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How do business model and health technology design influence each other? Insights from a longitudinal case study of three academic spin-offs

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ABSTRACT

Academic spin-offs often lack business expertise, face uncertainties regarding their innovation and their markets, and do not have a clear idea of how their product will create value. In spite of this vagueness, academic entrepreneurs must articulate a business model and rapidly establish trustworthy relationships with potential users, purchasers and capital investors. One may thus wonder how their technology development process is influenced by the long-term expectations of their putative customers as well as the short-term requirements of capital investors? This longitudinal case study examines how the business models of three Canadian health technology spin-offs sought to address the value expectations of clinical users and capital investors, how tensions were resolved, and the impact this had on technology design. We describe the *synergistic readjustments*, *drastic reconfiguration* and *mismatch* between business model and technology design we observed. Our discussion highlights the mediating mechanisms by which business models and technology design influence each other, clarifying why the initial value proposition of the spin-offs was either refined or reframed. Beyond confirming the importance of differentiating business models in the health technology industry, our study suggests that it is not only *who* makes decision that matters, but also *how* stakeholders' value expectations get embedded in a spin-off's value proposition.

1. Introduction

Most industrialized countries actively support the development of health innovations, ranging from medical devices to biotechnologies (Niosi, 2006). Many of the policy instruments deployed are targeted at building research capacity in niches seen as likely to yield radical innovation (e.g., pharmacogenomics, cancer vaccines, tissue engineering), at facilitating industry–university collaboration and at encouraging academic entrepreneurship (Grimaldi et al., 2011). As a result, nearly half of all spin-offs, patents and licenses of American and Canadian universities by early 2000 were in the life sciences (Niosi, 2006). Nevertheless, the ability of academic spin-offs to successfully pass the "threshold of sustainability" is uneven (Vohora et al., 2004), as they remain highly dependent upon venture capitalists who tend to foster short-term financial growth (Ackerly et al., 2008; Lazonick and Tulum, 2011; Petkova et al., 2012).

While a business model represents an important strategic choice that can enable an emerging spin-off to position itself within an industry (Willemstein et al., 2007), "there is little empirical evidence" that might help academic entrepreneurs know which business model to adopt (Pries and Guild, 2011, p. 151). Furthermore, while innovation scholars have examined the types of business model that are found within the health sector (Mangematin et al., 2003; Pries and Guild, 2011; Willemstein et al., 2007), very few studies have clarified the relationships between business models and technological innovation (Chesbrough and Rosenbloom, 2002; Teece, 2009). These relationships are

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particularly important considering that academic entrepreneurs must define how the value proposition of a new health technology should respond to the expectations of: (1) customers to whom value is offered (e.g., physicians, nurses, patients, third-party payers); and (2) capital investors and shareholders for whom value is captured (Baden-Fuller and Morgan, 2010).

In this paper, we explore the way business models influence and are influenced by health technology development by presenting the findings of a longitudinal multiple case study. Our fieldwork involved the gathering of multiple data sources that enabled examining three Canadian spin-offs that developed, respectively: (1) a heart ablation catheter; (2) a labor decision support software; and (3) a chronic disease home monitoring system. We analyze how the managers of these three spin-offs articulated their evolving business models, sought to respond to certain stakeholders' value expectations, and how these concerns were translated into product design priorities. Our goal is to provide theoretically informed empirical insights (Gibbert and Ruigrok, 2010) that may help consolidate current knowledge on the interplay between technology and business model innovation, a stream of literature that has increasingly attracted scholarly interest in the past years (Schneider and Spieth, 2013).[1]

Our study also brings an original empirical contribution to research on "hard" health technologies, or so-called medical devices (i.e., surgical equipment, imaging devices). The currently available body of evidence is in fact mostly focused on biotechnologies, e.g., the use of biological systems and living organisms in agriculture and food or drug production. While such research is informative, its observations are not straightforwardly applicable to the health technology sector for at least two reasons. First, the knowledge and know-how required to develop health technology (Metcalfe et al., 2005) differs greatly from the laboratory sciences underlying biotechnologies. Second, the health technology industry differs from the pharmaceutical industry where business models are rather well established and enable productive alliances with biotech spin-offs (Baum et al., 2000; Rothaermel and Deeds, 2004; Willemstein et al., 2007). A closer examination of health technology ventures is of practical relevance considering the dramatic increases in venture capital investments in this sector, reaching US$4.1 billion in 2007 (Ackerly et al., 2008). Innovation policy research can thus benefit from a better understanding of the interplay between business models and technology development (Petkova et al., 2012).

