Hunter Centre for Entrepreneurship

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"BUSINESS MODEL CHANGE IN EARLY-STAGE UNIVERSITY SPIN-OFFS"

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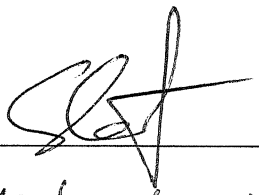
DECLARATION

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

Signed: 

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ABSTRACT

Business models are receiving increasing attention from practitioners and academics in entrepreneurship and management. However, few studies on business models follow the process of change in real time. This thesis explores the process of business model change in early-stage university spin-off firms, and how it impacts their performance. This thesis asks: (1) How does the process of business model change unfold in early-stage university spin-offs?, (2) How does business model change link to performance in early-stage university spin-offs?, and (3) How do business model elements change and interact over time in early-stage university spin-offs?

Driven by the exploratory nature of the research questions, an inductive, longitudinal multiple-case study of 8 early-stage university spin-offs was adopted. These firms combine uncertainty with low market and business knowledge, thus performing several business model changes to survive. Data was collected over 12 months from documentation, archival data, and 98 longitudinal interviews with founders. I created case histories, tables, sequences of key business models events, and performed open and selective coding to the data. Within- and cross-case analyses were performed to reveal patterns and induce propositions. Various triangulation tactics were used to ensure consistency of information and high research quality.

This thesis contributes mainly to the business model and university entrepreneurship literature with an identification of drivers and themes related to the process of business model change, and the introduction of the notions of realized and intended business models. It also generates a set of propositions relating business model change (aggregate and by element) and early-stage spin-off performance with: 1) commitment, market knowledge, managerial knowledge, and uncertainty, 2) technology scope and business scope, 3) relative frequency of causal and/or effectual behaviors (by using the effectuation theoretical framework), and 4) resource constraints (by using the resource-based view). Implications for entrepreneurs, managers, universities, policy makers, and business model educators are also discussed, as well as the limitations of the thesis and avenues for further research.

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LIST OF ABBREVIATIONS

ABS: Association of Business Schools

B2B: Business-to-Business

B2C: Business-to-Consumer

BCERC: Babson College Entrepreneurship Research Conference

BM: Business Model

C$: Cost Structure

CBO: Chief Business Officer

CEO: Chief Executive Officer

CFO: Chief Financial Officer

CH: Channels

CR: Customer Relationships

CS: Customer Segment

CSO: Chief Scientific Officer

CTO: Chief Technology Officer

GEM: Global Entrepreneurship Monitor

IP: Intellectual Property

IT: Information Technology

KA: Key Activities

KP: Key Partnerships

KR: Key Resources

NTBF: New Technology-Based Firms

NTBV(s): New Technology-Based Venture(s)

PRO: Parent Research Organization

PSED: Panel Study of Entrepreneurial Dynamics

R&D: Research & Development

R$: Revenue Streams

RBSO(s): Research-Based Spin-Off(s)

RBSU(s): Research-Based Start-Up(s)

RBT: Resource-Based Theory

RBV: Resource Based View

RCOV: Resources, Competences, Organization, Value

SME: Small Medium Enterprise

SMS: Strategic Management Society

TSB: Technology Strategy Board

TTO: Technology Transfer Office

VC: Venture Capital

VP: Value Proposition

1 INTRODUCTION

1.1 THESIS TOPIC AND KEY CONCEPTS

The overall purpose of this thesis is to explore the process of business model change in early-stage university spin-off firms. Previous studies have not addressed how different business model elements change in real-time. I do this by employing an inductive, longitudinal multiple case study to capture change in business model elements of these firms. From the case data, I derive a set of propositions that relate firm-specific constructs to the process of business model change.

This section provides an overview of the study. It introduces the thesis topic and key concepts, existing literature on business models and university spin-offs, and the research gap and questions. It also briefly describes the research design and methods employed, and outlines the structure of the dissertation.

The key concepts used throughout this thesis are:

- Business model
- Change
- Early-stage
- University spin-offs

These concepts are briefly defined below. A more thorough analysis of these concepts will be provided in subsequent chapters, as well as a discussion of their usage in this study.

Business Model

For the purpose of this study, and inspired on the work of Osterwalder et al. (2010), Zott & Amit (2010), and Zott et al. (2011), I define business model as follows:

A business model is a system of interdependent elements that model how an organization creates, delivers and captures value, encompassing activities that transcend the focal organization's boundaries.

Change

Common dictionary definitions of change usually suggest the existence of a transformative process whose output is the altered form: "An act or process through which something becomes different" (Oxford Dictionaries Online on Oct 2013). Adapting these definitions to the field of organizations, Van de Ven & Poole (1995: 512) present a more contextualized yet comprehensive definition of change, which I will adopt for this study:

"Change (...) is an empirical observation of difference in form, quality, or state over time in an organizational entity."

Early-Stage

The early-stage phase is defined as comprising both nascent and new business phases (Xavier, Kelley, Kew, Herrington, & Vorderwülbecke, 2013). The nascent phase contains new enterprises less than three months old; the new business phase contains the former nascent enterprises that have been in business for more than three months, but less than three and a half years. Therefore, inspired on the definitions used in GEM Reports, this study employs the following definition of early-stage:

Early-stage is a phase that comprises all new firms less than three and a half years old.

University Spin-Offs

There is some blurriness associated with the term university spin-off, mostly due to the heterogeneous nature of university spin-off processes (Bathelt et al.,

2010). There are also several different expressions used interchangeably to refer to university spin-offs, such as "university spin-out" or "academic spin-off". For the purposes of this study, I will employ the expression "university spin-off" and adopt Rasmussen's (2011: 449) definition:

> *"a new venture initiated in a university setting and based on technology developed at a university."*

1.2 BACKGROUND

Although the term "business model" has gained prominence in the beginning of this millennium, it has been used by practitioners for a long time and later by academics also (Casadesus-Masanell & Ricart, 2010; Zott, Amit, & Massa, 2011). A search for the term "business model" in ABI/INFORM Complete (full text[1]) reveals that its first use dates back to 1961 (NAA, 1961). The first use of the same expression in the title of a peer reviewed article dates back to 1985 (Barnett, 1985). The same search also shows a clear increase in the use of the term "business model" in the late 90's.

After almost 15 years, there is still no widely accepted definition of the term "business model" (Casadesus-Masanell & Ricart, 2010; George & Bock, 2011; Zott et al., 2011). However, scholars tend to agree that it represents the "logic of the firm" and describes the mechanisms of value creation, delivery, and capture employed by the firm (Linder & Cantrell, 2000b; Osterwalder, Pigneur, & Clark, 2010; Shafer, Smith, & Linder, 2005; Teece, 2010; Zott et al., 2011).

Business model research has been traditionally conducted in the fields of e-business, strategic management, and general management (Osterwalder, Pigneur, & Tucci, 2005; Shafer et al., 2005). More recently, this discussion has been extended to the field of entrepreneurship (Zott et al., 2011). In entrepreneurship, business models are important for several reasons: (1) the performance of entrepreneurial firms is strongly conditioned by their business models (Zott & Amit, 2007); (2) new ventures

[1] Search performed in the 2nd of November 2013.

in turbulent environments change their business models several times to succeed (Loch, Salt, & Bailey, 2008); and (3) business model design and change is especially critical to new technology-based firms (Andries & Debackere, 2007; Chesbrough & Rosenbloom, 2002).

The creation of new ventures by academics, usually referred to as university or academic entrepreneurship, also started long ago. In fact, the first reference to the expression "academic spin-off" in ABI/INFORM Complete (full text[2]) dates back to 1972 (Hodgins, 1972). Currently, the most common expression is "university spin-off". Similarly to the term "business model", the number of hits for the term "university spin-off" initiates a rising tendency in the late 90's. However, the term "business model" (total of 398831 hits) has a substantially higher popularity than the term "university spin-off" (total of 553 hits)[3].

There are several definitions of "university spin-off" and different expressions to represent the same concept, such as "university spin-out", "academic spin-off", among others. There is still some blurriness related to the term "university spin-off" (Bathelt, Kogler, & Munro, 2010), albeit many scholars view it as a new venture initiated in a university setting and based on technology developed at the university (Rasmussen, 2011).

University spin-offs fill a special gap between public research and the private sector. Their importance lies in their role as conduits of commercially relevant ideas (OECD, 2013), helping universities with their mission, and encouraging economic development (Shane, 2004). Additionally, their performance is typically higher than the average firm, and creating spin-offs is usually more profitable than licensing to established companies (Shane, 2004). For these reasons, the U.S. and European countries have established several policy initiatives to increase the commercialization of technology from university research (Abreu & Grinevich, 2013).

The growing interest among academics, practitioners, and policy makers both in business models (Zott et al., 2011) and university spin-offs (Mustar et al., 2006)

[2] Search performed in the 3rd of November 2013.
[3] Search performed in the 4th of November 2013.

calls for further research to better understand business model and university spin-off formation and evolution. Such knowledge may facilitate the creation of university spin-offs and enhance their performance and sustainability over time.

1.3 RESEARCH GAP AND RESEARCH QUESTIONS

Though the importance of understanding the *process of business model change* is well established, most business model research presents "a static perspective" (Sosna, Trevinyo-Rodriguez, & Velamuri, 2010: 384), "studying snapshots of business models at a certain moment in time" (De Reuver, Bouwman, & MacInnes, 2009: 270). Some studies do explore business model change (e.g., Linder & Cantrell, 2000a), dynamics (e.g., Mason & Leek, 2008), adaptation (e.g., Andries & Debackere, 2007), development (e.g., Andries, Debackere, & Van Looy, 2013), evolution (e.g., Demil & Lecocq, 2010), innovation (e.g., Chesbrough, 2010), and renewal (e.g., Doz & Kosonen, 2010). However, most of these studies focus on established firms. Some focus on entrepreneurial firms, though they do not employ longitudinal qualitative designs. Therefore, several authors have called for further insights on the process of business model emergence and change over time (Morris, Schindehutte, & Allen, 2005; Zott & Amit, 2007; Zott & Amit, 2008), and for the use of longitudinal designs (George & Bock, 2011; Svejenova, Planellas, & Vives, 2010).

An exception is the study by Andries et al. (2013), which employs a longitudinal multiple case study design and focuses on the business model development process of six new ventures. However, the interviews are retrospective, and some of the data is relatively old (e.g., January 1983). Other longitudinal studies have collected data in real time, though these studies do not explicitly focus on firms' business models. Ambos and Birkinshaw (2010) present a process study tracking the evolution of nine science-based new ventures using the concept of organizational archetype (Greenwood & Hinings, 1993). In the context of new ventures, Ambos and Birkinshaw (2010) identified three core elements in these archetypes: 1) the venture's primary driver of action, 2) its key stakeholder groups, and 3) the key area

of knowledge development. Though there is some overlap, the concept (and content) of these "archetype elements" differs greatly from the concept of "business model elements" used in this thesis.

Business model design is especially critical in environments characterized by high technological and market uncertainty (Andries & Debackere, 2007; Chesbrough & Rosembloom, 2002). These high levels of uncertainty induce more business model changes (Andries & Debackere, 2007; Loch et al., 2008), as the entrepreneur gains experience and new knowledge, often developed through interaction with others (Druilhe & Garnsey, 2004). Such high levels of uncertainty can be found in technology ventures in fast-moving, rapidly changing environments (Loch et al., 2008). *University spin-offs* are very often technology-based and their "road to commercially distributing products and services is (...) very rough and uncertain" (Fini, Grimaldi, & Sobrero, 2009: 384-385). They develop through an irregular, iterative, non-linear and complex process (Druilhe & Garnsey, 2004; Rasmussen, 2011; Vohora, Wright, & Lockett, 2004; Wright, Clarysse, Mustar, & Lockett, 2007), involving iterations with many actors at different levels (Rasmussen, 2011). The influence of the institutional context (comprising both the university and department level) upon the development of spin-offs' business models is especially acute at their *early stages* (Rasmussen, Mosey, & Wright, 2014). University spin-offs also face additional challenges when designing their business models, since they are usually characterized by lower market, managerial, and entrepreneurial knowledge than other new technology-based firms (Bower, 2003). Hence, in order to succeed, these firms may require more market-testing and business model adaptations than typical entrepreneurial firms (Clarysse, Wright, & Van de Velde, 2011), making them an interesting setting to study the process of business model change.

Choosing the right initial business model configuration (Chesbrough & Rosenbloom, 2002) or design (Zott & Amit, 2007) and managing its adaptation over time (Andries & Debackere, 2007) may have a critical impact on performance. However, the link between business model change and *entrepreneurial firm performance* is underexplored (Teece, 2010). In fact, few empirical studies have explored this relationship (e.g., Malone et al., 2006). Certain studies (e.g., Andries &

Debackere, 2007) have attempted to link business model adaptation with firm performance, but employing predominantly quantitative research designs. These designs do not capture the real-time evolution of different business model elements and other relevant constructs. The authors explicitly suggest the extension of their study to university spin-offs: "it would be interesting to look at spin-outs of universities and research institutes" (Andries & Debackere, 2007: 97). In their longitudinal multiple case study of new ventures, Andries et al. (2013) argue that committing to a business model early on positively affects initial growth, though hampering long-term survival. On the other hand, "simultaneous experimentation implies lower initial growth levels, but facilitates long-term survival" (Andries et al., 2013: 288). However, this enquiry is concentrated on how the approaches of 'simultaneous experimentation' and 'focused commitment' relate to initial growth and long-term survival. Therefore, the authors advocate "that further engagement in in-depth case studies may result in additional insights" (Andries et al., 2013: 308).

Morris et al. (2005) have stated that the elements of a business model are highly interdependent, with changes in one element having implications on the other elements. However, there is no clear understanding on the dynamics of this system of business model elements, and on the factors driving its change (Chesbrough & Rosembloom, 2002). Therefore, research is also needed on the evolution and interactions of *business model elements* over time (George & Bock, 2011; Morris et al., 2005).

Inspired on the research gaps above, this thesis asks the following research questions:

RQ1: *How does the process of business model change unfold in early-stage university spin-offs?*

RQ2: *How does business model change link to performance in early-stage university spin-offs?*

RQ3: *How do business model elements change and interact over time in early-stage university spin-offs?*

Given these research questions, the objectives of the study are:

1) To review and analyze streams of research and theoretical approaches relevant to the study of the process of business model change in university spin-offs

2) To establish an adequate methodology to capture real-time change in business model elements of early-stage university spin-offs, including the conceptualization of relevant constructs (e.g., performance, market knowledge, managerial knowledge, entrepreneurial knowledge) and the choice of a comprehensive business model framework

3) To carefully select cases based on theoretical and literal replication, and to collect in-depth, rich case data, with good access to documentation, possibility of frequent meetings with informants, and involving multiple data sources

4) To systematically organize data to provide rich descriptions, and to subsequently transform data in order to uncover relationships between constructs and patterns in the process of business model change

5) To generate a set of propositions linking business model change (at the business model and business model element level) and other relevant constructs with the performance of early-stage university spin-offs

6) To discuss the findings of the study, contrasting them with extant research and theoretical approaches that were previously reviewed

7) To establish conclusions concerning the reliability, validity and limitations of the study, to discuss the theoretical and practical implications of the findings, and to suggest avenues for future research.

This study seeks to contribute to the understanding of the process of business model change in early-stage university spin-offs and how it impacts their performance. First, by employing a longitudinal design, this research goes beyond the static perspective of traditional "snapshot" studies on business models. Second,

the case-study approach allows a more in-depth understanding of the mechanisms and processes through which business models change and impact firm performance. Third, this study follows research suggestions and deepens previous work on business model change and firm performance, including the extension to the context of university spin-offs. Fourth, by adopting a multilevel approach looking at the whole business model (aggregate level) and also at its individual elements (disaggregate level), this study expands typical single-level approaches. Finally, this research attempts also to contribute to theory development on the field, by considering different theoretical perspectives and discussing their fit with the data.

The results of the study should therefore have relevant implications for entrepreneurship, strategic management, and general management academics, and also practical implications for academic entrepreneurs, universities, and policy makers.

1.4 RESEARCH DESIGN AND METHODS

Mostly driven by the nature of the research questions (*how* type) and by the exploratory stance of the study, an inductive, multiple-case research design was chosen to explore business model change in early-stage university spin-offs. Moreover, since the research objective is to examine business model change in real-time, a longitudinal design is appropriate.

