



## A knowledge-based typology of university spin-offs in the context of regional economic development

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### ABSTRACT

Drawing on the literature pertaining to the role universities play in promoting technology transfer, this paper develops an insightful conceptualization of spin-off processes, and applies it to a current regional case study. The suggested typology of university spin-off/start-up firms is based on several variables, including the type of university sponsorship, university involvement in firm formation, the character of knowledge applied, and co-localization of the founders. The empirical case study is used to demonstrate the usefulness of this approach in analyzing spin-off firms, and their dynamics. The study is based on interviews conducted with university spin-offs/start-ups in the information technology (IT) sector located in the Kitchener and Guelph metropolitan areas. This region, which is home to the University of Waterloo – one of Canada's premier science and technology universities – has experienced an impetus of spin-off processes originating from university research dating back to the 1970s.

The results of our analysis expose several trends: Sponsored spin-offs are largely the result of particular university research projects, and apply specific knowledge inputs in the development of their initial core technology. Unsponsored spin-offs, which find their foundation in decentralized idea development outside of the university setting, almost entirely rely on generic broad knowledge bases for the development of innovative products and services, which have enabled the firm-formation process. Overall, it is surprising that even firms that have received some form of university support described the role the University of Waterloo had in their start-up process as marginal. The dynamic research approach applied in this study, which outlines the university's changing role over time and the regional dynamics associated with spin-off firms, further demonstrates the potential of our typology. As such, our typology of university-related start-up/spin-off firms is designed to support studies concerned with the wider impact of universities on technology transfer and regional development.

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### 1. Introduction

In the social science literature, the advantages knowledge-based, technology-intensive firms can accrue from being in close proximity to a university have been widely recognized (Nelson, 1959; Arrow, 1962). It is believed that high-tech ventures derive significant benefits from localized knowledge spillovers emanating from the two common tasks performed by universities; i.e., basic research and human capital creation (Audretsch and Lehmann, 2005). While these knowledge inputs are appealing to

firms, access to these inputs appears to depend on the spatial proximity to a particular university (Fujita and Thisse, 1996; Fischer and Varga, 2003). It was not until the late 1960s, when new information technology (IT) industries emerged, that scholars began to scrutinize the technology transfer mechanisms that led to the direct commercialization of university research through firm formation (Landström, 2005).

The seminal works of Roberts (1968), who examined spin-off processes from MIT along Boston's Route 128, and Cooper (1971), who studied spin-off phenomena in Silicon Valley, are especially notable in this regard. It was the institutional and structural change that began in the 1980s (such as the passage of the Bayh-Dole Act in the US) and increased labor mobility, along with a shift towards more flexible modes of production and venture capital financing, that propelled research efforts concerning university entrepreneurship and technology-based growth (see Rothaermel et al., 2007).

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University spin-off firms, also commonly called ‘university spin-outs’ or ‘research related start-up ventures’, are acknowledged in the literature as one of the key drivers of economic change and growth (Bercovitz and Feldman, 2006). Originally a phenomenon thought to be specific to North America, today most advanced national economies strive to generate economic wealth by exploiting and diffusing public research by means of university spin-offs (Clarysse et al., 2005). In many cases, however, such endeavors have had limited success (Callan, 2001). Surprisingly, much of the social science literature does not provide a clear-cut definition of the actual university spin-off phenomenon, despite a rapidly growing number of empirical and theoretical studies that span across multiple disciplines (Pirnay et al., 2003). As a consequence, the term ‘university spin-off’ frequently remains a vaguely defined concept, notwithstanding the apparent impact of such firms on the development of high-tech industries (Steffensen et al., 2000). Mustar et al. (2006: 290) conclude in their review that there is “an important gap in our comprehensive understanding of the diversity of RRSOs” (research-based spin-offs).

It appears that this lack of clarity is related to the inherent heterogeneous nature of university spin-off processes, combined with the plurality of research methods applied to study them. This not only poses problems in comparing empirical studies, as researchers potentially present different realities under a common heading, but more importantly, it also obscures our understanding of the underlying processes that drive regional innovation, which, in turn, limits the policy relevance of this type of research (Mustar et al., 2006). Furthermore, spatial considerations, beyond the actual co-location of spin-off ventures and universities, in most cases are not incorporated into the research design, despite the widespread agreement that university spin-off processes support, and sometimes essentially influence, regional economic growth. In our view, it is not desirable to construct a restrictive definition of university spin-off firms by reducing the group of actors and institutions included in the research framework, as this may eliminate important interactive processes that were stimulated or shaped by local universities from the analysis. Instead, the development of a multi-faceted typology of university spin-off firms, which takes into account the heterogeneous nature of such ventures and the spatial context in which they occur, is, in our perspective, a fruitful approach to elucidating and streamlining the complex findings found in the literature, and their diverse theoretical and empirical foundations (see, especially, Pirnay et al., 2003).

