Long Range Planning 49 (2016) 393–408

Contents lists available at ScienceDirect

Long Range Planning

journal homepage: http://www.elsevier.com/locate/lrp

Early Business Model Evolution in Science-based Ventures: The Case of Advanced Materials

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Business models of many types have received attention in recent management research, but less work has focused on models suited to the commercialization of scientific research in areas such as biotech, green tech and advanced materials. University spin-outs (USOs) are often required to demonstrate the potential value and viability of generic new technologies, but there has been little work to date looking at appropriate business models for these new firms. This study investigates how the business models of advanced material USOs often develop by trial and error in response to their unique challenges.

Many of the most commonly recommended strategies and resultant models do not translate directly into practice for ventures with generic, early-stage technologies, particularly those that have to commit considerable resources and attract funds and partners early on. Case exemplars reveal business models and strategies that have been successful, and also less successful, in creating value from science-based innovations of advanced material USOs. This evidence informs our conclusions and recommendations.

Introduction

Traditional lines between academia and business have begun to blur as academic spin-outs come to play a key role in the development, demonstration and early commercialization of revolutionary technologies. Although established firms in research-driven fields (nanotechnology, biopharmaceuticals, genomics, etc.) still play a powerful role in moving radical, generic technologies into widespread use, spin-outs from university laboratories are increasingly important in commercialization and R&D, supplementing or even substituting for corporate research labs. While these new vehicles bridge the gap between fundamental science and commercial application, they also face a host of unique external challenges, because they are remote from the end customer, have to choose between multiple disparate markets and applications, and require complementary innovation by partners and/or other players. They also face internal challenges, such as the need for substantial resources, lack of commercial experience and conflicting objectives of advancing science and creating wealth. Because these new firms face such distinct challenges, the business models used to commercialize previous generations of technologies are unlikely to be suitable. New business models must be created and adapted to suit the specific challenges these spin-outs face (Mustar et al., 2006; Pisano, 2006; Rothaermel and Thursby, 2007). But even though the key role of new materials innovation in enabling innovation further downstream is well known (Wield and Roy, 1995; Foresight, 2013), little research has been found offering insight and practical guidance into crafting business models for ventures launching radical, generic technologies. Nor is there guidance on how to enter or create the innovation ecosystems from which they will need to get resources and support.

In order to create commercial value, new firms must create a business model, whether explicit or implicit, which specifies their intended market, resource requirements and sources, position in the value chain and value proposition. While many previous studies focus on the customer-supplier transactions involved in innovation, there has been little research reported on transactions and exchanges that take place before a product has been fully developed. In the case of science-based ventures working with generic technologies, business model creation and development will often begin before the entrepreneur has selected a route to market and may change several times in response to opportunities and developments by any number of competitors and complementors before the first sales have begun.

Advanced-material university spin-outs (USOs) provide a fertile terrain to study the commercialization of emerging generic technologies. They face nearly all of the challenges inherent in technology ventures, with some unique differences. Unlike many IT innovations, they face established substitute products in many of their intended markets and industries. They are also unlikely to have the same market draw as the life-saving innovations found in biotech and biopharm. Choosing among potential markets and corresponding value networks is very exacting, as some of these materials technologies are so generic

http://dx.doi.org/10.1016/j.lrp.2015.03.001

that potential markets for a single application can range from energy to defense, from transport to telecommunications, each of which may require different combinations of resources from diverse business environments (Maine et al., 2012). Stakeholders often have conflicting objectives, and even within the firm there is a tension between the aims of advancing science and of making a profit. Early-stage, science-based entrepreneurs, who cannot rely on guidance proposed for other sectors, must keep these in mind as they design and adapt business models to operationalize their strategies.