This study is set on the firm level of analysis. The unit of analysis is the business model (and its constituting elements). In particular, the study focuses on how each business model element changes over time, mainly from the founders' point of view (collected from the interviews). This view is triangulated with other perspectives collected from alternative data sources (e.g., internal documentation, newspapers). Consistent with the "how" type of questions, this study attempts also to capture the reasons behind these changes, and subsequent outcomes, such as firm performance.

The research setting was early-stage university spin-offs. Early-stage firms usually combine more uncertainty, time limits, and drive than established companies, hence promising more business model changes than later stages (Gersick, 1994). University spin-offs tend to have less market knowledge than corporate spin-offs at start-up (Clarysse et al., 2011), and less business experience (Costa, Fontes, & Heitor, 2004). This limited knowledge, which may be rephrased as higher uncertainty, induces more adaptations (Conceicao, Fontes, & Calapez, 2012). Therefore, the combination of "early-stage" and "university spin-offs" promises a more vivid setting to study business model change.

Given the research objective of linking business model change with firm performance, I selected eight firms with varied values (low, medium, and high) on dimensions known to affect future performance: market knowledge, managerial knowledge, and entrepreneurial knowledge (Shane, 2004). This selection complies with both literal and theoretical replication logic (Yin, 2009). Firms were selected in September 2010 and were active for less than three and a half years, hence ensuring consistency with early-stage definition (Xavier et al., 2013).

The empirical data of the study are restricted to one country (the U.K.), one parent university, and five technology-intensive industry sectors: electronics and software, biotechnology, biopharmaceutical, semiconductors, and renewable energy. Limiting the scope to a single country and a single university serves to control for country- and university-specific influences, such as university policy and local practices towards spin-off firms. The inclusion of five different technology-intensive industries facilitates cross-industry comparisons and a broader generalizability of results.

This study employs the business model canvas (Osterwalder & Pigneur, 2010) framework to map business model changes over time. Therefore, changes are limited to the nine elements that compose this framework: customer segments (CS), value propositions (VP), channels (CH), customer relationships (CR), revenue streams (R$), key resources (KR), key activities (KA), key partnerships (KP), and cost structure (C$). Limiting data collection and analysis to a particular business model framework facilitates the process of collecting, organizing, and analyzing data

within and across cases. The business model canvas (Osterwalder & Pigneur, 2010) was selected because of its relative comprehensiveness, and of its wide acceptance both among academics and practitioners.

The first stage of data collection consisted of a "pilot" case study in which six retrospective interviews were conducted with university entrepreneurs that were awarded enterprise fellowships. This pilot study contributed to refine the data collection procedure concerning content and process to be followed (Yin, 2009). The subsequent "main" case study consisted of 12 months of longitudinal (monthly) semi-structured interviews with the founders of the eight spin-offs, totaling 98 interviews. Additionally, I gathered archival data from internal sources (business plans, company websites, presentations, internal reports, videos) and from external sources (media articles and company data from database services). The interview process started in April 2011 and ended in July 2012. In the two final months, information to assess performance was collected, and retrospective interviews were conducted with additional informants to triangulate data, hence reducing potential informant bias (Eisenhardt & Graebner, 2007).

The main steps of the data analysis process included 1) data transcription, 2) data reduction, 3) building case descriptions (Miles & Huberman, 1994), 4) building event sequence maps (Van de Ven & Poole, 1990), 5) further structuring and synthesizing data, 6) coding, memoing and annotating data, 7) within-case analysis of temporal relationships, patterns or phases (Van de Ven & Poole, 1990), 8) cross-case analysis, and 9) matching theoretical concepts (working iteratively with theory and data). These steps were not always performed sequentially. The qualitative data analysis software QSR Nvivo 10 was a valuable tool to manage and analyse the considerable amount of data, and to establish a chain of evidence (Yin, 2009).

Several tactics were employed to strengthen the quality of the research design (Patton, 2002; Yin, 2009). To fulfil the test of construct validity, many triangulation tactics were employed: 1) data triangulation (multiple sources of data), 2) investigator triangulation (multiple researchers), 3) theory triangulation (multiple theoretical perspectives), 4) methodological triangulation (multiple designs, e.g., longitudinal and retrospective), and 5) informant triangulation (multiple informants).

The external validity, reliability, and limitations of the study were also carefully addressed. This study complied with relevant ethical practices in relation to the persons and organizations directly involved, and to those who may be affected by its results.

1.5 STRUCTURE OF THE DISSERTATION

The present chapter has broadly introduced the topic of study and key concepts, highlighted existing literature on business models and university spin-offs, described the research problem, and set forth the specific research questions that will be investigated in this thesis. It also identified the research design and methods, and outlined the structure of this dissertation.

Chapter 2 reviews the previous research on university spin-offs, business models, and entrepreneurial firm performance. First, it reviews the literature on university spin-offs, and second, the literature on business models. The latter is organized in two streams of research: 1) the static view, comprising studies that discuss mainly snapshots of business models; and 2) the dynamic view, comprising studies that conceptualize and discuss business models as entities that change over time. Third, the specific business model literature on the intersection of entrepreneurship, technology-based businesses, corporate spin-offs, and finally university spin-offs is reviewed.

Chapter 3 presents the research philosophy, design, and setting used in this thesis. The procedures for collecting, measuring, and analyzing data in this thesis are reported. Finally, research quality issues and ethical considerations are discussed. Chapter 4 reports the results after data collection and organizing, namely the case summaries and business model sequence event maps for each case. The final section of this chapter includes cross-case displays synthesizing relevant case data. Chapter 5 presents the analysis of the data, organized by different thematic areas (e.g., intended and realized business models, effectuation versus causation). The findings and propositions of the thesis are reported in this chapter.

Finally, Chapter 6 provides the discussion and conclusion of the thesis. First, it presents a synthesis of the main findings. Next, it discusses the theoretical contributions for entrepreneurship, strategic management, and general management, and practical implications for academic entrepreneurs, universities, and policy makers. Finally, the limitations of the study and suggestions for further research are presented.

2 LITERATURE REVIEW

2.1 INTRODUCTION

This section reviews extant literature on business models and university spin-offs, setting the background for this study and helping to identify suitable operationalizations of the main constructs in this study's research questions. It draws fundamentally on strategic management and entrepreneurship literature, and also more generally on management literature.

The literature on business models is both vast and fragmented, spanning many different fields and topics. Hence, this review covers only literature that relates intimately to the research questions, to avoid overloading the reader with irrelevant information for the purpose of this study. The fragmented nature of the business model literature requires a structured approach to provide a clear perspective and to highlight present limitations.

In reviewing the business model literature, guided by the study's research questions, it became clear that a large stream of the literature examines "business models as snapshots in time" (De Reuver et al., 2009: 1), while other streams examine how business models change (e.g., business model evolution, adaptation). For this reason, this review is divided into a 'static' view of business models (Section 2.2) and into a 'dynamic' view of business models (Section 2.3). Both of these views make important contributions to the literature, and both have their weaknesses. The 'static' studies usually provide more detail on business model definitions and their constituting elements. They are also important from an historical perspective, since they were the first studies to emerge on business model research. However, these studies do not employ research designs that capture the dynamics of business models, and therefore fail to explain how they change. On the other hand, the 'dynamic' studies provide some insight on business model change over time. However, the relationship with firm performance is underexplored. Moreover, they treat the business model as a whole, and lack a fine-grained view that examines change at the level of the business model element. Therefore, this review intends to combine the complementary insights of both approaches, by presenting current knowledge that

informs the study's research questions. Since this study examines business model change in an entrepreneurial context, namely university spin-offs, Sections 2.4 and 2.5 review literature on business models at the intersection of entrepreneurship and university spin-offs, respectively.

In sum, Section 2.2 focuses on the literature on business models that adopts a 'static' approach to the research phenomenon, i.e., that looks at snapshots of business model configurations at one point in time. It provides an historical overview of business models, as well as existing definitions and different representations of the construct, such as the Osterwalder et al. (2010) Business Model Canvas. It also discusses the scarce literature investigating the relationship between business models and firm performance.

Section 2.3 examines literature on business models that employs a more 'dynamic' approach to the research phenomenon, by observing business model configurations at two or more points in time. This section begins by clarifying the concept of change, and then by discussing change in the context of business models. It then examines 'dynamic' studies on business models (e.g., business model dynamics, evolution, adaptation, innovation, design, renewal, reinvention, experimentation, and sense-testing), including also a discussion on longitudinal studies on business models of established firms. Finally, it summarizes commonly adopted theoretical perspectives, and limitations of current business model research.

Section 2.4 explores business model research carried out in the entrepreneurship context. It starts with business model studies in 'general' entrepreneurship, then narrows the scope to longitudinal studies on business models of new ventures, and finally discusses business models in the context of new technology-based firms and corporate spin-offs.

Section 2.5 provides background for the main context selected for this study, i.e., university spin-offs. It provides an overview of the topic of university spin-offs, by providing an historical perspective, discussing its importance, and reviewing typical definitions, process of formation, constraints, and common theoretical perspectives. It presents a brief section on the scarce literature at the intersection of

business models and university spin-offs, ending with a discussion on the limitations of university spin-off research.

Finally, Section 2.6 establishes the conclusions of the literature review by summarizing key points and discussing the limitations of extant literature.

2.2 BUSINESS MODELS: A STATIC VIEW

2.2.1 Overview

The term "business model" appeared for the first time in an academic article in 1957 (Bellman, Clark, Malcolm, Craft, & Ricciardi, 1957) and in the title and abstract of a paper in 1960 (Jones, 1960), according to Osterwalder et al. (2005). Nevertheless, it was the advent of the Internet in the mid-1990s and the dotcom bubble that spread the interest on the topic of "business models". As Magretta (2002: 3) describes, "a company didn't need a strategy, or a special competence, or even any customers – all it needed was a Web-based business model that promised wild profits in some distant, ill-defined future".

The increasing popularity of spreadsheet software and personal computers in general, also promoted the use of the business model concept, since it allowed a much more analytical approach to planning. A web search performed in Google in December 2013 using the expressions "business model" or "business models" returned 8,940,000 results[4]. A similar search in Google performed by Chesbrough & Rosenbloom (2002) in May 2000 returned 107 000 references. This rise in Google hits clearly demonstrates the increased attention in just one decade.

Initially invoked by practitioners, the "business model" has also recently got the attention of academics. The same search performed by Chesbrough & Rosenbloom (2002) in May 2000, of a database of academic journals in economics (Econlit), found only 3 hits. A search performed in December 2013 in ABI/Inform Complete, using the expressions "business model" or "business models" on

[4] The Web search was done in Google using the syntax "business model" or "business models".

document title, abstract or keywords (peer reviewed), yielded 2 685 hits[5]. This demonstrates the increase of attention it has been receiving also from academics.

The importance and power of business models is grounded on its many potential applications, and range of use. For example, it can be used as a planning and testing tool, but also as a communication and motivation anchor (Magretta, 2002; Shafer et al., 2005). Osterwalder et al. (2005) suggest that business models play several practical roles, such as understanding, sharing, analysing, managing, simulating, and patenting the business logic of a firm.

Based on evidence from Xerox Corporation's technology spin-offs, Chesbrough & Rosenbloom (2002) demonstrated that technologies might not be profitable using a traditional business model, but may be highly rewarding when commercialised with the right model. According to them, discovery-oriented research often creates "spillover" technologies that lack a straightforward path to market. The business model construct plays here a critical role in appropriating value from those technologies. In some of his more recent work, Chesbrough (2007a: 12) stresses that "a better business model often will beat a better idea or technology". In a similar fashion and written more recently: "A mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model" (Chesbrough, 2010: 355).

Zott & Amit (2008) also underline the importance of business model research, since this construct affects firms' possibilities for value creation and value capture, and thus can be a source of competitive advantage. George & Bock (2011: 83) similarly emphasize that "the formation, growth potential, and success of new organizational forms is often credited to the development of novel business models, especially in turbulent industries", and that this construct is critical for understanding value creation. Such a close link to firm performance and survival clearly demonstrates the relevance of this construct.

[5] Syntax used to perform the search: ab("business model" OR "business models") OR ti("business model" OR "business models") OR tag("business model" OR "business models"). Peer reviewed option was selected.

2.2.2 Business Models in Different Fields

Business models are discussed in various different fields, such as e-business, information systems, technology, strategy, management (Osterwalder et al., 2005; Shafer, Smith, & Linder, 2005) and, more recently, in entrepreneurship.

One of the first authors to come up with a formal definition of business models was Timmers (1998), in an article exploring the different models operating in electronic commerce. E-business is still the research stream that has devoted greatest attention to the concept so far (Zott et al., 2011). Researchers in this field have been mainly interested in defining and representing generic e-business models, and in developing typologies and taxonomies.

As a consequence of advances in information systems, some authors have been discussing business models in this context (e.g., Al-Debei & Avison, 2010; Hedman & Kalling, 2003; Osterwalder et al., 2005). These authors argue that because the business model concept creates a common language between business and information systems, it contributes to a better alignment between both domains. Alignment has therefore been a key issue in information systems management (Brancheau, Janz, & Wetherbe, 1996, in Osterwalder et al., 2005).

The concept has also been receiving increasing attention from the strategic management domain, as shown by the numerous works attempting to distinguish business models from strategy (George & Bock, 2011; Magretta, 2002; Osterwalder et al., 2005; Shafer et al., 2005). According to Zott et al. (2011: 1031), researchers of business models in the strategy domain have focused their attention on three aspects: "(1) the networked nature of value creation, (2) the relationship between business models and firm performance, and (3) the distinction between the business model concept and other strategy concepts".

The business model construct has been also present in the domains of innovation and technology management (Zott et al., 2011). This stream of research revolves around two ideas: 1) firms commercialize their innovative technologies via their business models, and 2) the business model represents a new source of innovation, complementing process, product, and organizational innovation.

Chesbrough (2007a) argues that business models can be innovated in each of the different elements (e.g., value proposition, market segments).

Business models have been increasing their presence in entrepreneurship research, as shown by the growing number of publications about the concept in this field (e.g., George & Bock, 2011; Morris et al., 2005). In fact, some authors argue that the business model is a central construct in entrepreneurship (Morris et al., 2005). Ventures fail despite the presence of necessary ingredients – market opportunities, business ideas, resources and talented entrepreneurs –, and such failure might be related to the underlying model driving the business. Zott & Amit (2007) emphasize the importance of business model design for entrepreneurial firms, since these are less constrained by path dependencies and inertia. The performance of these firms is then critically dependent on entrepreneurs' decisions regarding the business model elements. In a recent systematic review of business models through an entrepreneurship lens, George & Bock (2011) have re-emphasized the pertinence of the study of business models to entrepreneurship research.

2.2.3 Business Model Definitions

The literature on business models is young and dispersed (Zott et al., 2011). Though the term has become popular, researchers still do not agree on a common definition. Hence, definitions for the concept diverge widely (George & Bock, 2011). Moreover, many researchers study the concept without presenting explicit definitions. According to Zott et al. (2011), of the 103 business model publications they reviewed, more than one third (37%) do not define the concept, taking its meaning for granted; fewer than half (44%) explicitly define or conceptualize it; and the remaining publications (19%) refer to the work of other scholars when defining the concept. In fact, existing definitions only overlap partially, which generates a multitude of interpretations around this apparently "nebulous" concept. This obscurity promotes dispersion rather than convergence of perspectives and impedes cumulative research on business models (Zott et al., 2011). Other recent and comprehensive reviews on the topic of business models are available (e.g., Baden-

Fuller & Mangematin, 2013; George & Bock, 2011; Klang, Wallnofer, & Hacklin, 2010).

An inventory of definitions from highly cited articles and from more recent articles (2009 on) is presented on Table 2.1. The number of citations of the articles where retrieved from Google Scholar, Web of Science and ABI/Inform. This table was jointly inspired in the works of George & Bock (2011), Morris, Richardson, & Allen (2006a), Morris et al. (2006b), and Zott et al. (2011), with some more selected definitions, and including titles of the papers and citation indexes. The three most cited articles that contain the expression "business models" in the title of the article are the ones by Amit & Zott (2001), Chesbrough & Rosenbloom (2002), and Timmers (1998), measured by Google Scholar citation index. From this list of highly cited articles, the most recent are the articles by Osterwalder et al. (2005), Morris et al. (2005) and Shafer et al. (2005), being the article by Osterwalder et al. (2005) the most cited according to Google Scholar.

