



University spin-offs vs. other NTBFs: Total factor productivity differences at outset and evolution

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ABSTRACT

Previous empirical research suggests that university spin-offs under-perform in economic terms compared to other new technology-based firms (NTBFs) in their early years. The usual explanations suggest a lower capabilities endowment of university spin-offs compared to other NTBFs. Using a longitudinal Spanish dataset we compare the evolution of firms' total factor productivity (capabilities endowment) in both kinds of firm. Productivity grew faster in university spin-offs and their initial underperformance disappeared after 2 or 3 years of operation. The evidence therefore suggests that university spin-offs have lower initial substantive capabilities but greater dynamic capabilities than independent NTBFs. Possible explanations are discussed.

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1. Introduction

University spin-off companies, those new technology-based firms created with the support of a university by some of its members, have received increasing attention in the last two decades by policy makers and managers of higher education institutions, particularly in the US and Europe. These initiatives directly implied the commitment of public resources to stimulate the development of university spin-offs (Geuna et al., 2003; Lockett et al., 2005; Mustar and Wright, 2010), and opened a research stream aimed at identifying and evaluating the specific factors that facilitate the success and development of university spin-offs. Djokovic and Soutaris (2008) or Mustar et al. (2006) provide excellent summaries of this literature. Underlying this growing interest is the idea that higher education institutions have entrepreneurial capabilities that are underused and which can increase the wealth creation and competitiveness of the economy.

This idea is disputed by Harrison and Leitch (2010), who question the economic relevance of university spin-offs. Furthermore, the evidence comparing the economic performance of university spin-offs with other NTBFs reports that university spin-offs have lower growth rates in terms of sales, net cash-flows, employees, and a lower likelihood of obtaining profits than independent start-ups (Chrisman et al., 1995; Ensley and Hmieleski, 2005; Zhang, 2009). The results are the opposite when

the performance of firms is measured in terms of patents (quality or quantity) or product innovation (Cockburn and Henderson, 1998; Gittelman and Kogut, 2003; Toole and Czarnitzki, 2007, 2009; Zucker et al., 1998a, 2002a). In particular, this paper contributes to this literature in two main aspects: it applies a different performance measure (TFP), and a longitudinal approach.

From a managerial perspective, the resource-based view (RBV) literature (Barney, 1991; Peteraf, 1993; Teece, 1980; Wernerfelt, 1984) attributes firms' differences in performance to two sources: the firms' resources (assets that can be acquired and transferred) and the firms' capabilities (how such resources are combined and transformed). On the other hand, Solow (1958) shows that empirical economists usually divide a firm's sales growth into two components, variations in the firm's total factor productivity (TFP) and variations in the firm's resources. Combining both perspectives, the TFP has been proposed in the management (Dutta et al., 2005) and entrepreneurship (González-Pernía et al., 2012; Croce et al., 2013) literatures as an operative measure of the economic importance of differences in the aggregate capabilities of firms or groups of firms. Furthermore, using the terminology of Zahra et al. (2006), the longitudinal analysis adopted in this work allowed us to compare the economic effects of firms' (current) substantive capabilities and also their dynamic (capacity to improve) capabilities.

In empirical terms, this paper compares the evolution of the total factor productivity (TFP) of university spin-offs with that of other technology-based firms (NTBFs) on an unbalanced (since company information is not available for all years) data panel, which covers financial information on 177 Spanish high-technology firms over a 12-year period (1994–2005). According

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to our estimations, university spin-offs begin to have greater TFP after 2 or 3 years of operation. The capabilities used by university spin-offs to develop and exploit new businesses, in the long term, are of higher economic value than those used by other NTBFs. The evolution of estimated TFP indicates that university spin-offs initially possess lower substantive capabilities but show higher dynamic capabilities than other NTBFs. Those dynamic capabilities are economically relevant. This is a basic assumption behind the demands for specific public support for university spin-offs. The evidence is relevant both for policy makers in terms of the distribution of public resources and for university managers in claiming for said resources.

Differences in substantive capabilities have mainly been justified in the literature by two arguments, lack of managerial capabilities and differences in the technical development of projects. We discuss the relationship between those arguments and the differences in dynamic capabilities detected in the paper and we evaluate the consistency of those explanations with the evidence generated.

The paper is organized as follows. The following section engages with three theoretical questions. First, it summarizes previous literature on differences in managerial capabilities between university spin-offs and other NTBFs in order to develop hypotheses on initial differences in their substantive and dynamic capabilities. Second, it discusses alternative explanations to these hypotheses, particularly concentrating on the literature that emphasizes technological differences. Third, it discusses TFP as a measurement of firms' capabilities. Section 3 describes the data used and the empirical tests are presented in Section 4. Section 5 summarizes and discusses the main findings and limitations of the paper. Section 6 presents the conclusions.

