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ABSTRACT

Policymakers have become increasingly involved in fostering entrepreneurial activity, especially in science-based sectors. The many studies on policy measures and initiatives implemented to support science-based entrepreneurship constitute several lines of research that have not yet been integrated. Drawing primarily upon refereed articles on entrepreneurship, entrepreneurial finance, and management, our review covers four areas: (i) factors fostering the establishment of science-based entrepreneurial firms; (ii) policies fostering the establishment of science-based entrepreneurial firms; (iii) the financing of science-based entrepreneurial firms; and (iv) policies fostering the provision of finance to science-based entrepreneurial firms. This literature review describes the scope of scholarly inquiry into these topics by providing a systematic overview of the most relevant research findings and then identifies lines for future investigation.

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1

Introduction

Under pressure from changing external expectations, universities have adopted an economic development mandate in addition to their traditional missions of education and research (Rothaermel *et al.*, 2007). Internal pressures to generate new sources of income have also increased their involvement with the technology transfer process (Powers and McDougall, 2005b). These changes have attracted the attention of researchers and policymakers interested in understanding and fostering avenues for the capitalization of university knowledge. Several national governments have enacted policies aimed at fostering technology transfer, the co-production of knowledge, and a supportive environment for new technology-based firms. The creation of more direct links between science and industry is expected to promote knowledge dissemination and contribute to national and regional economic growth (Mustar *et al.*, 2006; O'Shea *et al.*, 2008).

In the current era of "open innovation," universities and researchers have recourse to several mechanisms for transferring knowledge, such as conferences and scientific publications, public interventions, training of skilled labor force, direct policy or managerial involvement, consultancy and cooperation agreements, patenting and licensing, incubators,

and science parks (Rothaermel *et al.*, 2007). In particular, universities have shown growing enthusiasm for pursuing riskier paths through the formation of new companies around in-house technologies (Powers and McDougall, 2005b). Such science-based startups mediate between the worlds of academic research and industry. In general, they are also expected to drive economic growth (Mustar, 1998; Shane, 2004). They represent a small but economically powerful proportion of high-tech startups, playing a key role in ensuring the dynamic efficiency and employment growth of the economic system (Mustar and Wright, 2010). Science-based entrepreneurial firms are unlikely to generate major, short-term shifts in macroeconomic performance on their own, but their indirect effect on technology-using sectors is significant. As they strive to develop radically innovative technologies, they generate social benefits far in excess of their private returns (Griliches, 1992). As a result, they have become central to research and innovation policies. The objective of this monograph is to survey the policies implemented to foster the establishment of science-based firms and finance their growth.

We articulate our review along four dimensions. First, we examine the literature on science-based entrepreneurial firms and explain how it reflects a research focus on this type of firm. Second, we describe policies for fostering the establishment of science-based entrepreneurial firms and position them in different contexts. Third, we move to the financing problems of science-based entrepreneurial firms and review the literature on how these firms can manage to overcome their financial constraints. Fourth, we conclude by discussing the policies aimed at fostering the provision of finance to science-based entrepreneurial firms.

First, the perceived importance of academic entrepreneurship to national economies is reflected in the explosion of research publications seeking to better understand and address the forces that shape this activity. The literature is divided into several distinct foci: the role of national legislation in stimulating academic enterprise (Shane, 2004), the factors in the university environment that facilitate the creation of business activities (O'Shea *et al.*, 2005), the institutional conditions under which spinoffs are incubated (Lockett *et al.*, 2005), the characteristics of individual academics who become entrepreneurs (Landry

et al., 2006), and the benefits that firms derive from affiliation with an academic institution (Mian, 1997). This monograph belongs to the last research stream.

A number of studies emphasize the impact of individual attributes and dispositions on science-based entrepreneurship. Given that scientist-entrepreneurs are actively involved in knowledge creation and dissemination, one would expect their academic affiliation to influence the performance of their business ventures. When they decide to invest a large amount of time or even shift their career path in order to create a business, they are likely to have a viable business plan (Zhang, 2009). Nevertheless, a scientific background may have downsides. First and foremost, the academic founders of a company may not have enough business or commercial experience to properly exploit their innovations (Ensley and Hmieleski, 2005; Zahra *et al.*, 2007). Being more innovative is not enough to achieve superior performance; in the context of labor specialization, prestigious research achievements are not necessarily linked to an inclination or talent for business. Moreover, academics involved in creating new ventures may not be motivated solely or primarily by an entrepreneurial vision (i.e., to maximize profits). For example, they may be attracted mainly by the prospect of enhancing their academic position (Meyer, 2003). Accordingly, this section reviews the relevant literature on the establishment of science-based entrepreneurial firms.