The second section of Table 2.1 offers an inventory of definitions from more recent articles, characterized also by a considerable number of citations. These later definitions are, in great part, based on reviews of the previous definitions. They emphasize the fact that the business model describes the "rationale" (Osterwalder et al., 2010) or the "logic" (Teece, 2010) of how an organization makes money, and consists of a set of managerial choices and their consequences (Casadesus-Masanell & Ricart, 2011). They suggest that the business model focuses on the activities of "value creation" (Osterwalder et al., 2010; Zott et al., 2011), "value delivery" (Teece, 2010; Osterwalder et al., 2010), and "value capture" (Osterwalder et al., 2010; Zott et al., 2011). They also propose a systemic view of the business model that transcends the focal firm (Amit & Zott, 2012; Baden-Fuller & Haefliger, 2013; Zott & Amit, 2010; Zott et al., 2011).

Table 2.1 Selected Definitions of Business Models

Author(s) (Year)	Title	Journal	Selected Definitions of Business Model(s)	Nr. of Citations* GS	WoS	ABI	Rank
Definitions from highly cited articles							
Amit & Zott (2001)	Value creation in E-Business	SMJ	Depicts "the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities" (p. 511).	1635	334	5	1
Magretta (2002)	Why Business Models Matter	HBR	"They are, at heart, stories—stories that explain how enterprises work" (p. 4).	699	67	42	2
Mahadevan (2000)	Business Models for Internet-Based E-Commerce	CMR	"A unique blend of three streams that are critical to the business. These include the value stream for the business partners and the buyers, the revenue stream, and the logistical stream" (p. 59).	528	90	38	3
Chesbrough & Rosenbloom (2002)	The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies	ICC	"The architecture of the revenue" (p.530); "Provides a coherent framework that takes technological characteristics and potentials as inputs, and converts them through customers and markets into economic outputs. (...) A focusing device that mediates between technology development and economic value creation" (p. 532).	809	177	-	4
Venkatraman & Henderson (1998)	Real strategies for virtual organizing	SMR	"A coordinated plan to design strategy along all three vectors (customer interaction, asset sourcing, and knowledge leverage" (p. 46).	616	78	19	5
Timmers (1998)	Business Models for Electronic Markets	EM	"An architecture for the product, service and information flows, including a description of the various business actors and their roles; A description of the potential benefits for the various business actors; A description of the sources of revenues" (p. 2).	1321	-	-	6
Osterwalder et al. (2005)	Clarifying Business Models: Origins, Present, and Future of the Concept	CAIS	"A conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams" (p. 17-18).	379	-	28	7

Morris et al. (2005)	The entrepreneur's business model: toward a unified perspective	JBR	"A concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets" (p. 727).	308	50	-	8
Rappa (2004)	The utility business model and the future of computing services	IBMSJ	"A method of doing business. All business models specify what a company does to create value, how it is situated among upstream and downstream partners in the value chain, and the type of arrangement it has with its customers to generate revenue" (p. 34).	212	42	5	9
Hedman & Kalling (2003)	The business model concept: theoretical underpinnings and empirical illustrations	EJIS	"Term often used to describe the key components of a given business" (p. 49).	222	35	-	10
Shafer et al. (2005)	The power of business models	BH	"A representation of a firm's underlying core logic and strategic choices for creating and capturing value within a network" (p. 202).	257	-	-	10
Linder & Cantrell (2000)	Changing business models: surveying the landscape	AISC	"The organization's core logic for creating value" (p. 1)	178	-	-	12
Other definitions from more recent articles (2009 -)							
Osterwalder et al. (2010)	Business Model Generation	Book	"Describes the rationale of how an organization creates, delivers and captures value" (p. 14).	143	-	- -	
Teece (2010)	Business Models, Business Strategy and Innovation	LRP	"A business model articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value" (p. 8).	740	135	97	1
Zott & Amit (2010)	Business Model Design: An Activity System Perspective	LRP	"A system of interdependent activities that transcends the focal firm and spans its boundaries" (p. 1).	335	60	37	2
George & Bock (2011)	The Business Model in Practice and its Implications for Entrepreneurship Research	ETP	"The design of organizational structures to enact a commercial opportunity" (p. 99); "A static configuration of organizational elements and activity characteristics" (p. 102); "The organization's configuration enactment of a specific opportunity" (p. 102).	93	14	17	4
Zott, Amit, & Massa (2011)	The Business Model: Recent Developments and Future Research	JM	"A new unit of analysis, offering a systemic perspective on how to 'do business', encompassing boundary-spanning activities (performed by a focal firm or others), and focusing on value creation as well as on value capture" (p. 1038).	275	53	38	3
Casadesus-Masanell & Ricart (2011)	How to Design a Winning Business model	HBR	"a business model consists of a set of managerial choices and the consequences of those choices" (p. 5)	87	6	8	5

Amit & Zott (2012)	Creating Value Through Business Model Innovation	MSMR	"a bundle of specific activities — an activity system — conducted to satisfy the perceived needs of the market, along with the specification of which parties (a company or its partners) conduct which activities, and how these activities are linked to each other." (p. 42)	52	10	8	6
Baden-Fuller & Haefliger (2013)	Business Models and Technological Innovation	LRP	"a system that solves the problem of identifying who is (or are) the customer(s), engaging with their needs, delivering satisfaction, and monetizing the value." (p. 419)	1	-	-	-

*Last three columns present the number of citations according to Google Scholar, Web of Science and ABI/Inform

Citation indexes retrieved on the 20th of September 2011 (for articles until 2008), and on the 12th of December 2013 (for recent articles, i.e., from 2009 on).

Journal Glossary

SMJ	Strategic Management Journal	JBR	Journal of Business Research
HBR	Harvard Business Review	IBMSJ	IBM Systems Journal
CMR	California Management Review	EJIS	European Journal of Information Systems
ICC	Industrial and Corporate Change	BH	Business Horizons
SMR	Sloan Management Review	CAIS	Communications of the Association for Information Systems
AISC	Accenture - Institute for Strategic Change	EM	Electronic Markets
JM	Journal of Management	ETP	Entrepreneurship Theory and Practice
LRP	Long Range Planning	MSMR	MIT Sloan Management Review

Based on the previous considerations, and greatly inspired by the reviewed definitions by Osterwalder et al. (2010), Zott & Amit (2010), and Zott et al. (2011), I present below the definition of "business model" that will guide the present study:

"A business model is a system of interdependent elements that model how an organization creates, delivers and captures value, encompassing activities that transcend the focal organization's boundaries."

The word "element" is more generic than "activity", and thus can represent also different entities, such as resources, partners, and others, as explained in the next section. The word "organization" is preferred to "firm", since it is also broader, and encompasses other entities to which the concept of business model can also be applied. Also, this definition emphasizes the tricotomy of value "creation, delivery and capture", which provides a more detailed insight than the dicotomy value "creation and capture".

2.2.4 Business Model Representations

Authors debating the concept of "business model" often discuss its different constituting "elements" (Zott et al., 2011; Osterwalder et al., 2005), "components" (Morris et al., 2005), or "building blocks" (Osterwalder et al., 2010). Table 2.2 presents a description of the business model elements proposed by the different authors and the respective total number of elements ("Nr"). For a matter of consistency, this table is based on the same works referred to in Table 2.1. This allows the comparison of information from both tables to build an overall picture of the authors, year and title of the publication, definitions of business models, citation indexes, description of the business model elements and their respective number. A glance through Table 2.2 quickly reveals a considerable disparity in the number of business model elements and their description. This observation clearly indicates that the lack of convergence regarding the definitions of "business models" also extends to the elements that constitute it, both numerically and conceptually.

Table 2.2 Perspectives on Business Model Elements

Author(s) (Year)	Perspectives on Business Model Elements	Nr.
Amit & Zott (2001)	1. Transaction content; 2. Transaction structure; 3. Transaction governance (p. 511).	3
Chesbrough & Rosenbloom (2002)	1. Value proposition; 2. Market segment; 3. Value chain; 4. Cost structure and profit potential; 5. Value network; 6. Competitive strategy (pp. 533-534).	6
Hedman & Kalling (2003)	1. Customers; 2. Competitors; 3. Offering; 4. Activities and organization; 5. Resources; 6. Supply of factor and production inputs; 7. Longitudinal process component (pp. 52-53).	7
Linder & Cantrell (2000)	1. Pricing model; 2. Revenue model; 3. Channel model; 4. Commerce process model; 5. Internet-enabled commerce relationship; 6. Organizational form; 7. Value proposition (p. 3).	7
Magretta (2002)	1. Who is the customer?; 2. What does the customer value?; 3. How do we make money in this business?; 4. How can we deliver value to customers?; 5. ...at an appropriate cost? (p. 4).	5
Mahadevan (2000)	1. Value streams; 2. Revenue streams; 3. Logistical streams (p. 67).	3
Morris et al. (2005)	1. How do we create value? (factors related to the offering); 2. Who do we create value for? (market factors); 3. What is our source of competence? (internal capability factors); 4. How do we competitively position ourselves? (competitive strategy factors); 5. How we make money? (economic factors); 6. What are our time, scope, and size ambitions? (personal/investor factors) (p. 730).	6
Osterwalder et al. (2005)	A. Product (1. Value Proposition); B. Customer Interface (2. Target Customer; 3. Distribution Channel; 4. Relationship); C. Infrastructure Management (5. Value Configuration; 6. Core Competency; 7. Partner Network); D. Financial Aspects (8. Cost Structure; 9. Revenue Model) (p. 18).	9
Shafer et al. (2005)	A. *Strategic choices* (Customer, Value Proposition, Capabilities/Competencies, Revenue/Pricing, Competitors, Output, Strategy, Branding, Differentiation, Mission); B. *Value Network* (Suppliers, Customer Information, Customer Relationship, Information Flows, Product/Service Flows); C. *Create Value* (Resources/Assets, Processes/Activities); D. *Capture Value* (Cost, Financial Aspects, Profit) (p. 202).	20
Timmers (1998)	Value chain' elements: 1. Inbound logistics; 2. Operations; 3. Outbound logistics; 4. Marketing & sales; 5. Service; 6. Technology development; 7. Procurement; 8. Human resource management; 9. Corporate infrastructure (p. 3).	9
Venkatraman & Henderson (1998)	1. Customer interaction; 2. Asset configuration; 3. Knowledge leverage (p. 34).	3
More recent articles (2009 -)		
Osterwalder et al. (2010)	1. Customer Segments; 2. Value Propositions; 3. Channels; 4. Customer Relationships; 5. Revenue Streams; 6. Key Resources; 7. Key Activities; 8. Key Partnerships; 9. Cost Structure (pp. 16-17).	9
Zott & Amit (2009)	1. Activity system content (refers to the selection of activities); 2. Activity system structure (describes how the activities are linked); 3. Activity system governance (refers to who performs the activities) (p. 5).	3
Teece (2010)	1. Technologies and features to be embedded in the product/service; 2. Benefit to customer from consuming/using the product/service; 3. Market segments to be targeted; 4. Revenue streams; 5. Mechanisms to capture value (p. 2).	5

George & Bock (2011)	1. Resource structure (static architecture of the firm's organization, production technology, and core resources leveraged to serve customers); 2. Transactive structure (organizational configuration that determines key transactions with partners and stakeholders); 3. Value structure (system of rules, expectations, and mechanisms that determine the firm's value creation and capture activities) (p. 99).	3
Casadesus-Masanell & Ricart (2011)	1. Policy choices; 2. Asset choices; 3. Governance choices.	3
Amit & Zott (2012)	1. Content; 2. Structure; 3. Governance.	3
Baden-Fuller & Haefliger (2013)	1. Customer identification; 2. Customer engagement; 3. Value delivery; 4. Monetization.	4

Some authors (e.g., Osterwalder et al., 2005) have attempted to create a reference model, i.e., create a common language in the business model field that could be shared among communities of practice or researchers. But the current stream of publications, with a few exceptions, either reviews previous business model representations and/or proposes alternative ones, revealing the present lack of agreement on a reference model. Such a business model representation, to be useful, "must be reasonably simple, logical, measurable, comprehensive, and operationally meaningful" (Morris et al., 2005: 729). One such representation that is well aligned with this description is the framework of Osterwalder et al. (2010), depicted in Figure 2.1 below. For this reason and others that will be detailed subsequently in the methodology chapter, this framework of nine elements was chosen to guide this study. These elements are:

1. *Customer Segments* (CS): defines the different groups of people or organizations an enterprise aims to reach and serve;

2. *Value Propositions* (VP): describes the bundle of products and services that create value for a specific Customer Segment;

3. *Channels* (CH): describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition;

4. *Customer Relationships* (CR): describes the types of relationships a company establishes with specific Customer Segments;

5. *Revenue Streams* (RS): represents the cash a company generates from each Customer Segment (costs must be subtracted from revenues to create earnings);

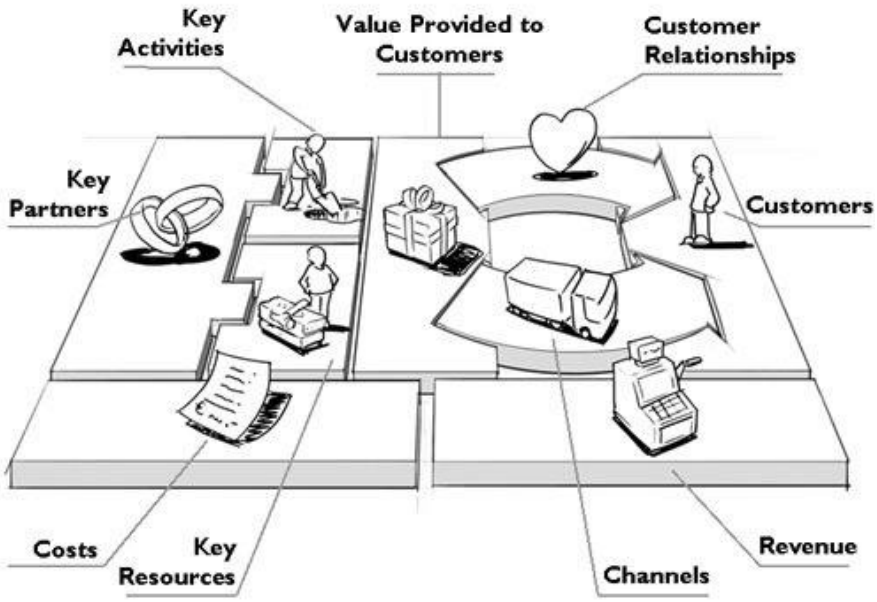
6. *Key Resources* (KR): describes the most important assets required to make a business model work;

7. *Key Activities* (KA): describes the most important things a company must do to make its business model work;

8. *Key Partnerships* (KP): describes the network of suppliers and partners that make the business model work;

9. *Cost Structure* (CS): describes all costs incurred to operate a business model.

Figure 2.1 The Business Model Canvas (Osterwalder et al., 2010)



2.2.5 Business Models and Firm Performance

Several authors suggest that business models matter (Chesbrough, 2007b; Magretta, 2002), and that the right business model may be more rewarding (Chesbrough & Rosenbloom, 2002). Such considerations strongly suggest a link between business models and firm performance. Nevertheless, few large-scale systematic empirical studies have explored this link (Malone et al., 2006).

Within the consulting business, Linder & Cantrell (2001) studied the effectiveness of business models by looking at the 1000 largest firms in the US, and by collecting general financial and market measures to place firms in performance quartiles. An assessment of the business model landscape found no "silver bullets", i.e., no specific business models guaranteeing financial success. Also in the practice arena, Pohle & Chapman (2006) interviewed 765 corporate and public sector leaders. They found that CEOs are looking at business model innovation as a source of sustainable competitive advantage. The authors' analysis of financial performance revealed that companies whose operating margins have grown faster were twice as likely as their lower performing peers to emphasize business model innovation. Over half of the interviewees reported that business model innovation resulted in cost reduction and increased strategic flexibility.

The academic studies emerge slightly later. Malone et al. (2006) defined a typology for business models and classified the models of all 10,970 publicly traded firms in the US economy from 1998 through 2002. They analyzed these firms with six measures of financial performance and concluded that no model outperforms others on all dimensions. However, they found that some models were superior on specific measures of performance.

Other studies have attempted to explore the link between business models and performance, but they are too narrowly focused in one sector, such as mobile services (e.g., De Reuver & Haaker, 2009; Methlie & Pedersen, 2007). Also, other studies explore firm performance using more complex models in which the business model is coupled with other variables, making it more difficult to untangle its role (e.g., Koo et al., 2007).