2. Theory and hypotheses

2.1. General conceptual framework and main hypotheses

From an empirical perspective, there is some evidence of the economic under-performance of university spin-offs in comparison with other NTBFs. Ensley and Hmieleski (2005) compared two samples of 102 university spin-offs and 154 independent NTBFs in the southeast of the United States. Based on survey data, they report lower net cash-flows and a lower rate of sales growth during the previous 5 years for university spin-offs. From a cross section database of US firms backed up by venture capitalists, Zhang (2009) compares the performance of 483 university spin-offs versus 3150 independent start-ups and found a lower probability of making profits and a lower level of employment, although the significance of those parameters depends on the controls used.

From a theoretical perspective, the RBV is a common framework for explaining differences between firms' performance and has guided most empirical work related with research-based spin-offs (Mustar et al., 2006). Those differences are attributed to two sources: the firms' resources and the firms' capabilities. The RBV literature also distinguishes between substantive and dynamic capabilities. Substantive capabilities are the firm's current ones, while dynamic capabilities are those that increase substantive capabilities, reconfiguring internal and external competences (Teece et al., 1997) over time [see Zahra et al. (2006), for further discussion of this distinction].

Notice that while the empirical literature points out differences in performance, it remains silent on the contribution of capabilities to such differences. The firm has contractual rights to its resources but not to its capabilities. Thus, it is difficult to distinguish which capabilities belong to the firm and which to the people who combine and transform the resources, mainly the entrepreneurs and/or managers. Although both kinds of capabilities could be economically

relevant, most of the theoretical arguments used to explain the underperformance of the university spin-offs are based on differences in the entrepreneur or founder capabilities.

This is due to the fact that the available evidence on university spin-offs (Darby and Zucker, 2003; Ensley and Hmieleski, 2005) showed that, in most cases, the academic entrepreneur was also the owner and manager of the firm for the initial years of operation. For example, from a questionnaire sent to a sample of Spanish university spin-offs that had been in operation for an average of 3.8 years, Ortín et al. (2007) show that the original founders retained, on average, 90% of the firm's ownership and in 86% of cases were still the senior managers of the firm. Those figures were similar for a comparative sample of high-tech firms. Additionally, certain authors (Heirman and Clarysse, 2004) argue that—in new firms—the founders' managerial capabilities seem to be the most relevant factor because the firm's capabilities (for example, organizational systems, routines or relationships between the firm's members) are probably far less developed.

Ample evidence shows that the level of previous managerial experience is an indicator of the current entrepreneur's managerial capabilities (Agarwal et al., 2004; Boeker, 1989; Kimberley, 1979; Klepper, 2001; Schein, 1984). Moreover, with regard to university spin-offs and other NTBFs, extensive evidence suggests that there are significant differences in managerial and industrial experience between founders of university spin-offs and other NTBFs (Chrisman et al., 1995; Colombo and Delmastro, 2002; Ensley and Hmieleski, 2005; Ndonzuau et al., 2002; Siegel et al., 2003). For example, Shane and Khurana (2003) show that in 1397 MIT-assigned inventions between 1980 and 1996, only 21% of the research teams had at least one founder with previous industry experience. Consequently, some authors argue that a lack of managerial skills may directly influence the behavior of academic entrepreneurs (D'Este et al., 2012; Landry et al., 2006) and thus the performance of university spin-offs (Roberts, 1991; Shane, 2004; Vohora et al., 2004). We therefore formulate the following hypothesis:

Hypothesis 1. University spin-offs have lower endowment of initial *substantive* capabilities than other NTBFs.

In comparative terms, it could be argued that academic entrepreneurs on average have little managerial experience because they have devoted more time to applied research and knowledge-generation than is the case for other entrepreneurs. This fact could affect their dynamic capabilities.

Clarysse and Moray (2004) describe the learning process for the founding members of a university spin-off from different critical situations and how this process affects the reorientation of the firm's activities in adapting to a competitive environment. They illustrate the difficulties of acquiring such knowledge from external sources, such as for example venture capitalists (Ortín-Ángel and Vendrell-Herrero, 2010).

In fact, in the literature on organizational learning (Huber, 1991; Yeo, 2005; Thomas and Allen, 2006), it is usually assumed that people and organizations have different modes of learning of differing efficiency. Existing research (see Zahra et al., 2006, p. 933–936 for a summary) has identified four learning modes: (i) *Improvisation*, (ii) *Trial-and-error learning*, (iii) *Experimentation* and finally (iv) *Imitation*. More or less explicitly, the knowledge acquisition literature seems to postulate that, although *Experimentation* might be the most expensive mode, it is also the one that provides higher-quality knowledge: "knowledge or behaviors gained are more likely to be generalizable, systematic, and contain information about main and interaction effects" (Table 2 in Miner et al., 2001, p. 319). For example Argyris, one of the most representative authors in this field, observed the following in 1991:

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