Drawing on the literature pertaining to the role universities play in promoting technology transfer, this paper aims to develop a spin-off typology that emphasizes a *knowledge* perspective, and links the spin-off phenomenon to *regional* development in a *dynamic* perspective. In particular, the objective of this paper is to discuss and define the university spin-off phenomenon in a regional context, and to suggest a taxonomy of spin-offs/start-ups based on several variables, including the type of university sponsorship, university involvement in firm formation, the type of university knowledge applied, and co-localization of the founders. We use the empirical findings from a recent regional case study to demonstrate the usefulness of this approach in classifying university-related start-ups/spin-offs; the genesis of these firms is of particular interest to this research. The start-up configuration is expected to be an indicator of future development prospects in terms of growth trajectories, and the potential wider regional economic impact these firms will project. Through the analysis of these varying configurations, we intend to find predictive patterns, which subsequently allow for the development of efficient policy programs.

The semi-empirical evidence utilized in our study is derived from 18 semi-structured interviews that were conducted in 2007 and

2008 with university spin-off/start-up firms located in the Kitchener and Guelph metropolitan areas, about 100 km west of Toronto, Canada. In media reports, these municipalities are often referred to as the Waterloo region, in part because of the role of the University of Waterloo as a regional driver of technologies, provider of high-quality technical skills, and generator of start-up firms. This region was chosen as a case study for our research, because it has experienced an impetus of spin-off processes originating from university research since the 1970s, which is unusual in the context of Canadian universities, and has subsequently been widely publicized. Similar to the findings of Mustar et al. (2006), that research-based spin-offs have become an important aspect of the technology transfer process, it is often suggested that regional growth and modernization in the Kitchener and Guelph metropolitan areas have been triggered by IT-related university spin-off activities (e.g. Bramwell et al., 2008). In particular, based on the activities of the University of Waterloo, numerous IT firms, such as Dalsa, Open Text, Research in Motion (RIM), Sybase, and Waterloo Maple, have been successfully launched. They have established a growing technology base in the region (Bathelt and Hecht, 1990; Bathelt, 1991; Parker, 2001; Bramwell et al., 2008), which has led us to focus specifically on the role of IT spin-offs in the present research.

While we are interested in how the university spin-off firms in our sample fit into the various categories developed in our typology, and whether the categories allow us to draw conclusions regarding the firms’ collective development potential, particular attention will be given to the university’s role at the time of firm formation and how this has changed over time. Our paper is thus structured as follows: In Section 2 we review some of the existing literature concerning university spin-off firms, with a focus on many of the critical issues identified in this stream of research. Based on these findings, we propose a typology of university spin-offs and university-related start-ups, which forms the foundation for our empirical investigation. Section 3 discusses the research approach and methodology applied, and in Section 4, we examine IT-based university-related start-ups/spin-offs in the Kitchener and Guelph metropolitan areas through the lens of our proposed typology. Section 5 summarizes the main findings and draws conclusions.

## 2. The university spin-off research framework

The significance of university spin-off and start-up ventures as a technology transfer mechanism for generating and sustaining regional economic growth and competitiveness is widely acknowledged (Rogers, 1986; Etzkowitz et al., 2000; Wright et al., 2004). Nonetheless, considerable differences exist between the various interpretations used by scholars to describe spin-off phenomena. This can easily create confusion as a study by Pirnay et al. (2003) exemplifies. In reviewing the literature concerning MIT spin-offs in the Boston region, they found studies that identified rather different start-up rates from MIT. Similar variations occur when looking through reports on spin-off activities related to the University of Waterloo. Pirnay et al. (2003: 355) conclude that “[a]ll these estimations are supposedly accurate but probably rely on different definitions of [university spin-offs], which are not explicitly clarified by the authors.” This demonstrates that there is a need to generate a coherent typology and stylized facts that will lead to the development of a policy-relevant theory regarding university spin-offs (an issue that is also emphasized by Mustar et al., 2006), and their impact on local economic development. It is only recently that conceptual studies have identified the differences in existing definitions, and suggested more precise and comprehensive taxonomies of

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