Andries & Debackere (2007) tested the relationship between business model adaptation and firm performance through a survival analysis of a sample of new technology based (NTB) businesses. They demonstrated that NTB businesses that adapt their business models have higher probability of surviving than those who never made any adaptation. Moreover, business model adaptation is more beneficial in less mature, capital-intensive and high-velocity industries.

Using a data set of 190 entrepreneurial firms that were publicly listed on U.S. and European stock exchanges, Zott & Amit (2007) investigated the impact of business model design in the performance of entrepreneurial firms. In sum, they found that business model design matters to entrepreneurial firm performance. Their study shows that the more novelty-centred an entrepreneurial firm's business model design, the higher the firm's performance. Their analysis shows also that this positive relationship is "remarkably stable across time, even under varying environmental regimes" (Zott & Amit, 2007: 182). However, the authors add that entrepreneurs' attempts to design both efficiency- and novelty-centred business models may be counterproductive. Their study also shows that

> *"(...) firms can innovate not only by recombining the resources they control, but also by harnessing those of partners, suppliers, and customers who participate in their business model."* (Zott & Amit, 2007: 195)

In a subsequent study, Zott & Amit (2008) examine the fit between a firm's product market strategy and its business model, and their implications for the focal firm's performance. They found significant interaction effects of the business model construct with product market strategies on the perceived performance of firms. In particular, they found again a positive relationship between novelty-centred business models – coupled with product market strategies that emphasize differentiation, cost leaderships, or early market entry – and firm performance.

In an empirical study of 112 French IT companies set up between 1998 and 2002, Redis (2009) investigated the influence of business model characteristics on the performance of new firms. He looked at three business model characteristics – the positioning on the industry value chain, the target customer base and the income

model – and discovered a positive impact on the time it takes a business to make profit, the turnover and the amount of venture capital raised. These findings confirm the impact of the business model on the performance of firms – at least, on new IT firms.

In a review of the business model construct, George & Bock (2011) refer to the practitioner-focused work of Slywotzky (1999, in George & Bock, 2011: 85) that "interlinks business models and strategy and suggests that business model innovation is the cornerstone of long-term performance". They also refer to an alternate analysis that suggests that firm performance is linked to "business model consistency across international subsidiaries or partners (Roberts & Senturia, 1996)" (George & Bock, 2011: 85). In another review of the business model concept, Zott et al. (2011) provide a synthesis of the literature exploring the relationship between business models and firm performance. Their considerations regarding this relationship are well aligned with the previous discussion.

2.3 BUSINESS MODELS: A DYNAMIC VIEW

The previous section presented a review of the literature that adopts a "static" view of business models. Motivated by the nature of the research questions, that draw on the need to understand the process of business model change over time, this section reviews the literature employing a more "dynamic" perspective to the study of business models.

2.3.1 Change and Dynamic Environments

The semantic meaning of "change" points towards the idea of something that becomes different, that alters its form:

> *"Change (v): 1. (cause sb/sth to) become different; alter; 2. Pass from one form to another. (...)*

Change (note on usage): Change has a general use and indicates any act of making something different." (Oxford Advanced Learner's Dictionary, 1991: 187)

Other definitions suggest the existence of a transformative process whose output is the altered form:

"Change (noun): 1. An act or process through which something becomes different." (Oxford Dictionaries Online on Oct 2013)

Specifically in the context of organizations, Van de Ven & Poole (1995: 512) present a very insightful differentiation between process, change, and entity:

"(...) we refer to process *as the progression (i.e., the order and sequence) of events in an organizational entity's existence over time.* Change, *one type of event, is an empirical observation of difference in form, quality, or state over time in an organizational entity. The* entity *may be an individual's job, a work group, an organizational strategy, a program, a product, or the overall organizational."*

Therefore, since the primary unit of analysis of this study, or the entity, as Van de Ven & Poole (1995) put it, is the business model, I define "business model change" as *"an empirical observation of difference in form, quality, or state over time in a business model"*.

Fuelled by globalization, the Internet and new technologies, today's business environment changes constantly and rapidly (e.g., Voelpel et al., 2005). New competitors emerge at a fast pace. Customers are more educated, informed and demanding. Mergers and alliances happen at a frenetic rhythm, making the industry landscape more dynamic and volatile (Linder & Cantrell, 2000). These are just a few factors accelerating the speed of change in the business environment. Table 2.3 provides support to this undeniable fact by many scholars in the business model stream of research.

Since to every action there is always a reaction (Newton, 1687), more changes in the industry landscape require more business model adaptations by the companies. Firm success is critically dependent in the speed of reaction to that change, as Linder & Cantrell (2000a: 2) put forward: “Today’s faster paced business environment won’t tolerate either the slow processes or the high rate of failure firms have experienced when changing in the past”. Succeeding in this process is of utmost importance, since failure may be fatal, as Wirtz et al. (2010) emphasize: “Being unable to adapt one’s business model in the face of significant environmental change has proved deadly for many firms”.

Table 2.3 Citations on the Dynamic Nature of Today’s Business Environment

(Author, Year)	**Title**	**Selected Citations on Today's Dynamic Business Environment**
(Linder & Cantrell, 2000b)	Changing Business Models: Surveying the Landscape	"The days of comprehensive annual business plans that actually stick are over. The world just moves too fast" (p. 14); "Most firm's business models are under constant pressure to change" (p. 10).
(Linder & Cantrell, 2000a)	Carved in Water: Changing Business Models Fluidly	"Thriving in the no-time-to-think economy means companies must learn how to change business models quickly and effectively" (p.1)
(Doz & Kosonen, 2010)	Embedding Strategic Agility: A Leadership Agenda for Accelerating Business Model Renewal	"In the face of discontinuities and disruptions, convergence and intense global competition, companies now need to transform their business models more rapidly, more frequently and more far-reachingly than in the past" (p. 1).
(Wirtz, Schilke, & Ulrich, 2010)	Strategic Development of Business Models: Implications of the Web 2.0 for Creating Value on the Internet	"Firms are increasingly confronted with fundamental environmental alterations, (...) which often require managers to significantly adapt one or more aspects of their business models" (p. 2).
(Voelpel, Leibold, & Tekie, 2004)	The wheel of business model reinvention: how to reshape your business model to leapfrog competitors	"In today's rapidly changing business landscape, new sources of sustainable competitive advantage can often only be attained from business model reinvention that is based on disruptive innovation" (p. 259).
(De Reuver et al., 2009)	Business model dynamics: a case survey	"In the turbulent world of e-commerce, companies can only survive by continuously reinventing their business models" (p. 1).
(McGrath, 2010)	Business Models: A Discovery Driven Approach	"The business model concept offers strategists a fresh way to consider their options in uncertain, fast-moving and unpredictable environments" (p. 1).
(Teece, 2010)	Business Models, Business Strategy and Innovation	"Changing technology and enhanced competition will require more than defenses against imitation. It is also likely that even successful business models will at some point need to be revamped, and possibly even abandoned" (p. 18).

Such statements are strong motivators to develop a better understanding of the process of business model change, and how to effectively and efficiently conduct it (Pateli & Giaglis, 2005; Wirtz et al., 2010).

2.3.2 Business Model Change

Extant literature uses many different expressions to represent a more dynamic approach to business models: *business model change* (e.g., Linder & Cantrell, 2000) *business model dynamics* (e.g., De Reuver et al., 2009), *dynamic business models* (e.g., Mason & Leek, 2008), *business model evolution* (e.g., Demil & Lecocq, 2010), *business model adaptation* (e.g., Andries & Debackere, 2006, 2007), *development* (e.g., Andries, Debackere, & Van Looy, 2013), *business model innovation* (e.g., Chesbrough, 2010), *business model renewal* (e.g., Doz & Kosonen, 2010) and *business model reinvention* (e.g., Voelpel et al., 2004). Table 2.4 shows the popularity of these expressions in Google, Google Scholar and ABI/Inform.

Table 2.4 Popularity of Business Model "Expressions"

Expressions	Google	Google Scholar	ABI/Inform	Rank
"Business model innovation"	342,000	3,110	859	1
"Business model change"	1,430,000	455	487	2
"Dynamic business model"	3,120,000	240	215	3
"Dynamic business models"	2,580,000	222	91	4
"Business model evolution"	229,000	258	82	5
"Business model dynamics"	79,700	116	24	6
"Business model reinvention"	76,000	92	19	7
"Business model adaptation"	30,100	68	17	8
"Business model renewal"	10,800	49	6	9

Notes:

Date of search: 7th March 2011
ABI/Inform search performed in "All fields + text"
"Rank" equals the rank of the sum of the 3 individual ranks (Google, Google Scholar, ABI/Inform)

The expression "business model innovation" comes first in the rank, but it is employed almost exclusively for established companies that want to revamp their businesses. The second most used expression – *business model change* – is employed in the context of established companies, but is also used frequently when dealing with start-ups. Thus, in agreement with considerable part of the existing literature, I will use this term to address changes in business models during the early stages of a venture.

Though "most firms' business models are under constant pressure to change" (Linder & Cantrell, 2000b: 10), "most studies [still] look at business models as snapshots in time" (De Reuver et al., 2009: 1). Linder & Cantrell (2000b) were among the first authors to use the term "changing business models" or simply "change model":

> *"A change model (...) describes how an organization adapts in a dynamic environment. A change model is the core logic for how a firm will change over time to remain profitable in a dynamic environment."* (Linder & Cantrell 2000b: 2-3)

Through interviews with 70 company executives and analysts, and additional secondary research, Linder & Cantrell (2000b) conclude that: 1) developing a sound business model matters, b) business models wear out, and c) leading companies don't just adjust their business models incrementally – they also master change models. In fact, the authors add that successful organizations master the ability to change effectively their business model at a pace that matches the dynamics in their markets.

In another study, Linder & Cantrell (2000a) interviewed executives in 40 companies about how they are changing their business models faster. They concluded that a few leading firms (13%) have learned how to change their business models much faster. The best way to change business models fluidly and faster is by nurturing a multitude of business model alternatives (Linder & Cantrell, 2000a). This can be done by buying firms and learning from them, or by deliberately experimenting. Once a firm has several business model options, then it needs to master the art of timing, i.e., making the right move at the right time. Armed with

multiple business models and the skill of timing, the next step is to switch between models without modifying the organizational structure. Such a skill "requires naming the mindsets, providing broad goals and incentives, and practicing role flexibility" (Linder & Cantrell, 2000a: 11). A subsequent article by Linder and Cantrell (2001) shares a very similar argument to the previous publications (Linder & Cantrell, 2000a; Linder & Cantrell, 2000b).

Grounded on a systematic synthesis of existing literature, Pateli & Giaglis (2005) recognized the lack of a structured approach to change the business model of a firm. Some authors have suggested methodologies for business model change (Auer & Follack, 2002; Petrovic, Kittl, & Teksten, 2001; Pramataris et al., 2001), but they provided a rather strict linear sequence of steps. This approach might yield satisfactory results for relatively stable industry settings, but not for more turbulent and complex contexts. Pateli & Giaglis (2005: 168) propose "a stepwise methodology allowing companies to design alternative scenarios for BM evolution or extension". The methodology is a combination of scenario-based planning (to generate potential future scenarios) and of a novel contingency approach (to choose among scenarios). Though the authors criticize the linearity of existing "stepwise" methodologies for business model change, they end up also proposing a linear sequence of steps (see Pateli & Giaglis, 2005: 171-174).

Cavalcante, Kesting, & Ulhoi (2011) distinguish between four types of business model change: 1) business model creation, 2) business model extension, 3) business model revision, and 4) business model termination. They argue that companies tend to avoid major business model revisions, since these changes usually question managers' mental models and firms' existing processes. The authors also discuss individual agency as a driving force for business model dynamics.

> *"In its essence, business model dynamics is driven by an individual's ability to recognize the need for change and by the will to promote and implement such change."* (Cavalcante et al., 2011: 1336)

2.3.3 Business Model Dynamics and Dynamic Business Models

Not many authors in management have used the expressions "business model dynamics" or "dynamic business model(s)" to denote the change of business models over time. A few exceptions are Cavalcante et al. (2011), De Reuver et al. (2009), Mason & Leek (2008), and Schweizer (2005). The expression "dynamic business model(s)" has been used in the realm of Information Systems, in particular when dealing with Business Process Modelling (e.g., Thiagarajan, Srivastava, Pujari, & Bulusu, 2002; Weigand, Verharen, & Dignum, 1997). This domain of knowledge is not of direct interest for this study, and will not be addressed.

According to Schweizer (2005: 50), "the competitive situation changes either due to internal (desire for greater revenues or company growth) or external (competence-destroying technologies) drivers". As a consequence, "companies may face the immediate need to change and adapt their business models in order to remain competitive. Hence, one needs to consider the dynamic perspective of business models" (Schweizer, 2005: 48). Their discussion is too narrowly focused on the particularities of an adopted typology, and does not consider the individual changes in business model elements.

In a longitudinal study of three firms (the focal firm and two suppliers), Mason & Leek (2008: 775), explore how "inter-firm knowledge transfer [is] involved in the creation of dynamic business models". They conceptualized dynamic business models as

> *"preconceived organizational and network structures built through the development of interdependent operational and administrative routines that evolve through problem solving activities"* (Mason & Leek, 2008: 776)

This definition suggests that business models as a whole evolve in a rather unplanned way, resulting from inter-firm learning and knowledge transfer between firms (e.g., focal firms and suppliers). However, this study is too narrowly focused on building a supply network, and does not describe how the different elements of the business model evolve.

De Reuver et al. (2009: 1) examined "which types of external drivers are strongest in forcing business models to change". They studied 45 longitudinal case descriptions on business model dynamics of organizations in various industries. They found that technological and market-related forces are the most important drivers, while regulation plays a minor role. They also state that:

> *"for start-ups, the effect of technological and market-related drivers is strongest in the early stages of a new business model, while the effects are moderate over time for established, large companies". (p. 1)*

Their study is based on business school teaching case studies. This data has quite a few limitations. First, many of the teaching cases might be based on retrospective accounts, and not on interviews at different points in time. Secondly, these teaching case studies focused on the business model as a whole, and not on the different elements of the business model and how they evolve over time. Third, their discussion is not grounded on the same business model framework, which limits cross-case comparisons. Finally, teaching cases are developed for teaching purposes, and have different rigor concerns than research case studies (Yin, 2009).

2.3.4 BM Evolution, Adaptation, Development, Innovation, Design, Renewal, and Reinvention

Some authors have used the expression "business model evolution" to represent business model change over time (e.g., Demil & Lecocq, 2010). Demil & Lecocq (2010) distinguish between the "*static approach*", in which the business model is a blueprint that enables description and classification, and the "*transformational approach*", where the business model is considered as a concept or a tool to address change. They build on the RCOV (Resources, Competences, Organization, Value) framework, inspired by a Penrosian view of the firm, to reconcile these two approaches and look at the interactions between the business model components. They define "*business model evolution*" as

> *"(...) a fine tuning process involving voluntary and emergent changes in and between permanently linked core components, and find that firm*

sustainability depends on anticipating and reacting to sequences of voluntary and emerging change, giving the label 'dynamic consistency' to this firm capability to build and sustain its performance while changing its business model." (Demil & Lecocq, 2010: 227)

Svejenova et al. (2010) draw insights from a longitudinal, in-depth, inductive study of the business model evolution of the gastronomic chef and co-owner of the restaurant elBulli. The authors identify triggers and mechanisms that drive business model transformation over time. However, this study is more focused on the dynamics of business models of individuals, and not exactly on firms' business models.

Dunford, Palmer, & Benveniste (2010) performed a study to understand the process underlying both business model evolution and early, rapid internationalisation. According to the authors,

"(...) speedy business model evolution depended on the effective transfer of accumulated learning across the global network of subsidiaries and the 'co-option' of ideas originating in one country into other's operations." (p. 666)

Other authors have also referred to business model evolution, though not many (e.g., Lee, Park, & Park, 2013; Nair, Nisar, Palacios, & Ruiz, 2012).

Few authors use the expression "*business model adaptation*" to denote changes in business models (see Table 2.4). Wirtz et al. (2010) conducted in-depth field interviews with managers from 22 different U.S. and German internet companies, to research how business models adapt to environmental changes. Their study focuses in one environmental change – the Web 2.0 phenomenon – and its impact on the "4C" Internet business model typology (Wirtz & Lihotzky, 2003). Such discussion does not shed much light on the process of business model change.

