



Inventors and entrepreneurs in academia: What types of skills and experience matter?

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ABSTRACT

This paper aims to improve our understanding of the attributes of academic researchers that influence the capacity to contribute to technical advance, by adding to the pool of technological opportunities available to industry or engaging in the exploitation of entrepreneurial opportunities. We investigate a number of factors associated with the skills developed by academic researchers. We find that contributions to the pool of technological opportunities and exploitation of entrepreneurial opportunities involve different sets of skills and expertise of scientists. Our results show that the former is driven by academic scientists' research excellence and discovery of earlier technological opportunities and the latter is driven by previous collaboration with industry partners, scientific breadth and experience of technological discovery.

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1. Introduction

Public research organizations, particularly universities, are becoming increasingly entrepreneurial, focusing on the realization of commercial value from research and searching for new organizational arrangements that produce a closer alignment between scientific research and innovation (OECD, 2003; Siegel, 2006; Rothaermel et al., 2007). The entrepreneurialism of universities is epitomized by the rise in patenting, licensing and creation of spin-off companies by academic researchers (Wright et al., 2007; Siegel et al., 2003). Evidence of different entrepreneurial performance among academics highlights the need to understand what distinguishes academic researchers in terms of their inclination to engage in knowledge transfer activities and, especially, to become academic entrepreneurs (Bercovitz and Feldman, 2008; Hoyer and Pries, 2009).

Scholars of entrepreneurship and innovation studies have examined the entrepreneurial behavior of university researchers, and universities' entrepreneurial activities more generally (Chrisman et al., 1995; Stuart and Ding, 2006; Rothaermel et al., 2007). However, few works look at the skills developed by academic researchers in terms of their capacities to contribute to the pool of technological opportunities available to industry

as opposed to engaging in the exploitation of entrepreneurial opportunities. To our knowledge, there are no studies examining whether the skills and expertise of academic researchers influence the discovery of technological opportunities and the exploitation of entrepreneurial opportunities in distinct ways. A better understanding of the entrepreneurial process would provide an important contribution to the academic entrepreneurship literature, and the innovation literature would benefit from an investigation of how university research contributes to the rate of technological advance. The paper examines several researcher characteristics associated with the skills and experience required for the discovery of technological opportunities and the exploitation of entrepreneurial opportunities including the following: (a) knowledge of the marketplace and collaboration with users; (b) prior experience in invention activity; (c) integration of multiple fields of research; (d) research excellence; (e) participation in a wide research network.

We contribute to the literature on academic entrepreneurship in several ways. We show that academics' contributions to technological opportunities and the entrepreneurial exploitation of these opportunities are driven by different skills. More specifically, we find that previous collaboration with industry and breadth of scientific knowledge increase the possibility that the researcher will exploit an entrepreneurial opportunity. We find also that scientific excellence is a critical driver of opportunity discovery, and works by generating research findings that add to the pool of technological opportunities available to industry from

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university research. Finally, we show that prior invention experience affects both the discovery and the exploitation of technological opportunities.

The paper is structured as follows. Section 2 discusses the conceptual background and proposes a set of hypotheses. Section 3 provides a detailed description of the design of the empirical research. Section 4 presents the results and Section 5 concludes.

2. Background literature and hypotheses

2.1. Discovery of technological opportunities and exploitation of entrepreneurial opportunities

The entrepreneurship literature defines entrepreneurialism as being concerned with the discovery, evaluation and exploitation of profitable opportunities, and points to a number of extensions to inform theory and empirical analysis (Venkataraman, 1997; Shane and Venkataraman, 2000; Eckhardt and Shane, 2003). One of these is related to the distinction between the sources of opportunities and their enactment (via identification and exploitation) (Shane and Venkataraman, 2000; Eckhardt and Shane, 2003). The literature on academic entrepreneurship acknowledges the importance of these notions, seeing them as distinctive and crucial to the study of entrepreneurship (Eckhardt and Shane, 2003; Wright et al., 2004; Park, 2005).

In discussing the sources of opportunities, Eckhardt and Shane (2003) emphasize the role of shifts in the pool of technological opportunities catalyzed by the creation of new knowledge. Klevorick et al. (1995) define technological opportunities as comprising the set of possibilities for technological advance, available to industry at a point in time, which contribute to shaping the level of industry research and development (R&D) and the rate of product and process innovation. Technological advances based on university research are one of the main sources of new contributions to the pool of technological opportunities. Indeed, technological opportunities based on the creation of new technical knowledge by academia have become an important source of opportunities for enhancing industrial innovation performance (Mansfield, 1995; Bierly et al., 2009; Bishop et al., 2011). Academic inventors are important contributors to the pool of new technological possibilities, which is expanding the horizon of profitable entrepreneurial opportunities available to firms.