In the following, we identify the particular challenges that advanced material ventures are likely to encounter in their early development and discuss how applicable the business models currently advised in popular and academic literature may be. We use a framework combining Penrosian resource-based theory, to identify how firms use resources to realize market opportunities, and more recent work on business ecosystems (Adner, 2012), to address how value creation is influenced by the wider value chain. The concept of the business model is used to bridge these well-established theoretical approaches to provide a holistic analysis of value creation in science-based ventures. Through three case studies, we follow the early evolution of the business models of two science-based USOs and a second-generation spin-out seeking applications for their generic technologies. Evidence from these cases serves to highlight the main drivers of early business model change, and to illustrate successful strategies for accessing complementary resources, navigating specific challenges and leveraging their unique position as USOs. They also highlight the inherent tension these firms face: they must experiment with the often large number of markets where their technologies could be applied to find where they can create the most value, they need resources only available from established partners, and investors may be limited to particular markets. However, the collaborators needed by the venture may be wary of experimentation and often press for early commitment to key elements of a business model. These theoretically grounded case studies inform the conclusions and recommendations of this study.

Science-based ventures: new business models for a new paradigm

In many science-based sectors, university spin-out (USO) firms are increasingly seen as a necessary vehicle for early technology commercialization, bridging the gap between scientific research and specific commercial application before the ventures are either acquired or, more rarely, bring their technology to market independently (Shane, 2004; Gill et al., 2007). Rather than grow to displace the industry giants, science-based ventures generally provide the ideas and innovations that ignite competition and drive market and industry evolution (Schumpeter, 1928; Geroski and Pomroy, 1990). For example, Cambridge Display Technology developed its P-OLED (Polymer – Organic Light-Emitting Diode) technology for over a decade before it was acquired by Japanese incumbent Sumitomo Chemical. Seven years after founding, Oxford biotech spin-out Avidex Ltd was acquired by Medigene AG, which then integrated the Avidex T-cell protein technology with their own offering. But, while they hold the power to transform industries and spawn new ones, science-based ventures face a host of unique commercialization challenges that make their journey particularly difficult (Shane, 2004), and that require them to devise and adapt novel business models.

Heterogeneity in science-based business

Science-based businesses are a unique group in that they are "entities that both participate in the creation and advancement of science and attempt to capture financial returns from this participation" (Pisano, 2010, 471). At the core of this definition is the fact that these firms are attempting to create value from newly established or as-yet unproven scientific principles. Thus, while decades ago information technology (IT) innovations, such as semi-conductors, emanated from scientific knowledge, most IT innovations are now based on well-understood technologies and no longer fit into this category. The culture and objectives of the science base from which radically new technologies tend to emerge is often at odds with traditional business. In a university lab, publications are often favoured over patents or secrecy, and contribution to knowledge emphasized over contribution to the commercial bottom line (Pisano, 2010). University entrepreneurs are often experienced in scientific discovery but not in business (Bower, 2003). Moreover, the university often becomes a stakeholder in addition to partners, investors and customers. Science-based ventures embrace and attempt to balance their conflicting objectives and stakeholder needs with mixed, if not negative, results.

They are also subject to the risks associated with long development times (five to ten years is not uncommon) and the need for much greater capital and resource investment than other types of ventures, such as those working with IT or devices (Christensen et al., 2004; Maine and Garnsey, 2006). Hence, before value can be created, science-based firms must gain access to funds, often running into hundreds of millions. This generally requires the engagement of large firms and financiers, and often requires securing IP and other resources from the parent university. Rather than taking a relatively passive role, customers of science-based ventures are often highly interactive, acting as partner and co-producer, offering access to various combinations of complementary assets, including finance, scientific knowledge, technical know-how, scale-up facilities, market knowledge and distribution channels. Resources may also be needed from the parent university, investors, government or regional business support services, to enable the startup to assemble the resource base necessary for viable operation (Dosi, 1982).

It is not always recognized in the literature that science-based ventures are highly heterogeneous (Druilhe and Garnsey, 2004). They span a number of categories, which are not necessarily mutually exclusive, including devices, biotech, pharmaceuticals, genomics, green-tech, nanotech, energy, and advanced materials, each of which are subject to specific challenges