Christensen, Parsons, & Fairbourne (2010) refer to business model adaptation, but in the specific context of microfranchising. However, Andries & Debackere (2007) studied business model adaptation and performance of new technology businesses. They argue that new ventures experience difficulties in

finding a viable business model, and need to adapt often their initial business model due to the presence of uncertainty and ambiguity. This is crucial for technology-based companies, since they are confronted with high levels of uncertainty and ambiguity. They define "*business model adaptation*" as:

> *"(...) a new business' adjustments to its business model as the business evolves from an initial idea or business plan through the early stages of the organizational life-cycle towards a more stable business."* (Andries & Debackere, 2007: 83)

Their findings suggest "that adaptation is beneficial in less mature, capital-intensive and high-velocity industries but not so in more mature, stable industries" (Andries & Debackere, 2007: 81). In a more recent study, Andries et al. (2013: 288) examined the process of "business model development" in a cohort of six new ventures. This study will be discussed more thoroughly in Section 2.4 ("Business Models: The Entrepreneurship Context").

Many authors have studied business model innovation (e.g., Chesbrough, 2010; Gambardella & McGahan, 2010), though most of these studies are centred on revamping established businesses (see also issue on business model innovation in the Int. J. Product Development, Vol. 18, Nos. 3/4, 2013). The same observation is valid for the topic of business model renewal (e.g., Doz and Kosonen, 2010) and business model reinvention (e.g., Govindarajan & Trimble, 2010; Voelpel et al., 2004). Therefore, these streams of research will not be explored further in this study.

2.3.5 Business Model Experimentation and Sense-Testing

Today's fast-moving environments are characterized by high uncertainty and unpredictability. In face of such uncertainty, one of the ways to change the business model, especially in early stages of development, is through business model experimentation. The business model concept offers strategy practitioners a new way to evaluate their options. McGrath (2010: 247-248) proposes a rather experimental and dynamic perspective on both strategy and business models:

"(...) unlike conventional strategies that emphasize analysis, strategies that aim to discover and exploit new [business] models must engage in significant experimentation and learning – a 'discovery driven', rather than analytical approach. (...) In highly uncertain, complex and fast-moving environments, strategies are as much about insight, rapid experimentation and evolutionary leaning as they are about the traditional skills of planning and rock-ribbed execution".

McGrath argues that business models must be learned over time, and emphasizes the relevance of experimentation in their development. She proposes that new business models emerge when a specific constraint is lifted. However, given the uncertainty about how such constraints (e.g., changes in technology, regulations, social norms, financial constraints) "might affect the future workings of a potential business model, it is more sensible to engage in experimentation and discovery than try to assume the relevant information is all known" (McGrath, 2010: 253). She states that business model evolution is highly path-dependent, and thus early experiments shape the trajectory for subsequent business models. The "message" of applying the discovery-driven planning approach to business model design is that business model assumptions have to be both articulated and tested in a way that provides maximum learning at the lowest possible cost. This statement has a certain similarity with some of the grounding principles of the effectuation approach (Sarasvathy, 2001).

Voelpel et al. (2005) contend that most business models are based on traditional strategy formulation and implementation, leading to incremental rather than disruptive business model change. They then propose a "sense-testing tool", emphasizing four aspects that help organizations changing business models beyond "traditional practices". This tool results from applying the sensemaking concept (Weick, 1995a) to business model testing.

Murray & Tripsas (2004) examined technology-based entrepreneurial firms under conditions of significant uncertainty and ambiguity. The authors focus on start-up firms in the era of ferment, i.e., the earliest period of the industry life cycle. This is a period "during which industry actors test and explore distinctive configurations

of technology, market application and business model" (Murray & Tripsas, 2004: 46). They propose a definition of "*purposeful experimentation*" as "the application of the scientific method by entrepreneurs to key parameters of their business" (Murray & Tripsas, 2004: 47). Such experiment involves developing a hypothesis about the business, the performance of a specific test, and the analysis of results. They propose that entrepreneurial firms learn through purposeful experimentation, in addition to both routine-based learning and opportunistic adaptive behaviour. These firms build testable propositions concerning which combinations of the tri-domain technology-market-business model are most effective. They authors argue that the entrepreneurs "consciously analysed the trade-offs involved in choosing among these different alternative experimental designs, and that the constraints of the entrepreneurial context influenced their choices" (Murray & Tripsas (2004: 48).

Similarly, Sull (2004) has conducted extensive empirical research on new venture creation and uncertainty. He advocates that entrepreneurs should manage uncertainty with a disciplined approach, and start the process by formulating a *working hypothesis*, i.e.,

> *"a mental model that generally includes a definition of the opportunity, the resources required to pursue it, the value that would be created if it were to be successful and a plan to pursue it."* (Sull, 2004: 72)

The entrepreneur then runs an *experiment* to test their working hypothesis. Depending on the results, the entrepreneur may revise the hypothesis and run another experiment, harvest the value created through a sale, or abandon the hypothesis. Entrepreneurs may revise their hypotheses several times, using feedback from potential investors or partners. In the entrepreneurial context, Sull (2004: 74-75) defines *experiment* as "a test designed to reduce sources of uncertainty critical to the success of a new venture before deciding to commit additional resources". Examples of experiments include undertaking customer research, building prototypes, and working with beta customers. He differentiates between partial and holistic experiments. Partial experiments reveal information about a single critical source of uncertainty, while "holistic experiments (...) allow managers to test and refine their business models before scaling the operations" (Sull, 2004: 75).

More recently, the lean startup principles have gained widespread popularity among entrepreneurs and managers. Ries (2011) analogously proposes experimentation following the scientific method, beginning with a clear hypothesis, and then testing it empirically. Using Osterwalder et al. (2010) business model canvas, Blank & Dorf (2012) refine these principles and advance a systematic process for business model development. Their "customer discovery process" uses the Business Model Canvas to state hypotheses for each element of the business model, and then (weekly) keeps track of changes over time, as experiments are conducted to test initial assumptions. The work of Ries (2011) and Blank & Dorf (2012) emphasize continuous, systematic experimentation with the business model, which in turn leads to frequent business model change, especially in early stages of business development. The next subsection presents a brief review of existing longitudinal studies on business models of established firms.

2.3.6 Longitudinal Studies on Business Models of Established Firms

A Business Source Complete (EBSCO) database search[6] for "business model" or "business models" anywhere in the abstract and "longitudinal" in the full text (peer reviewed work) generated 118 hits. A similar search performed in ABI/Inform Complete generated 120 hits. To validate and complement the previous searches, a search was performed in Google Scholar using the expressions "business model" or "business models" in the title and "longitudinal" in the full text[7], generating 491 hits.

Many of the studies found are published in very specialized journals, narrowly focused on topics such as information systems, electronics, Internet, telecommunications, construction, and retailing. Most of these studies were not very informative from a management or entrepreneurship perspective, and therefore were not considered. After reading the abstracts of the remaining studies, I realized that many of them were not focused on the business model concept. Other studies were

[6] Search performed in the 17th of December 2013
[7] Search string used in Google scholar: intext:longitudinal (intitle:"business model" OR intitle:"business models")

published in journals not listed in the ISI Web of Knowledge or with a very low grade, according to the ABS Journal Quality Guide. Finally, the Google Scholar search revealed many conference papers, working papers, and masters essays. Hence, I selected studies from general management, strategic management and entrepreneurship journals, listed in the ISI Web of Knowledge or classified as grade 2 or above (according to the ABS Journal Quality Guide, Version 4). Conference papers from mainstream strategic management or entrepreneurship conferences, such as SMS Conference or BCERC, were also included.

The list of selected papers is displayed on Table 2.5 and Table 2.6. The 17 papers are divided in peer reviewed (13) and conference papers (4). The peer reviewed papers are further subdivided in studies of business models of "established firms" (7 papers, Table 2.5) and of "new ventures" (6 papers). The list of selected longitudinal studies on business models of "new ventures" is presented in Section 2.4 below, since they relate to the more specific context of entrepreneurship. Therefore, some of the remaining comments on this section refer also to Section 2.4 and Table 2.6.

Most of the peer reviewed papers are published in strategic management journals (54%), namely *Long Range Planning* (6 papers) and *Strategic Management Journal* (1 paper). In particular, Long Range Planning published a Special Issue on Business Models in April/May 2010, and very recently, in December 2013, an issue entitled "Managing Business Models for Innovation, Strategic Change and Value Creation".

I included the work of Dunford et al. (2010), Sosna, Trevinyo-Rodriguez, & Velamuri (2010), and Svejenova et al. (2010) from the issue of April/May 2010; and the work of Achtenhagen, Melin, & Naldi (2013), McNamara, Peck, & Sasson (2013), and Velu & Stiles (2013) from the issue of December 2013. The "oldest" paper dates back to 2007 (see Willemstein, Ven der Valk, & Meeus, 2007), which reveals the newness of longitudinal research in business models. Also, 6 out of the 13 peer reviewed papers (46%) were published in 2013, which indicates that researchers are just now starting to address the lack of longitudinal studies on business models.

Table 2.5 Longitudinal Studies on Business Models of Established Firms

Author(s) (year)	Title	Journal	Method	Summary	ABS	IF	5-IF
Achtenhagen, Melin, & Naldi (2013)	Dynamics of Business Models – Strategizing, Critical Capabilities and Activities for Sustained Value Creation	LRP	Longitudinal study of 25 SMEs; interviews, triangulation with archival data; multiple points in time.	Examines how companies change and develop their business models to achieve sustained value creation; identifies three capabilities and illustrates how these capabilities, their activities and the strategizing actions create value.	3	3.667	2.885
Ghezzi (2013)	Revisiting business strategy under discontinuity	MD	Two longitudinal case studies: TIM and Vodafone; retrospective data (2002 onward); 2 waves of interviews (2008 and 2010-2011).	Studies the role of business models, value networks and resource management as strategic tools to identify discontinuous phenomena and trigger strategic re-planning.	1	3.787	2.467
Huelsbeck, Merchant, & Sandino (2011)	On Testing Business Models	TAR	Longitudinal data used by top management (> 8 years, 1998-2006); single case (medical equipment manufacturer).	Explores decisions related to formal empirical tests of business models and interpretations and uses of those tests in a successful single-product firm following a consistent strategy over a long period of time.	4*	2.319	3.204
Mason & Leek (2008)	Learning to Build a Supply Network: An Exploration of Dynamic Business Models	JMS	Longitudinal case study focused on the BM of a supply network (3 firms); interviews and archival data (Oct 2004 - Mar 2006).	Examines three components of dynamic business models – network structure, inter-firm routines and knowledge forms – and describes their integration through a problem solving approach to building an offshore supply network.	4	3.799	4.744
McNamara, Peck, & Sasson (2013)	Competing Business Models, Value Creation and Appropriation in English Football	LRP	Panel data of all the clubs which appeared in the English Premiership football league over a twelve year period.	Develops four stable business model types based on 2 dimensions – team talent and team experience –, which lead to differing value creation and capture outcomes. Transitioning between BMs may involve a (temporary) decline in performance.	3	3.667	2.885
Sosna, Rodríguez, & Velamuri (2010)	Business Model Innovation through Trial-and-Error Learning	LRP	Longitudinal single case study design (Naturhouse); interviews, documents and news (2004-2008, multiple points in time).	Studies the drivers of BM innovation, documenting the evolution of the BM in 2 phases: 1) 5-year phase of experimentation; 2) a high-growth exploitation phase. Emphasizes trial-and-error learning for BM innovation.	3	3.667	2.885

Velu & Stiles (2013)	Managing Decision-Making and Cannibalization for Parallel Business Models	LRP	Longitudinal and in-depth single case study of a major bank in the US; > 40 interviews with senior management, and secondary data.	Examines how a firm can manage the decision-making and cannibalization processes when a new and an existing business model need to be run in parallel.	3	3.667	2.885

ABS: Association of Business Schools Journal Guide 2010 (grade from 1 to 4*)

IF: Impact factor (ISI Web of Knowledge) 5-IF: 5-Year Impact factor (ISI Web of Knowledge)

LRP: Long Range Planning MD: Management Decision TAR: The Accounting Review JMS: Journal of Management Studies

2.3.7 Theoretical Perspectives on Business Model Change

This subsection presents theoretical lenses that have been discussed in the business model literature and related to the construct. Traditionally, most of the business model literature is linked to main theoretical frameworks of strategic management and entrepreneurship research, such as innovation (Schumpeter, 1942), industrial organization (Porter, 1980), in particular the value chain (Porter, 1985) and the value system (Porter, 1995), resource-based view of the firm (e.g., Barney, 1991; Wernerfelt, 1984), strategic network theory (Jarillo, 1995), the relational view (e.g., Dyer, 1998), and transaction cost economics (e.g., Williamson, 1975; Williamson, 1981).

The recent efforts to conceptualize the business model as a dynamic construct have motivated researchers to search for alternative theoretical perspectives seeking to explain the phenomenon of business model change. Therefore, some authors have linked the concept of business model change with system dynamics (e.g., Auer & Follack, 2002; Petrovic et al., 2001), options approach (Kulatilaka & Venkatraman, 2001), scenario planning (Pateli & Giaglis, 2005), organizational narrative (George & Bock, 2011; Magretta, 2002), and sensemaking and enactment (George & Bock, 2011; Voelpel et al., 2005).

Teece (2010: 190) established a more dynamic view of business models by linking it with dynamic capabilities, arguing that "the selection/design of business models is a key microfoundation of dynamic capabilities". McGrath (2010) merged business model change with her concept of discovery-driven planning, while Demil & Lecocq (2010) adopted the Penrosian view of the firm as a bundle of resources. Doz & Kosonen (2010) related business model renewal with the strategic agility framework developed in their earlier empirical research (Doz & Kosonen, 2008). In a discussion on business model innovation, Chesbrough (2010) briefly mentions the concept of effectuation (Sarasvathy, 2001) without exploring the link in detail. Finally, Murray & Tripas (2004), Ries (2011), and Blank & Dorf (2012) applied concepts such as the scientific method, experimentation and learning, to business model change.

However, most of these early theoretical discussions on business models resemble more products of ongoing theorizing than "full-blown theories" (Weick, 1995b: 385). In fact, Teece (2010) has recently argued that the concept of business model lacks theoretical grounding in economics or in business studies. Other scholars have also suggested more theory development and empirical studies in entrepreneurship using the business model construct (Wiklund et al., 2011).

This wide range of theoretical perspectives have been traditionally related to the business model construct, though sometimes this relationship has not been thoroughly explored. Hence, drawing on my review of the literature, on discussions with other scholars in the field, and on preliminary analysis of the data, I chose effectuation and resource-based theories to inform this study. This choice of theoretical perspectives will be explained further in Chapter 5.

2.3.8 Limitations of Business Model Research

An interesting paradox in business model research is that authors agree that one of its limitations is the lack of agreement on business model definitions and representations. In fact, George & Bock (2011: 107) mention that "rigorous research on business models remains in a nascent stage [characterized by] the fragmentation of definitions and constructs". Wiklund et al. (2010: 3) similarly state that scholarly literature on business models is still "fragmented and confounded by inconsistent definitions and construct boundaries". Other authors (e.g., Al-Debei & Avison 2010; Osterwalder et al., 2005) acknowledge the absence of a business model framework that works as a reference. This inconsistency and fragmentation of the literature "has precluded integrated and accretive research on business models" (George & Bock, 2011: 107). Similarly, Osterwalder et al. (2005: 33) state that "one of the shortcomings in business model literature is that the different authors rarely build on each other".

The above considerations on the limitations of business model research are well aligned with the recent discussion of the topic by Zott et al. (2011). They summarize the limitations of the literature on business models as follows:

"First, much of the reviewed literature is quite recent (...). Second, only a few contributions have appeared in top journals. Third, the literature is widely divergent (...). Fourth, the business model remains a theoretical underdeveloped (and sometimes overloaded) concept." (pp. 1037-1038)

Similarly, Teece (2010: 176) states that the concept of business model lacks theoretical grounding in economics or in business studies, though its importance is paramount:

"Clearly, the study of business models is an interdisciplinary topic which has been neglected – despite their obvious importance, it lacks an intellectual home in the social sciences or business studies".

Therefore, a commonly stressed limitation is the lack of a theoretical framework to support business model research. Hedman & Kalling (2003: 56) conclude that "the construct [of business model] is not well defined, nor is there theory to support it".

Another limitation is lack of research on the *process of business model change*, as Zott & Amit (2008: 20) state: "Little research has been conducted so far on how business models evolve". Business models are also frequently seen as a system of interconnected elements, where "the components of the model are typically highly interdependent, with changes in any one having major implications for the others" (Morris et al., 2006a: 46). An additional limitation is the lack of insight on the internal *dynamics of this system of business model elements* (Morris et al, 2005).