2. Business and technology design challenges facing academic spin-offs

2.1. Background

Academics in the health sector are increasingly expected to embark on research programs that have commercial value and can lead to the creation of spin-offs (Grimaldi et al., 2011). Yet, academic spin-offs often lack business expertise, face significant uncertainties regarding their innovation and their markets, and do not have a clear idea of how their product will create value (Doganova and Eyquem-Renault, 2009). In spite of this initial vagueness, these organizations must rapidly establish trustworthy relationships with prospective users and purchasers, as well as with capital investors who may not always be fully cognizant of the commercialization challenges of non-drug health technologies (Ackerly et al., 2008). As a result, very early on in their existence, academic spin-offs stand at the confluence of significant but often ill-defined challenges that affect both their business and the development of their innovation (Farley and Rouse, 2000; Niosi, 2006).

When Research & Development (R&D) efforts are channeled through a small academic spin-off whose survival revolves around the development of one core innovative technology, active efforts must be made to manage the design process and to reduce the uncertainty associated with the more experimental discovery end of the R&D spectrum (Aspara, 2009; Bruce et al., 1999). By *design process* we mean all the creative and analytical steps by which a given idea is gradually fleshed out into a new product that can be mass-produced and commercialized (Lehoux, 2006). These activities are goal-oriented and informed by various considerations – such as user demand, production costs or competing technologies – that affect which design priorities are to be pursued (Bruce et al., 1999). As part of this process, a series of contingent, and consequential decisions are made, defining the purpose, shape and functions of a technology.

Considering the significance of the R&D investments devoted to technological innovation in health, understanding how design priorities are set at an early stage is important, because if technology developers rely on incorrect or incomplete assumptions, they may "unknowingly spend the rest of the project attempting to identify and recover from these wrong assumptions" (Martin et al., 2012, p. 185). It does in fact take many years to come up with a fully designed health technology (Metcalfe et al., 2005) and around 50% of medical device patents never end up in a commercialized product (Mattes et al., 2006). The literature on business models and technology design remains however scarce, a situation that precludes scholars from formulating well-grounded hypotheses regarding the nature of the relationships at play (Schneider and Spieth, 2013). This is the research gap our study seeks to bridge.

So far, business models of biotech firms have been examined as *static* constructs (Willemstein et al., 2007), using either predefined categories or empirically derived types of business models (Mangematin et al., 2003). Pries and Guild (2011) posited the business model as a dependent variable, examining the impact of technology characteristics (i.e., legal protection, commercial uncertainty, technological dynamism) on whether commercialization was enabled by: (a) creating a new firm; (b) transferring the property rights; or (c) retaining ownership and transferring limited rights. Willemstein and colleagues (2007) posited the business model as a *dynamic* construct, looking at the shifts that occur after foundation in the business model, here categorized as service, platform, product, or "hybrids." More recently, Sabatier and colleagues (2012) examined how emerging business models in bioinformatics (e.g., a sub-group of firms active in the biotech industry) both evolved over time and posed particular challenges to the established business models in the drug industry. They classified the emerging business models under the following categories: platform technology, bundling, software as service, hybrid and collaborative discovery. Overall, these categories, be they empirically or conceptually derived, pinpoint to the fact that new business models can result from "hybridizations" between models (Baden-Fuller and Morgan, 2010).

The above-mentioned studies not only emphasize the diversity of business models in the health sector (Mangematin et al., 2003), but they also beg the question of the relationship that business models are supposed to entertain with technological innovation. While Zott and colleagues (2011) suggest that business models entail consequences for technological innovations and, in return, may be shaped by them, Teece (2009) argues that technological innovation could be "matched with" innovative business models. Observing that only few empirical studies have been conducted,

[1] In their systematic review summarizing 35 peer-reviewed publications on business model innovation published between 1981 and 2012, Schneider and Spieth (2013, p. 25) observe: "despite its evidently early stage of research and vague understanding of the phenomenon, a strong interest in the topic is indicated by the fast rising number of publications within the last two years."