of business management focus on identifying the internal characteristics of firms that affect their innovation behaviour. Many of these investigations adopt the resource-based view (RBV), which highlights the heterogeneity of firms and the role played by internal attributes in business strategy (Wernerfelt, 1984). In this perspective, each firm possesses a unique set of resources and capacities, tangible and intangible, which have been acquired and developed over time and which, in the final instance, determine the degree of efficiency with which they perform functional activities (Dierickx and Cool, 1989; Galende and Suárez, 1999). Following this approach, researchers have evaluated a considerable number of organisational characteristics as possible determinants of innovation, which in turn have been classified within the broader category of "basic competences" (Leonard-Barton, 1992; Tidd, 2000). These basic competences include:

- Technological competences, generally measured by R&D intensity (Bhattacharya and Bloch, 2004; Love and Roper, 1999);
- Human resource competences, which include, among other things, a firm's knowledge and skills, accumulated either through the training of its workforce (Song et al., 2003) or as a result of the experience acquired over time (Hoffman et al., 1998);
- Organisational competences, which are related to administrative styles (Webster, 2004), the formalisation of internal communication systems (Rothwell, 1992; Souitaris, 2002b), and the interdependence of work teams (Cooper, 1990).

In line with this view, Cohen and Levinthal proposed the concept of absorptive capacity, defined as "the ability of a firm to recognise the value of new external information, assimilate it and apply it to commercial ends" (Cohen and Levinthal, 1990, p. 128). This concept, in common with the RBV, acknowledges that internal capacities are a key element in a firm's technological development, and highlights their dynamic and cumulative nature.

[1] Acs and Audretsch (1988), for example, in their study show that small firms are more innovation-intensive than large firms, because, among other reasons, they generally have fewer rigidities to hinder the introduction of the innovation. Also, authors such as Arrow (1962) and Lundvall and Nielsen (1999), show that faced with increased competition firms feel pressure to transform themselves and develop through innovation in order to survive.

Despite these efforts, there is no consistent body of theory related to the factors that determine the innovative performance of the firm. Some authors highlight methodological differences between studies, related to the nature of innovation (radical *vs.* incremental), the technological intensity of industrial sector (low *vs.* high tech), the characteristics of the firm (small and medium sized *vs.* big enterprise) and even geographical region, as reasons for the diversity of the results (Souitaris, 1999). In addition, the methodological difficulty involved in integrating existing theoretical perspectives has led researchers to separately analyse industry characteristics and firm's internal capacities as determinants of innovation, and to pay little attention to identifying the links between the two groups of factors (Keizer et al., 2002; Nieto and Quevedo, 2005).

Taking account of the above, we analyse the determinants of product innovation in manufacturing firms by defining a model that considers the joint effect exercised by factors external and internal to the firm on its innovative performance, and how this effect varies by industrial sector. The empirical study focuses on the determinants of product innovation in Spanish manufacturing firms, but the proposed model can be applied to other geographical contexts.

The paper is structured as follows. Section 2 provides a description of the model of analysis defined for the study. Section 3 presents the methodological aspects of the empirical study, describing the data, the measurements of the variables and the econometric specifications evaluated. Section 4 presents the results and Section 5 presents the main conclusions.

2. Model of analysis: background and hypothesis

Identification of both internal and external factors that determine innovative performance is relatively new in the firm innovation literature. Most existing studies analyse the interactions between external sources of knowledge and in-house R&D activities and several argue that the external acquisition of knowledge may stimulate rather than substitute for firms' own R&D (Arora and Gambardella, 1990; Veugelers, 1997). Cohen and Levinthal (1989, 1990) explain this relationship of complementarity in some depth, using the concept of absorptive capacity. In their research, they use absorptive capacity as a variable to explain the effect of the structural characteristics of an industry (appropriability conditions and technological opportunity) on the firm's R&D intensity. Cohen and Levinthal concluded that in-house R&D activities not only contribute to the generation of new knowledge, but also enhance the firm's ability to assimi-