The avenues for future research suggested by scholars in the field of business models emerge almost directly from its limitations. The subsequent questions by Zott & Amit (2007: 195) indicate possible directions for future research, suggesting a focus on business model emergence, evolution, change, relative stability, and performance over time:

"How do regulations, customer preferences, and competition influence the emergence and evolution of these [business model] designs? What are the

dynamics of business model design change, and how stable are business model designs across time? How reliable is the impact of various business model design themes on performance (...)?"

These questions imply that there is still no clear insight on the *process of business model change* over time. Morris et al. (2005: 734) also conclude that business model research needs a better understanding of how business models emerge and evolve: "further insights are needed into the dynamics of [business] model emergence and evolution". Among other suggestions for further research, Svejenova et al. (2010) recommend a focus on *longitudinal research methods and process studies*:

> *"(...) As additional attention is needed to unraveling the ways in which individuals - entrepreneurs, scientists, artists and other professionals - shape their business models over time, process studies could offer insights into the mechanisms that drive or encourage their evolution."* (Svejenova et al., 2010: 425)

Moreover, George & Bock (2011: 105) recognize the challenge of researching *early-stage entrepreneurial activity*, since it "often comprises a limited number of participants and observers, limiting data collection mechanisms and objectivity". They also suggest that "of particular benefit would be longitudinal analysis of business model structures at firms to determine how structures change as firms transition from opportunity enactment to opportunity management" (p. 105).

Scholars also contend that we need more studies looking at the construct with a higher degree of granularity, in order to understand how the system of *business model elements* and relationships interact. This is advocated by Morris et al. (2006a: 45), who posit the demand for more "investigations of relationships among (...) the components of the model". Zott et al. (2011: 1038) similarly argue that we need more insights on "the mechanisms through which it [read: business model] works". Aligned with previous authors, George and Bock (2011) clearly emphasize the need to research on the interactions between business model elements over time:

> *"Understanding the nature of dimensional interaction [between business model dimensions (read: elements)] represents a potentially informative area of study, and processual studies of business model change could describe how dimensional dynamics interact with underlying changes in the opportunity landscape."* (p. 106)

Teece (2010) ties together the concepts of business models, entrepreneurship and *firm performance*, and emphasizes their collective importance:

> *"Our understanding of the nature of the firm itself, together with the role of entrepreneurs and managers in the economy and in society, should also benefit from a better appreciation of business models and their role in entrepreneurship, innovation and business performance."* (Teece, 2010: 192)

Another avenue is towards *theoretical development*. Such path is endorsed by Zott et al. (2011: 1038), who argue that "we need more clarity about the theoretical building blocks of the business model". In a similar fashion, Wiklund et al. (2011: 3) suggest "new directions for theory development and empirical studies in entrepreneurship by linking the business model to entrepreneurial cognition, opportunity co-creation, and organizational outcomes". A stronger theoretical ground will allow a more cumulative development of the field, as advocated by Zott et al. (2011: 1038): "the field is moving toward conceptual consolidation, which we believe is necessary to pave way for more cumulative research on business models". Morris et al. (2005) suggested additional theoretical perspectives to approach business models, such as self-efficacy and effectuation (Sarasvathy, 2001), though they did not explore these possibilities in detail. Such considerations reveal a promising avenue for business model research, in terms of theory development and exploring alternative theoretical perspectives.

Finally, most of the literature on the lean startup movement (Ries, 2011) and the customer discovery process (Blank & Dorf, 2010) is fundamentally grounded on the authors' own experience as entrepreneurs and consultants, and on anecdotal evidence. Such practices remain decoupled from main theoretical frameworks, and their linking to firm performance still lacks validation by rigorous empirical research.

2.4 BUSINESS MODELS: THE ENTREPRENEURSHIP CONTEXT

Before considering the narrower context of university spin-offs (see Section 2.5 below), I will first start by exploring the topic of business models in the broader context of entrepreneurship (Section 2.4.1). The following Section 2.4.1 focuses on longitudinal studies of business models of new ventures. Finally, Section 2.4.3 presents research on business models in new technology-based ventures and corporate spin-offs.

2.4.1 Business Models in Entrepreneurship

Typically, research in business models has been conducted in the domains of management and strategic management. The combination of business models and entrepreneurship, which were initially two distinct streams of research, is a fairly recent topic in the entrepreneurship research field (Trimi & Berbegal-Mirabent, 2012).

Using the ABI/INFORM Complete database, I conducted a search[8] for peer-reviewed work that mentioned "business model(s)" and "entrepreneurship" anywhere in the abstract. This search identified a total of 59 papers: 27 papers using the word "model"; 32 papers using the plural "models". Some of these papers were duplicates and some did not provide an in-depth discussion of the topic. For instance, some papers investigated business models for heat entrepreneurship (e.g., Okkonen & Suhonen, 2010; Suhonen & Okkonen, 2013) and social entrepreneurship (e.g., Makhlouf, 2011; Wilson & Post, 2013; Witkamp, Raven, & Royakkers, 2011). Therefore, after an initial screening of the papers, only 9 were selected for a closer inspection. To these papers, a few relevant papers, collected throughout the period of the study, were added.

Kaplan, Sensoy, & Stromberg (2009) studied 50 venture capital financed firms from early business plan to initial public offering (IPO) to public company (3 years after the IPO). They found out that firms grow dramatically, but

[8] Search performed in the 20th of October 2013.

"(...) their core businesses or business ideas appear remarkably stable. (...) This suggests that the firms' business idea or line of business is fixed or elemental at an early stage in a firm's life." (Kaplan et al., 2009: 77)

Since these firms survived and became public, they can be classified as high performing, which appears to suggest that this class of firms achieve a relative stability in their business models at an early stage of development. Though this stable behaviour is true for "high growth survivors", it may not be for other type of entrepreneurial firms. Their results also debate the relative importance of the business ("horse") and the management team ("jockey"). Their findings suggest that:

"(...) poor or inappropriate management team is much more likely to be remedied by new management than a poor or inappropriate business idea is to be remedied by a new idea. (...) Identifiable lines of business [customer segments, value proposition, etc.] and important physical, patent, and intellectual property assets [key resources] are created in these firms by the time of the early business plan, are relatively stable, and do not change or disappear as specific human capital assets turn over." (Kaplan et al., 2009: 79)

These results emphasize the importance of the business model over the management team, and explain how the core elements of the business model are developed in early stages, and then sustained with relative stability over time. According to Kaplan et al. (2009), the difference between non-biotech firms and biotech firms is that unlike biotech firms, non-biotech firms rarely narrow the scope of their businesses.

The business model "stability" that characterizes *post* early-stages of successful venture development is also noted by Schindehutte, Morris, & Kocak (2008). According to the authors, market-driving firms establish their revolutionary business models early on, and they tend to suffer few modifications over time:

"In the case of many of the market-driving firms cited in the literature, we find a fairly revolutionary business model, which, with only very minor

modifications, drives the market for an extended period of time. This business model tends to be in place early on, in effect establishing the DNA of the firm." (Schindehutte et al., 2008: 12)

Morris et al. (2005) also consider the business model to be a central construct for entrepreneurship research. However, the authors acknowledge that while "highly emphasized in entrepreneurial practice, business models have received limited attention from researchers" (Morris et al., 2005: 726). According to them, a possible cause for entrepreneurial firm failure, despite the presence of market opportunities, business ideas, resources, and talented entrepreneurs, may be the underlying business model. The authors state that some entrepreneurs start with a clear formulation of their business models, but many start only with partially formed models. These entrepreneurs then undergo a process of experimentation through which a more complete version of the business model emerges, though in some cases a viable model may never emerge. Morris et al. (2005: 753) argue that "conceptually, it is possible to envision a business model life cycle involving periods of specification, refinement, adaptation, revision, and reformulation." The authors then explain each of these periods in more detail.

Zott & Amit (2007) and Zott & Amit (2008) have studied the link between business model design and firm performance in a set of 190 entrepreneurial firms. Their contribution has been discussed previously in Section 2.2.5 ("Business Models and Firm Performance"). The next subsection presents a brief review of existing longitudinal studies on business models of new ventures.

2.4.2 Longitudinal Studies on Business Models of New Ventures

This section complements Section 2.3.6 above, and presents the remaining papers that result from the search and selection previously described. The list of selected longitudinal studies that focus on business models of new ventures is displayed on Table 2.6 below, and complements Table 2.5 above. They are divided in peer reviewed (6) and conference papers (4).

Table 2.6 Longitudinal Studies on Business Models of New Ventures

Author(s) (year)	Title	Journal	Method	Summary	ABS	IF	5-IF
Andries, Debackere, & Looy (2013)	Simultaneous experimentation as a learning strategy: business model development under uncertainty	SEJ	Six longitudinal case studies (period: 1983-2005); 28 interviews and documents (data collection between 2004-2005).	Reveals two approaches to BM development: 1) focused commitment (positively affects initial growth, but jeopardizes long-term survival); 2) simultaneous experimentation (lower initial growth levels, but facilitates long-term survival).	3	1.205	3.105
Doganova & Renault (2009)	What do business models do? Innovation devices in technology entrepreneurship	RP	Longitudinal single case study of the first years of a university spin-off; documents and 3 interviews (Mar 2007, Feb 2009*).	Investigates the role played by BMs in the innovation process; shows that the BM is a narrative and calculative device that allows entrepreneurs to explore a market and to construct the network of an innovation.	4	2.850	4.387
Dunford, Palmer, & Benveniste (2010)	Business Model Replication for Early and Rapid Internationalisation: The ING Direct Experience	LRP	Longitudinal single case study (global retail bank), during 5-year period (2004-8); 71 interviews and secondary data (archival material).	Analyses the processes of BM emergence and evolution of a new venture, as it underwent early and rapid internationalisation; identifies the contribution of 4 processes: clarification, localisation, experimentation and co-option.	3	3.667	2.885
Bohnsacka, Pinkseb, & Kolk (2013)	Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles	RP	Longitudinal multiple case study of electric vehicle projects of key industry players over a 5-year period (2006–10); content analysis.	Explores how firms' path dependencies have affected the evolution of BMs; identifies 4 BM archetypes and traces their evolution over time; suggests that incumbent and entrepreneurial firms approach BMI innovation differently.	4	2.850	4.387
Svejenova, Planellas, & Vives (2010)	An Individual Business Model in the Making: a Chef's Quest for Creative Freedom	LRP	Longitudinal in-depth single case study (25 years of history, 1983 to 2008); interviews and secondary data (collection: 2004-2009).	Explores the individual business model and investigates the set of activities, organizing, and strategic resources individuals employ to create and capture value while pursuing their interests and motivations.	3	3.667	2.885

Willems-tein, Valk, & Meeus (2007)	Dynamics in business models: An empirical analysis of medical biotechnology firms in the Netherlands	Techno-vation	Data on a survey completed by 80 Dutch DBFs, together with longitudinal data on shifts in BMs of 4 case studies.	Examines BMs of Dutch biotechnology firms, focusing on the dynamics in BMs and the mechanisms that generate these dynamics; focus on the BMs at founding and the shifts that occurred in these BMs afterwards.	3	3.177	3.449
Conference and Working Papers		**Conference**					
Costa (2013)	Business model change and performance of early-stage entrepreneurial firms	BCERC	Longitudinal multiple case study (8 university spin-offs, 2007-2012); 96 interviews and archival data; data collection: Apr 2011 to Jul 2012.	Examines how BMs change in real time for early-stage entrepreneurial firms facing technology, market, and managerial uncertainty, and how this process of change links to firm performance.			
Costa & Levie (2012)	Business model change in early-stage entrepreneurial firms facing high uncertainty	SMS	Longitudinal multiple case study (8 university spin-offs, 2007-2012); 96 interviews and archival data; data collection: Apr 2011 to Jul 2012.	Explores how BMs change in entrepreneurial firms, and how this process links to performance; suggests that committed teams change their BMs faster; teams with higher knowledge change their BMs less often.			
Löwegren (2010)	Business model development and performance in swedish university spin-offs (interactive paper)	BCERC	Longitudinal data and case studies; database of Swedish university spin-offs performed in 1992; study focuses on the 36 surviving firms.	To describe and analyze how and why BMs of USOs in a Swedish context have evolved over a longer period of time, and if changes in the business model could be related to performance.			
Wilker & Günzel (2010)	Patterns in business model development: a longitudinal case survey	BCERC	Case study survey of 50 start-ups; BM characterizations from existing companies, and written project reports.	Explores how start-ups evolve; identifies structural patterns that are specific to high-expectation ventures, and describes their growth mechanism; identifies 3 types of change models: realization, extension, and reemerging models.			

* Authors do not mention the date of the third interview.
ABS: Association of Business Schools Journal Guide 2010 (grade from 1 to 4*)

IF: Impact factor (ISI Web of Knowledge) 5-IF: 5-Year Impact factor (ISI Web of Knowledge)

LRP: Long Range Planning JMS: Journal of Management Studies RP: Research Policy
SEJ: Strategic Entrepreneurship Journal BCERC: Babson College Entrepreneurship Research Conference SMS: Strategic Management Society

Considering specifically the peer reviewed papers, 3 out of the 6 papers are single case studies (see Doganova & Eyquem-Renault, 2009; Dunford et al., 2010; Svejenova et al., 2010). As such, these studies do not allow cross-case comparisons of patterns of business model development. From the remaining 3 papers, one is a multiple case study focused on electric vehicle projects (Bohnsack, Pinske, & Kolk, 2013), and the other is a survey blended with four case studies focused on biotechnology firms (Willemstein et al., 2007). These two studies are very sector-specific, which again hinders generalizability.

Perhaps the study that is closer to the present research is the one by Andries, Debackere, & Looy (2013), which has just been published in December 2013[9]. The authors describe their study as longitudinal, since it considers relatively long periods of firms' development. However, the interviews are retrospective, and therefore are more prone to hindsight bias. Moreover, some of the data is relatively old, going back up to 30 years; in fact, one of the cases is analyzed in the period between January 1983 and October 1988.

This review of longitudinal studies focused on the business model construct shows that these studies are rare, especially in the context of new ventures. In particular, and at the time of writing, studies performing real time tracking of business model changes in early stages of venture development appear to be non-existent. The next subsection will examine literature on business model research in the specific context of research or technology entrepreneurship, such as new technology-based firms (NTBFs), research-based start-ups (RBSUs), research-based spin-offs (RBSOs), and corporate spin-offs.

2.4.3 BMs in New Technology-Based Firms and Corporate Spin-Offs

Chesbrough and Rosenbloom (2002) explore the role of the business model in technology spin-offs. According to them, a successful business model bridges technology with the realization of economic value. The view of the business model operating as a bridge between technology and market is also evident in their words:

[9] This paper was published when I was revising the dissertation (today is the 23th of December).

"established firms as well as startups take technology to market through a venture shaped by a specific business model" (Chesbrough & Rosenbloom, 2002: 529-530). Moreover, they stress the importance of finding the right business model in order to capture the value from the technology. Failure in finding the appropriate business model will result in capturing less value to the firm from technologies. Chesbrough & Rosenbloom (2002: 550-551) clearly conclude how important is for "technicians" to develop fluency on business model "language" and skills:

> *"Creating value from technology is not simply a matter of managing technical uncertainty. (...) Identifying and executing a new or a different business model is an entrepreneurial act, requiring insight into both the technology and the market. (...) Technology managers must themselves become conversant in these issues [business models]. They need to extend their experiments to include experiments in alternative business models."*

In novel technologies that are ahead of their time, learning about the customer appears to play a vital role in the road to success. Chesbrough & Rosenbloom (2002: 551) refer to the cases of 3Com and Adobe, in which:

> *"The ultimate business model emerged from an interactive process involving the entrepreneurs' robust vision of latent opportunity (...) tempered by adaption in response to substantive interactions with potential customers and sources of funding."*

Chesbrough & Rosenbloom (2002) also attribute failure, in some degree, to little change in the initially adopted business model. According to them, in these "unsuccessful" spin-offs, the leaders

> *"(...) failed to discover appropriate business models that were capable of realizing the value latent in the technologies. In fact, the search process seems to have been very limited in these two cases, in that the business model each venture initially adopted was little modified thereafter."* (p. 551)

Willemstein et al. (2007) examined the dynamics of business models of Dutch biotechnology firms, focusing on the business models at founding and in the

shifts they suffered afterwards. The authors identified a prevalence of *solo* product business models and hybrid product business models at founding, especially between 2005 and 2007. After founding, there are frequently shifts towards an increasing hybridization of business models. The reasons for these shifts appear to be related to a combination of management's ambition to develop products and creating potential for out-licensing through product development; and "the reasons for not starting with product development from the beginning are a lack of up-to-date technology, need for short-term revenues to finance the R&D expenses, or simply not having the ambition to develop products" (Williamstein et al., 2007: 229-230). Therefore, most product development firms employ short-term revenue generating activities such as out-licensing and selling research products.