Shane and Venkataraman (2000) suggest that entrepreneurial opportunities emerge as a result of new means–ends relationships in (among others) product markets, factor markets or new materials. The existence of an entrepreneurial opportunity is not enough to ensure entrepreneurship: it requires the opportunity and its value to be identified, and also an ability to guide the resource allocation decisions of others (*identification*). Additionally, the potential entrepreneur must take the decision to exploit the opportunity, that is, to acquire resources and engage in activities that change prices and generate entrepreneurial profit (*exploitation*).

The contributions of academic researchers to the pool of technological opportunities are often equated with invention disclosure to university technology transfer offices and academic patenting (Jensen and Thursby, 2001; Colyvas et al., 2002; Shane, 2002; Jensen et al., 2003; Lubango and Pouris, 2007). However, Jensen and Thursby (2001) show that a large majority (over 75%) of the university inventions disclosed are no more than proof of concept at the time of licensing, and point to the embryonic state of most of the technologies in academic patents. The rationale behind regulations encouraging university patenting is that intellectual property rights favor the realization of academic inventions into practice. They encourage firms to invest resources in inventions that require a protracted development trajectory before becoming an innovation,

in exchange for a license agreement with the university (Jensen and Thursby, 2001; Colyvas et al., 2002; Mowery and Sampat, 2005). Several authors show that patents play a crucial role in the creation of new firms and that researchers engaged in activities linked to the protection of intellectual property are more likely than those engaged in other work to create spin-offs (Landry et al., 2007, 2010). Thus, academic inventions and patents are seen as important sources of technological and profitable opportunities (Shane, 2001a,b; Lowe and Ziedonis, 2006) and we would therefore argue that academic patents are a good expression of early stage inventions and constitute sources of potential technological and entrepreneurial opportunities—however far from commercial use.

Opportunities can be exploited by academic researchers setting up businesses in order to realize the market potential of their discoveries. In this case, commercialization activity is not limited to identifying a technological breakthrough, but extends to the activities related to bringing an invention to the market (Mustar, 1997). These include design of a business plan, obtaining venture capital and managing (or advising on) the new company's manufacturing and commercialization activities. Establishing a firm is not the only route to commercializing academic inventions; patenting, and licensing to non-academics allow the appropriation of the returns from innovation (Shane, 2002). However, in this paper we focus on setting up businesses and equity ownership by academics since these actions capture a more direct and comprehensive engagement in the exploitation of entrepreneurial opportunities. We study involvement in the wide range of activities associated with materializing new goods or services and the organization of methods that allow outputs to be sold at more than the cost of their production (Shane, 2000).

The literature on academic entrepreneurship is rather vague about the factors that contribute to the development of entrepreneurial skills in academic scientists—particularly the skills required to build technological opportunities sources and to exploit them. Studies suggest that a good knowledge of markets and customers' problems contributes positively to the development by academic researchers of new discoveries and technological breakthroughs and leads to the identification of potential commercial opportunities (Shane, 2000). However, the discovery of a technological opportunity does not necessarily lead to its realization and commercialization. Identifying a technological breakthrough is qualitatively different from bringing a new technology to the market. Exploitation of a potentially profitable opportunity is likely to require different skills from those involved in its discovery.

Although both patenting and spin-off activity may be motivated by the academic researcher's desire to exploit a university invention, spin-offs involve the specific activity of creating an independent venture to exploit the invention, while patenting can be seen as identifying a source of technological advance. In the latter case, the inventor does not necessarily perceive the invention as having direct commercial potential. This distinction is central to our discussion: it makes clear the idea that patenting is associated with exploring an opportunity and adding to the pool of technological opportunity sources, while spin-off activity is associated with the exploitation of a technological opportunity for profit.

2.2. Factors influencing the discovery of technological opportunities and the exploitation of entrepreneurial opportunities

The literature on academic entrepreneurship highlights the importance of understanding the factors that shape the behavior of academic entrepreneurs and explains why some researchers discover opportunity sources and exploit entrepreneurial opportunities. Therefore, entrepreneurship research is a natural starting point in the search for a conceptual framework to investigate the

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