

# Innovative competence, exploration and exploitation: The influence of technological diversification

Cristina Quintana-García<sup>a,\*</sup>, Carlos A. Benavides-Velasco<sup>b,1</sup>

<sup>a</sup> Dpto. Economía y Administración de Empresas, Facultad de Ciencias Económicas y Empresariales, Campus El Ejido, s/n, 29071 Málaga, Spain

<sup>b</sup> Dpto. Economía y Administración de Empresas, E.T.S. Ingenieros Industriales, Campus El Ejido, s/n, 29071 Málaga, Spain

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## Abstract

This paper investigates how technological diversification influences the rate and specific types of innovative competence. We test a set of hypotheses in a longitudinal study of a sample of biotechnology firms. Our findings provide strong support for the premise that a diversified technology base positively affects innovative competence. Furthermore, technological diversification is found to have a stronger effect on exploratory than on exploitative innovative capability. This empirical evidence suggests that technological diversity may mitigate core rigidities and path dependencies by enhancing novel solutions that accelerate the rate of invention, especially that which departs from a firm's past activities.

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## 1. Introduction

Over the last few decades, firms and industries have witnessed technological diversification due to increases in the complexity of products (Rosenberg, 1976; Giuri et al., 2002; Breschi et al., 2003). The range of disciplines relevant to firms' innovative processes is expanding in both breadth (the number of relevant disciplines) and depth (their sophistication and specialization) (Wang and von Tunzelmann, 2000). For developing product innovation, firms use various scientific and technological sources, embodying different characteristics and aiming at different corners of the market (Dosi, 1988).

Such "technological diversification" can be defined as the diversity in the knowledge system and principles underlying the nature of products and their methods of production. It is related to a corporation's expansion of its technological competence into a broader range of technical and discipline areas (Granstrand and Oskarsson, 1994, p. 355), although such expansion does not necessarily have to be associated with product diversification (Granstrand et al., 1997; Gambardella and Torrisi, 1998; Andersen and Walsh, 2000).

In general, technological diversification has only recently attracted the attention of researchers (Granstrand, 1998; Gemba and Kodama, 2001; Suzuki and Kodama, 2004). At the firm level, analyzing samples of large companies (many of them related to the information and communication technology sector), some descriptive studies have empirically demonstrated that, nowadays, multi-field competency and technological diversity is the dominant feature (Rao

\* Corresponding author. Tel.: +34 95 213 41 47;  
fax: +34 95 213 12 93.

E-mail addresses: [cqg@uma.es](mailto:cqg@uma.es) (C. Quintana-García),  
[cabv@uma.es](mailto:cabv@uma.es) (C.A. Benavides-Velasco).

<sup>1</sup> Tel.: +34 95 213 25 28; fax: +34 95 213 12 93.

et al., 2004; Mendonça, 2006; Palmberg and Martikainen, 2006). Another group of works provides interesting insights into the relationship between technological diversification and some organizational dimensions such as size, product diversification or corporate internationalization (Cantwell and Piscitello, 2000; Cantwell and Santangelo, 2000; Piscitello, 2000; Le Bas and Patel, 2004). For example, Piscitello (2000, 2004) and Valvano and Vannoni (2003), examining patenting activities of large and leading industrial companies, confirm that technological diversification does not proceed in a random way but coherently. Moreover, coherence of corporate diversification strategies, which positively influences economic performance, is higher when firms are active in sectors sharing similar technological resources. Particularly, there has been little research on how technological diversification affects innovation performance (Nesta and Saviotti, 2005; Garcia-Vega, 2006). These studies find that diversification of the technology base enhances R&D intensity and the number of patents.

The aim of this paper is to advance in the knowledge of the impact of technological diversity on innovation. This investigation is novel as it explores, in a particular high-technology sector, the influence of a diversified technology portfolio on specific types of innovative capabilities: exploitation and exploration. Exploitative innovation is based on intensive search, which means experimentation along an existing knowledge dimension. Exploration is rooted in extensive search that pursues potential new knowledge (March, 1991). Exploitative innovation improves the methods or materials used to achieve the firm's objectives of profitability and satisfying customer needs. In contrast, exploratory technological innovation involves novel methods or materials that are derived either from a completely different knowledge base or from a recombination of parts of the firms' established knowledge base with a new stream of knowledge (Freeman and Soete, 1997).

Based on evolutionary theory and organizational learning research (Dosi, 1982; Nelson and Winter, 1982; March, 1991; Levinthal and March, 1993), we test a set of hypotheses about how technological diversification enables organizations to improve their innovative capacity and influences exploratory and exploitative inventions in a different way. We address this issue because it is relevant for theory and practice. From the technology management perspective, compared to concentration, developing a diverse R&D portfolio implies integrating new technical staff, assimilating new technological knowledge (Lee and Allen, 1982),

and, in general, a more complex process of building research competences. Consequently, technological diversification constitutes a critical decision especially in high-technology industries where research projects demand large investment and developing successful innovations can take several years. On the other hand, evidence to improve our understanding of how a diversified technology base influences particular types of innovative capabilities is relevant for organizational learning theory. Search with high scope enriches the firm's knowledge base by adding distinctive new variations (Fleming, 2001; Katila and Ahuja, 2002). However, extremely high levels of technological diversity may damage the desired balance or combination between exploitation and exploration (March, 1991; Levinthal and March, 1993), and hence, the firm's capacity for sustaining its competitive position through mixed processes of knowledge creation, adaptation and consolidation.

The paper is in four sections. First, we present the theoretical framework. After a section on research methodology to test the hypotheses, the results from a sample of biotechnology companies in a longitudinal study are offered. Finally, the findings are discussed and areas of future research are proposed.

## 2. Theory and hypotheses

The complexity of many modern innovations necessitates a pooling and integration of multiple strands of knowledge (Subramaniam and Youndt, 2005). It is suggested that due to shortening product life cycles and expanding numbers of technology options, the ability to effectively integrate technology is now more important (especially in some sectors such as the computer industry) than the ability to develop new technology (Iansiti and West, 1997; Christensen, 2002). Technological diversification can be beneficial to organizations for a number of reasons (Granstrand et al., 1997; Patel and Pavitt, 1997). For example, organizations can benefit from introducing new technology into existing products and systems to improve performance and develop new functionalities. Or, organizations can take advantage of the continuing relevance of old technologies by combining them with pertinent and necessary emerging technological opportunities. Furthermore, organizations can benefit by coordinating innovation in core products with complementary changes in the production system and supply chain.

Hence, technological diversity may influence firms' capacity for combining and recombining their stock of existing knowledge with new components that result in new breakthroughs. Moreover, as such diversifica-

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