Andries & Debackere (2007: 82) argue that "defining an appropriate business model from the beginning is difficult, and that adaptation to the initial business model is therefore crucial for success". The set of all potential business models is often not foreseeable in advance, due to the high technological and market uncertainty, especially in new technology-based businesses. The relationship between uncertainty and business model adaptation in new technology-based ventures (NTBVs) has been discussed by the same authors elsewhere (Andries & Debackere, 2006). These high levels of uncertainty and risk induce the need to change the business model, as the entrepreneur gains experience with products, markets, suppliers, employees, and other key variables (Andries & Debackere, 2007). Though existing literature suggests that adaptation is a necessary condition for survival, their research indicates that this is not a general rule. The authors found that the impact of adaptation in performance is highly dependent on the sector in which a NTB business is operating and on whether it is an independent business or a business unit of an established company. They argue that:

> *"(...) adaptation is beneficial in immature, capital-intensive and high-velocity industries such as the biotech industry. (...) However, adaptation appears to be detrimental in mature, stable industries such as the environmental sector. (...) The effect of adaptation also differs between independent NTB businesses and NTB business units of established companies. (...) Adaptation reduces*

failure rates in dependent NTB business units as compared to independent NTB ventures. (...) The quality of adaptation is higher in NTB business units of established firms than in independent NTB ventures." (Andries & Debackere, 2007: 95-96)

Andries et al. (2013) identified two approaches to business model development for new ventures operating under uncertainty: 'focused commitment' and 'simultaneous experimentation'. Ventures adopting the focused commitment approach "select one specific business model very early on and then commit to this business model for several years" (Andries et al., 2013: 296). Ventures adopting the simultaneous experimentation approach "do not commit early on to a specific business model, but develop diverging search paths by engaging in a series of related business model experiments (Andries et al., 2013: 302). The authors conclude that focused commitment has a positive effect on the initial growth of ventures operating under uncertainty, though jeopardizing long-term survival. On the other hand, simultaneous experimentation reduces the initial growth of these ventures, but facilitates their long-term survival. Simultaneous experimentation represents an effectual logic (Sarasvathy, 2001), whereas focused commitment follows a causal logic. Since the simultaneous experimentation approach involves careful selection of related experiments, it then reconciles the notions of 'action' and 'planning'. In fact, the authors clearly state that:

"The ventures in our case study do not just 'go with the flow' in developing a portfolio of business model experiments. Instead, they consciously select and design these experiments." (Andries et al., 2013: 306)

Therefore, simultaneous experimentation seems to imply the combination of effectual experimentation with conscious planning. Though the authors relate their findings with effectuation in the discussion section, the data was not specifically examined through this theoretical lens. Therefore, their findings related to effectuation, business model change and performance lack depth. The authors suggest engaging with in-depth case studies to get more insight on additional approaches and on the combination of different approaches over time.

The following subsection will review literature on university spin-off research, and on its intersection with business model research.

2.5 THE UNIVERSITY SPIN-OFF CONTEXT

The research setting for this study is early-stage university spin-offs. The reasons behind this choice were presented previously on Section 1.4. A more thorough discussion on the adequacy of this setting will be conducted in the Methodology chapter (Chapter 3).

This section reviews literature on university spin-offs of particular relevance for the context of this study. It presents a brief historical perspective of university spin-off research, discusses their importance, provides common definitions, and describes the formation process and typical constrains. It then highlights theoretical perspectives linked to university spin-offs, and reviews the scarce literature on business models in university spin-offs. Finally, it points out limitations of existing research on university spin-offs.

2.5.1 University Spin-Offs: Introduction

Both in Europe and in the U.S., the nature of universities has changed dramatically since the mid-1990s (Shane, 2004; Wright et al., 2007). Harrison & Leitch (2010: 1245) argue that the role of the university has progressively shifted "from a conservator of knowledge to an originator and exploiter of knowledge for local economic development". Greater attention has been paid worldwide to the creation of new firms that involve the exploitation of technology and knowledge generated by universities (Wright et al., 2007). Governments are investing increasing sums of money in universities, "with the goal of turning them into engines of economic growth through [university] spinoff company formation" (Shane, 2004: 1). This section aims to provide a brief review of key research work on university spin-offs published in leading entrepreneurship, innovation, strategic management, and general management journals.

Using the ABI/INFORM Complete database, I searched for peer-reviewed work that mentioned "university spin-offs" and similar expressions (see Table 2.7) anywhere in the abstract.

Table 2.7 Search Strings, Results and Selections (University Spin-Offs)

Search string	Results	Selected
ab("university spin-off")	22	9
ab("university spin-offs")	39	18
ab("university spinoff")	5	1
ab("university spinoffs")	5	2
ab("university spin-out")	14	1
ab("university spin-outs")	3	1
ab("university spinout")	4	4
ab("university spinouts")	2	1
ab("academic spin-off")	22	6
ab("academic spin-offs")	27	14
ab("academic spinoff")	1	1
ab("academic spinoffs")	1	0
ab("academic spin-out")	1	1
ab("academic spin-outs")	3	2
ab("academic spinout")	1	0
ab("academic spinouts")	1	0
ab("university entrepreneurship")	28	5
ab("academic entrepreneurship")	104	35
Total=	**283**	**101**

Notes:
Date of search: 3rd and 4th October 2013
spin-off or spin off gives the same results

The resulting studies ranged from 1989 (Louis, Blumenthal, Gluck, & Stoto, 1989) to 2013 (Abreu & Grinevich, 2012; Bozeman, Fay, & Slade, 2013; Burg, Gilsing, Reymen, & Romme, 2013; Damsgaard & Thursby, 2013; Festel, 2012; Mindruta, 2012; Perkmann et al., 2012). Table 2.7 shows the search strings used, reflecting the similar expressions mentioned above, the number of articles found, and the number of articles selected for the purpose of this literature review. The abstracts were searched using 18 different search strings, ranging from "university spin-off" to

"academic entrepreneurship". A total number of 283 articles was reached, and the expression that yielded more search results was "academic entrepreneurship" (104 results).

Many of the articles found were published in leading entrepreneurship and small business management journals (*Journal of Business Venturing, Journal of Small Business Management, International Small Business Journal, Entrepreneurship and Regional Development,* and *Small Business Economics*), and in leading innovation journals (*Journal of Product Innovation Management*, and *Technovation*). However, despite the particular link of university spin-offs to entrepreneurship and small business, this topic has also been researched and published in other areas of business administration, namely, in social science (*Research Policy*, *Regional Studies*, and *Industrial and Corporate Change*), general management (*Administrative Science Quarterly*, *Journal of Management Studies*, and *Academy of Management Perspectives*), strategic management (*Strategic Management Journal*), management science (*Management Science*), management education (*Academy of Management Learning and Education*) and organization studies (*Organization Science*).

The resulting 283 articles were filtered according to fit (by reading the abstract and scanning the paper), and according to journal quality, using as a reference the Academic Journal Quality Guide (version 4, March 2010) from The Association of Business Schools (ABS). The selection was focused on ratings of 4 and 3, though sometimes, due to high fit and/or track record of the authors, articles with ratings of 2 were also selected. The outcome of this screening process was a total of 101 articles. These articles contained duplicates, since sometimes two different search strings were contained in the abstract of a same paper. Therefore, these duplicates were deleted. The resulting number of papers, after deleting the redundant ones, was 80. From these papers, I selected the few that presented a more thorough literature review to get a wider but well-grounded grasp of the subject. To this fine-grained selection I added relevant books on the topic (e.g., Shane, 2004; Wright et al., 2007), and also articles often cited in the literature that were not captured along this process (e.g., Mustar et al., 2006). This procedure left me with 41

key articles and books, and the remaining of this section draws fundamentally on these publications.

2.5.2 University Spin-Offs: Overview and Importance

Universities are defined by Perkmann et al. (2013: 423) as "organisations that perform a key role within contemporary societies by educating large proportions of the population and generating knowledge". In recent decades, there has been a growing awareness of their importance as sources of new ideas and inventions. Policy initiatives (e.g., Bayh-Dole Act of 1980) have been set up both in the U.S. and in European countries to foster the commercial exploitation of inventions that result from government-funded research (Abreu & Grinevich, 2013). This commercial exploitation of academic knowledge can be accomplished through several avenues. One such avenue is the so-called academic entrepreneurship, which involves the creation of university spin-offs, defined as new companies founded to exploit pieces of intellectual property created in academic institutions (Shane, 2004). In order to accelerate technology commercialization, many institutions around the world established Technology Transfer Offices (TTOs), which facilitate the process of transferring research from academia to commercial markets.

Shane (2004) presents several different arguments that justify the importance of university spin-offs for the overall economy and for the parent universities. The author claims that "university spin-offs are valuable in at least five ways" (2004: 17):

1) Spin-offs encourage economic development (they generate significant economic value, create jobs, induce investment in university technologies, and promote local economic development)

2) Spin-offs enhance the commercialization of university technologies (they are an effective commercialization vehicle for uncertain technologies, and for encouraging inventor involvement)

3) Spin-offs help universities with their mission (they support additional research, attract and retain faculty, and help to train students)

4) Spin-offs are high performing companies

5) Creating spin-offs is more profitable than licensing to established companies.

Having briefly described the origin and importance of university spin-offs, the following subsection turns the attention to typical definitions of university spin-offs and other similar expressions, concluding with the definition adopted for this study.

2.5.3 University Spin-Offs: Definitions

There are many different expressions used interchangeably to refer to university spin-offs, namely by combining the words "university" or "academic" with "spin-off", "spinoff", "spin-out" or "spinout". A computerized search was carried out using all the different expressions that result from the combination of the referred words. The search was performed in ABI/INFORM of Proquest, Google Scholar and Google. The popularity of the different expressions was measured by the number of hits that resulted from the search. According to this rating principle, the most popular expressions in this field are "university spin-offs", "university spin-outs" and "academic spin-offs". Some authors also use the term "research-based spin-offs" (e.g., Mustar et al., 2006) to refer to firms of the same nature. The most used expression both in academic literature (15 hits in ABI/Inform) and in the World Wide Web in general (3,100 hits in Google Scholar and 681,000 hits in Google) is "university spin-off", which will be the one adopted for the present study.

In addition to the fuzziness generated by several distinct terms to represent the same concept, there are also different definitions for the same term. Table 2.8 presents some definitions used in previous studies for the term "university spin-off", Table 2.9 displays additional definitions for the term "university spin-out", and Table 2.10 shows definitions for the term "academic spin-off".

Table 2.8 Definitions Used in Previous Studies – University Spin-Offs

Definition	Reference
"a university spin-off is defined as a new venture initiated in a university setting and based on technology developed at a university."	(Rasmussen, 2011: 449)
"We define a university start-up/spin-off as a firm which draws upon knowledge that is produced or circulated at the university, in which the founders have met or become associated in the context of a university, and where the business opportunities are an outcome of the university's existing areas of competence in research and teaching."	(Bathelt, Kogler, & Munro, 2010)
"…university spin-offs as companies founded by university employees"	(Zhang, 2009: 255)
"…university spin-offs as new ventures that are dependent upon licensing or assignment of an institution's IP for initiation."	(Wright et al., 2007: 4)
"…university spinoff as a new company founded to exploit a piece of intellectual property created in an academic institution."	(Shane, 2004: 4)
"new firms created to exploit commercially some knowledge, technology or research results developed within a university".	(Pirnay et al., 2003: 356)
"A spin-off is a new company that is formed (1) by individuals who were former employees of a parent organization, and (2) a core technology that is transferred from the parent organization."	(Steffensen et al., 2000: 97)

University spin-offs involve present university employees (Zhang, 2009) or former employees (Steffensen, Rogers, & Speakman, 2000). Furthermore, university spin-offs involve intellectual property produced in an academic institution (Shane, 2004; Wright et al., 2007), or in other words, commercialization of knowledge, technology or research results developed within a university (Pirnay, Surlemont, & Nlemvo, 2003; Steffensen et al., 2000). Thus, according to Shane (2004: 4), "companies established by current or former members of a university, which do not commercialize intellectual property created in academic institutions, are not included in the definition of a spinoff". The definition of Rasmussen (2011) relaxes the more restrictive nature of the previous definitions, since it does not specify the present or past role of the founders, and refers to technology rather than intellectual property.

Table 2.9 Definitions Used in Previous Studies – University Spin-Outs

Definition	Reference
"We define a USO as a start-up company whose formation is dependent on the formal transfer of intellectual property rights from the university and in which the university holds an equity stake."	(Wright et al., 2007: 481-482)
"university spin-out companies, defined as firms that have been spun off from academic departments or research centres within a university with the aim of commercializing technology invented at the university"	(Libaers et al., 2006: 444)
"Spin-outs from universities are usually thought of new firms commercializing a proprietary leading-edge technology from a university department, and backed by venture capital."	(Druilhe & Garnsey, 2004: 269)
"Spinouts involve: 1. The transfer of a core technology from an academic institution into a new company. 2. The founding member(s) may include the inventor academic(s) who may or may not be currently affiliated with the academic institution."	(Nicolaou & Birley, 2003a: 340)
"a spinout is a company that is created using the intellectual assets of the university but which is neither wholly owned nor managed by the university."	(Birley, 2002: 136)
"A (university) spin-out company is defined in two ways: (1) the founder was a faculty member, staff member, or student who left the university to start a company or who started the company while still affiliated with the university; and/or (2) a technology or technology-based idea developed within the university was used to start the company."	(Smilor et al., 1990: 64)

Considering now the definitions of university spin-outs used in previous studies (see Table 2.9), most authors state that these firms commercialize university technology (Druilhe & Garnsey, 2004; Libaers, Meyer, & Geuna, 2006; Nicolaou & Birley, 2003a; Smilor, Gibson, & Dietrich, 1990). In addition, the founding team may include academic staff or students who may or may not be currently affiliated with the university (Nicolaou & Birley, 2003a; Smilor et al., 1990). Such considerations appear to be in line with the previous discussion regarding university spin-offs. The definition of Wright et al. (2007) requires that the university holds an equity stake on the start-up company, though this restriction is not shared by the other definitions displayed on Table 2.9. However, Birley (2002: 136) states that the spinout is "neither wholly owned nor managed by the university", which suggests that the spinout is in fact partially owned or managed by the university.

Table 2.10 Definitions Used in Previous Studies – Academic Spin-Offs

Definition	Reference
"We define an academic spin-off as a company that has either a university or at least one academic (full, associate, or assistant professor; or Ph.D. candidate, research fellow, or technician) among the founders, regardless of the presence of a formal commitment from the parent university (Fini et al., 2009). Our definition excludes firms that had been based on university-owned knowledge that had been licensed to external entrepreneurs (Radosevich, 1995)."	(Fini et al., 2011: 1117)
"new firms created to exploit commercially some knowledge, technology, or research results developed within a university"	(Muller, 2010: 190)
"…academic spin-offs are companies founded by university teachers, researchers, or students and graduates in order to commercially exploit the results of the research in which they might have been involved at the university"	(Bellini et al., 1999: 2)
"…academic spin-offs, have their roots in academic research, i.e. at least one of the founders worked in a research establishment before the inception of the firm. These ventures were therefore established to commercialise a product or service developed in a university laboratory."	(Jones-Evans et al., 1998: 61)
"…an academic spin-off can be described as a business venture which is initiated, or become commercially active, with the academic entrepreneur playing a key role in any or all of the planning, initial establishment, or subsequent management phases"	(Weatherston, 1995: 1)

According to the definitions for "academic spin-offs" presented on Table 2.10, these firms somehow involve academic staff as members of the founding team (Bellini et al., 1999; Jones-Evans, Steward, Balazs, & Todorov, 1998) or playing a key role in certain phases of development of the spin-off (Weatherston, 1995). A more recent definition by Müller (2010: 190) relaxes the nature of the founding team, since it just mentions that the new firm must exploit knowledge, technology, or research results "developed within a university". Fini, Grimaldi, Santoni, & Sobrero's (2011: 1117) definition excludes firms "based on university-owned knowledge that had been licensed to external entrepreneurs".