Second, fostering technology entrepreneurship as a means to release currently unexploited opportunities hidden in individuals, shelved technologies, and resource combinations (Audretsch *et al.*, 2005; 2011) has become a major issue for (regional) public policymakers. In particular, spinoffs from universities and Public Research Organizations (PROs) are receiving growing interest from policymakers, and many measures for encouraging their formation and development have been adopted (Shane, 2004). Although research-based spinoffs are unlikely to generate major, short-term shifts in macroeconomic performance by themselves, their indirect effect on technology-using sectors is significant. The most notable and successful case is the rise of the US biotech industry, which has critically contributed to the birth of the myth of academic spinoffs as an effective means of promoting innovative

high-tech industries. Indeed, academic spinoffs have been crucial to the genesis of the US biotech industry, since they allowed knowledge and information flows to be as direct as possible. This acceptance of the importance of scientific entrepreneurship to national economies is reflected in the increase in the number of research publications seeking to better understand and address the forces shaping the activities of science-based firms. Researchers in the field of technology entrepreneurship have conducted detailed studies of, for example, the factors fostering (successful) technology-based university spinoffs (Rothaermel *et al.*, 2007; Shane, 2004), corporate spinoff creation (e.g., Zahra *et al.*, 2007), spinoff creation from research institutions (e.g., Clarysse *et al.*, 2005; Lockett *et al.*, 2005), and the role of science parks and incubators (e.g., Bergek and Norrman, 2008; Phan *et al.*, 2005). The literature on corporate and university spinoffs has been growing in diverse directions, as will be surveyed in this section. The regional contexts of the role of science parks and regional clusters will also be discussed.

Third, the existence of asymmetric information in capital markets means that financial institutions might not adequately assess their investment projects. This effect is most important for small and innovative businesses, due to the lack of reliable information about their real status and performance (Hernandez-Canovas and Martinez-Solano, 2007). Providing convincing signals about the quality of an innovation project is costly and sometimes leads to market failure due to the "lemon problem" (Akerlof, 1970; Spence, 1973; Stiglitz, 2000). Nevertheless, access to financing is a key determinant of growth in any new technology-based firm (Wright *et al.*, 2006). The debate over financing largely concerns understanding, evaluating, and improving the external funding environment confronting innovative startups in the absence of sufficient internally generated cash flows. Many discussions have revolved around the unsuitability of debt for early-stage financing (Stiglitz and Weiss, 1981), whereby debt holders bear the downside risk but do not share the upside of successful innovation (Berger and Udell, 1998). Prospects for contractual funding such as securing collateral loans against appropriate assets are severely limited for science-based entrepreneurial firms since most of their resources are intangible and tend to have limited

salvage value because of their highly specific nature (Hubbard, 1998). We conclude with an overview of innovative financing mechanisms such as microfinance, crowdfunding, and peer-to-peer lending.

Fourth, for the reasons discussed above, science-based entrepreneurial firms frequently seek external equity investors willing to bet on future value creation opportunities (Carpenter and Petersen, 2002). Both private (e.g., venture capital) and public (e.g., stock exchanges) equity are possible. These are strictly interconnected, as venture capitalists are more likely to invest when there is an active equity market that permits them to exit by selling their shares (Black and Gilson, 1998). Accordingly, many public policies (especially in the EU) have adopted the explicit goal of developing risk capital markets capable of sustaining entrepreneurship and facilitating the expansion of existing small firms (European Commission, 2005). Several stock exchanges have set up market segments dedicated to small firms, with lower listing barriers. In the last decade, almost every European country has launched an alternative second-tier market, thereby at least partially fulfilling the aforementioned EU goal (Paleari *et al.*, 2008). This development has created a favorable setting for enabling science-based entrepreneurial firms to attract investment through initial public offerings. In this section, we describe the policies implemented in various countries to foster the provision of public equity to science-based entrepreneurial firms. Special attention will be paid to governmental venture capital as an example of direct intervention, about which we review the literature while distinguishing systemic-level studies from firm-level studies. Most of the literature on technology transfer has focused on demand-side public interventions, such as technology transfer offices, incubators, accelerators, and other initiatives of network development, as well as matchmaking between prospective entrepreneurs and investors. This section aims to refocus the attention of technology transfer scholars onto supply-side policies seeking to increase the supply of financing to entrepreneurial ventures (Meoli *et al.*, 2013). In particular, we highlight the role of Governmental Venture Capital (GVC) funds in order to inform the broader public about the impact of public policy concerning Venture Capital (VC) and provide policymakers with an international

and comparative perspective on the effects of government efforts, which may be used to guide future interventions. First, we review the research on this topic and provide a picture of GVC programs around the world. Then, we identify several open research questions and widen the scope to encompass the role of public policies in developing VC markets and fostering access to public equity markets. For several reasons, the equity gap faced by science-based entrepreneurial firms cannot be entirely solved by the private VC market. In response, many governments have set up programs to foster VC financing through the establishment of GVC funds (Cumming *et al.*, 2009). Besides addressing the financial gap problem, GVCs can pursue investments that will ultimately yield social payoffs and positive externalities for society as a whole. The drawback of these instruments, however, is that they may crowd out rather than stimulate private investments. The rationale and appropriateness of these programs are at the center of an academic debate, which we review in this section.

Finally, a brief section will conclude the review by discussing the main recent political developments, namely "Trumpism" and Brexit, and their impact on the global market.

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