The previous tables, displaying various definitions at different points in time for university spin-offs, university spin-outs and academic spin-offs, show simultaneously their similarities and differences. The definitions also clarify that these three different expressions are often used interchangeably, but they appear to

hold the same meaning. Some authors might claim that the word "academic" refers to universities plus "stand-alone" research institutes (as parent research institutions), whereas "university" refers solely to universities, though this view may be disputed. In fact, many of the definitions of academic spin-offs refer only to "universities" as parent institutions (e.g., Bellini et al., 1999: 2; Fini et al., 2011: 1117; Jones-Evans et al., 1998: 61; Müller, 2010: 190). Recently, Bathelt et al. (2010: 520) claimed that "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". Therefore, the term "university spin-off" remains a vaguely defined concept, and it seems that this blurriness is related to the heterogeneous nature of university spin-off processes and of research methods to study them (Bathelt et al., 2010).

For the purposes of this study, I will employ the expression "university spin-off" and adopt the definition of Rasmussen (2011: 449) as *"a new venture initiated in a university setting and based on technology developed at a university"*.

Having briefly reviewed the several expressions and definitions of university spin-offs, I now turn the attention to the process of spin-off at the firm level. Since this study deals with the process of business model change in university spin-offs, it is relevant to understand also the process of spin-off. The next subsection presents a short and focused review on the topic.

2.5.4 University Spin-Off Process and Constraints

Most studies looking at the process of development of university spin-offs have employed multi-staged approaches. However, recent research has acknowledged the irregular and complex patterns that characterize spin-off development, and has turned attention to less linear approaches and different theoretical perspectives (Rasmussen, 2011).

Shane (2004) argues that the process of university spin-off firm creation comprises the following five steps: 1) use of funded research, 2) creation and disclosure of invention, 3) decision to seek intellectual property protection, 4)

marketing the technology, and 5) licensing decision. He divides this process in two activities: 1) undertaking additional technical development, and 2) developing a market for the technology. The first activity involves establishing proof of principle, developing the prototype, and engaging in the product development process (productizing the invention, and performing changes to make technologies appropriate for the commercial environment). The second activity involves dealing with market uncertainty, gathering market information (identifying and satisfying a need, and obtaining customer feedback), choosing an application, and selling the products and services.

Wright et al. (2007) identify the following five phases of university spin-off development: 1) research phase, 2) opportunity-framing phase, 3) pre-organization phase, 4) reorientation phase and, finally, 5) sustainable returns phase. They argue that the firm needs to accomplish a specific group of activities before it can move to the next phase of development. However, "spin-offs move through a number of successive phases in their development in an iterative non-linear way" (Wright et al., 2007: 115).

Rasmussen (2011: 448) argues that "university spin-offs are usually a result of long and complex development paths" and that the complexity of the process "is evident from the many actors involved at different levels and their often different and unclear objectives". He explains that pioneering studies have examined the process of spin-off development using stage models (such as the studies above), but contends that these linear models are too rigid. He combines the four basic change process theories – life-cycle, teleological, dialectic and evolutionary (Van de Ven & Poole, 1995) – to develop a more comprehensive theoretical framework to study the emergence and development of university spin-offs. He concludes that "different process theories are more salient at different times in the spin-off process, and that each theory inherently focuses on different aspects of the process" (Rasmussen, 2011: 466).

University spin-offs may require large sums of money, due to the technical and market development they need to undertake. In fact, some researchers advocate a positive relationship between the amount of capital acquired and the performance of

these firms (e.g., Shane, 2004), which further emphasizes the importance of financial resources. Therefore, the lack of financial resources appears to be a typical constraint to university spin-off formation and development.

Wright et al. (2007: 150) also mention access to financial resources as critical for spin-off development: "A key constraint for spin-offs is finding access to finance". They even go slightly further, adding that "shortfalls in human capital in terms of the knowledge and understanding required to develop the case for investment (...) might be particularly problematical". Therefore, it is not only the lack of financial resources, but also the lack of knowledgeable human resources that detain the expertise to attract financial capital. Hence, the lack of specialised human resources and knowledge may also be important constraints in the development of the spin-off.

In their early stages, university spin-off firms face critical junctures (thresholds) in terms of resources needed before reaching the next growth stage (Van Geenhuizen & Soetanto, 2009). These authors claim that evidence on how university spin-offs' needs for resources change over time is scarce, though increased attention has been recently given to this subject. Hence, the goal of their study was to explore the nature of obstacles that prevent growth during the early years of university spin-offs. The authors concluded that market-related obstacles occur most often, with financial and management obstacles in the second and third place, respectively:

> *"In more detail, a lack of marketing knowledge is the most frequently experienced obstacle (16.1% of all obstacles), followed by a shortage of sales skills (13.2%), a lack of cash flow (12.6%), problems in dealing with uncertainty in management (11.5%), and management overload (10.9%)" (Van Geenhuizen & Soetanto, 2009: 675).*

Therefore, the lack of marketing (and potentially market) knowledge, sales skills, financial resources, and management knowledge, appear to be the most prominent obstacles to spin-off development. The authors argue that the lack of marketing knowledge was a predicted obstacle, since many spin-offs evolved from an initial idea in a non-commercial environment. Van Geenhuizen & Soetanto (2009)

identify an additional obstacle, which they call "credibility in the market". According to them, many of these spin-offs "are subject to a vicious circle of failing to acquire a large customer, just because they had not supplied a large customer previously" (Van Geenhuizen & Soetanto, 2009: 675).

2.5.5 Theoretical Perspectives in University Spin-Offs

Review authors in the mid-2000s have suggested that the majority of the research in university spin-offs is more or less atheoretical (Rothaermal et al., 2007) and descriptive in nature (Mustar et al., 2006). Authors claim that these studies focus "mainly on the description of the phenomena and/or testing casually observed relationships without invoking any discernible deductive logic" (Rothaermal et al., 2007: 706). According to them, all articles using some kind of dominant theoretical lens were published post-1998, with most of them published only after 2001. Since then, an increasing number of studies in university spin-offs have attempted to integrate theoretical perspectives mostly borrowed from other fields. Rasmussen (2011: 449) also acknowledged recently "the atheoretical nature of spin-off research", and has been adding theory-driven studies to the field. These emerging attempts of 'theorizing' (Weick, 1995b) in university spin-off research reflect the field's increasing maturity.

The most common theoretical lenses are derived from sociology, using predominantly *network theory*, and from strategic management, applying the *resource-based theory* of the firm (Mustar et al., 2006; Rothaermal et al., 2007). Some authors focus on social resources at start-up, while others focus mainly on the financial resources, technological resources, or human resources (Druilhe & Garnsey, 2004). Other studies focus on the relationship between the university spin-offs and their parent organizations. Since this view draws heavily on *institutional theory*, Mustar et al. (2006: 291) label this group of papers as the "institutional perspective".

Van Burg et al. (2008) adopt a *science-based design* approach consisting of five design principles. These principles draw both on practitioner knowledge (single

case study) and on theoretical insights from *opportunity identification* (Djokovic & Souitaris, 2008; Shane, 2000, 2004), *knowledge theories* (Djokovic & Souitaris, 2008), *resource-based theory* (O'Shea, Allen, Chevalier, & Roche, 2005), *organizational development theories* (Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005), *social capital theory* (Nicolaou & Birley, 2003b), and *organizational development theories* (Clarysse et al., 2005). Other scholars investigating science-based ventures (Ambos & Birkinshaw, 2010) have employed the theoretical lens of *organizational archetypes* (Greenwood & Hinings, 1993).

Some studies have investigated university spin-offs from a *process perspective*, though these studies have adopted *stage models* (Clarysse & Moray, 2004; Vohora, Wright, & Lockett, 2004). However, Levie & Lichtenstein (2010: 336) have recently claimed that "stages models and *life-cycle theories* of business and entrepreneurial growth, although popular among researchers and practitioners, do not accurately represent the growth and development of entrepreneurial firms." Responding to the demand for theoretically-driven studies that capture the complexity of the spin-off processes, Rasmussen (2011) provides a more comprehensive framework that uses *organizational change process theories* (Van de Ven & Poole, 1995). In a more recent study, Rasmussen et al. (2014) have integrated *entrepreneurial competencies* (Danneels, 2002) and the *evolutionary perspective* (Nelson and Winter, 1982) to better understand the complexity of new venture emergence.

2.5.6 Business Models in University Spin-Offs

There is not much scholarly literature on university spin-offs that has mentioned the expression "business model(s)". Moreover, literature on university spin-offs that has employed and discussed the business model construct is strikingly rare. This section intends to briefly cover this thin branch of literature.

The founders of university spin-offs are often academics and they face more challenges than founders with industrial backgrounds (Bower, 2003). Founders must make critical strategic choices if they are to attract the right resources to deploy their

businesses, and some of these choices require an understanding of changing fashions in business models and investors' preferences. Selecting the right applications and business models that will enable successful venture creation is a difficult challenge for founders with low market knowledge and no previous investment experience.

Bower (2003: 103) recommends "establishing and maintaining credibility of the business idea and model, often under radical changes in the business environment". The author argues that to succeed, this requires close relationships with sponsors, financial and corporate, which bring complementary credibility, technical skill, and knowledge of financial markets. As the environment evolves, perceptions of what is lucrative and of risk also evolve, and therefore applications may have to change accordingly to meet the criteria for credibility. According to Bower (2003), environmental changes may have to be followed by subsequent changes in the business models of university spin-offs. The author refers an example where "failure to anticipate and respond to systemic changes which changed perceptions of risk led to business failure" (Bower, 2003: 104).

Druilhe & Garnsey (2004) performed an analysis of Cambridge university spin-offs using a combination of database evidence and nine case studies. The case study data provided more in-depth knowledge on the process of business model change. The results show that business models of new ventures evolve as entrepreneurs improve their knowledge of resources and opportunities. This relevant knowledge and experience is developed through engagement with others (e.g., appropriate partnerships) and involvement in entrepreneurial activities. The authors "see [venture, and thus business model] development as an iterative, non-linear process" (Druilhe & Garnsey, 2004: 282), distinct from the processes described by linear "phase models". According to them, "a number of factors, including the maturity of the entrepreneurs' initial resources and business model selected, influence the kinds of phases the venture experiences" (Druilhe & Garnsey, 2004: 282). The matching process requires continual attention to external factors, namely market factors and competition dynamics. Druillhe & Garnsey (2004: 283) encourage entrepreneurs

"(…) to view a change of business model and market focus as part of their learning experience rather than as an admission of inadequacy. Ventures need support from sector specialists and those experienced in different kinds of business models suited to different types of activity."

In their study of research-based start-ups (RBSUs), Heirman & Clarysse (2004) found that more experienced entrepreneurs prefer business models with short-term revenue streams (through consulting or product sales) and financial independence, i.e., without being backed by venture capital. Also, in their sample, 42% of the companies started without a clear idea about their business models. Therefore, during their early growth they refined their business models, and convinced experienced people to join and further develop the technology. Heirman & Clarysse (2004: 263) additionally state that "spin-outs from corporations seem to start differently from their academic equivalents, i.e., with a less broad and innovative technology and more often with a close to market product". The authors contend that university spin-offs secure venture financing more easily than independent start-ups and corporate spin-offs. According to them, this happens because venture capitalists value: 1) the technological bases of the university spin-offs, 2) the link with the university itself, and 3) the network of the technology transfer office.

Vohora et al. (2004) examined the development of university spin-offs, and found that they undergo a number of distinct phases. The authors claim that each phase involves an iterative, non-linear process of development. Also, each venture must pass through the previous phase in order to progress to the next one, and at the interstices between the different phases of development ventures face "critical junctures" (opportunity recognition, entrepreneurial commitment, credibility and sustainability). Throughout the development process, the university spin-offs address many of the early uncertainties and refine their business models. Sustainable business models are often achieved through "learning by doing", i.e., by re-orientating business models as they are implemented.

Based on an extensive review of the literature, Mustar et al. (2006) acknowledge the heterogeneity of university spin-offs and develop a taxonomy of

research-based spin-offs (RBSOs) based on three dimensions: type of resources, the business model and the institutional link. Some of the reviewed studies indicate that input "resource endowments" obtained from the parent organization are sometimes seen as having an impact on the firm's ability to access further resources. Therefore, these inputs may have a lasting effect on the business model of the university spin-off, both in terms of the nature of the opportunities exploited or the type of activities performed (Mustar et al., 2006).

Wright et al. (2007) propose a spin-off taxonomy which is built upon different theoretical perspectives and that distinguishes between three types of spin-offs. Similarly to the taxonomy developed by Mustar et al. (2006), the three theoretical perspectives are: 1) the institutional point of view, 2) the business model perspective, and 3) the resource-based point of view. The three types of spin-offs are: 1) the venture capital backed spin-off, 2) the prospector spin-off, and 3) the lifestyle spin-off. Concerning the business model perspective, Wright et al. (2007) argue that VC-backed spin-offs look mainly for investor acceptance, and therefore prioritize value creation and tradability of their assets over selling products or services in the short-term. Lifestyle spin-offs typically seek market acceptance. Hence, they usually bootstrap, and look for minimal costs and a fast time to break even. Finally, the prospector spin-offs still have to refine their business model and may seek investor acceptance, market acceptance, or both.

In a study of eight Nordic university spin-offs, Sanz-Velasco & Saemundsson (2008) identified nine different learning behaviors that lead to business model changes. Inspired by the entrepreneurial learning view, the authors classify the behaviors as either "learning based on experience" or "learning through external relations". Table 2.11 below shows the nine identified behaviors classified according to the previous two categories. The authors also discuss the influence of the surrounding external environment on learning behaviors. They propose that:

> *"(...) academic entrepreneurs in less supportive environments are probably more dependent on learning through trial-and-error for changing their business models as compared to academic entrepreneurs in more supportive environments."* (Sanz-Velasco & Saemundsson, 2008: 30)

In more supportive environments, academic entrepreneurs are more likely to complement their experience-based learning with learning through external actors, and therefore business model changes are triggered by both types of learning.

Table 2.11 Observed Learning Behaviors Classified in Two Categories

Learning based on experience	*Learning based on external relations*
Market scanning	Adding new employees
Virtual market experimentation	Obtaining external expert advice
Interaction with existing customers	Participation in entrepreneurial education programmes
Interaction with new customers with new requirements	–
Imitation	–
Responding to external changes	–

Source: Sanz-Velasco & Saemundsson (2008: 26)

Drawing on a single case study of the first years of a new university spin-off, Doganova & Eyquem-Renault (2009) examined the firm's business model and its role in the process of entrepreneurship. The business model objectifies two entities: the new venture and its product. The business model is "embedded in various material forms which vary across space and time and circulated across a wide array of actors" (Doganova & Eyquem-Renault, 2009: 1567). The business model is continuous and adaptive: it is robust enough to allow calculation and capture the interest of potential partners, but also flexible enough to allow for the changes required by the enrolment of these partners.

Ambos & Birkinshaw (2010) present a process study on the evolution of new science-based ventures. This study does not explicitly focus on business model change over time and does not employ any business model framework; however, the authors adopt the theoretical concept of 'organizational archetypes', which provides a holistic perspective on new venture evolution and sheds light on the driving forces of archetype transitions. Therefore, this study also provides some insight on the

process of business model change, since these driving forces may be closely related to the forces or factors triggering changes in business models. According to the authors,

> *"the (...) ventures go through interarchetype transitions, which are triggered by collective cognitive dissonance between the venture leaders' understanding of the old interpretive scheme and the emerging reality and are resolved through internal negotiations."* (Ambos & Birkinshaw, 2010: 1125)

Munari & Toschi (2011) analysed whether venture capital (VC) firms have a bias against investment in university spin-offs. Drawing on a sample of 247 new ventures in the micro and nanotechnology sector in the UK, they examine if the university spin-off's probability of receiving VC financing is affected by a number of factors, including the type of business model adopted. According to the authors, the majority of the sample tends to adopt a technology-based business model, followed by service-based and finally product-based. They conclude that the adoption of a service-based business model has a negative impact on obtaining VC financing. Moreover, evidence suggests that "private VCs are less keen on investing in ASOs [Academic Spin-Offs] adopting business models based on service, when compared to publicly-supported VC funds" (Munari & Toschi, 2011: 421).

2.5.7 Limitations of University Spin-off Research

University spin-off scholars point out several limitations and avenues for future studies. Recent research in university spin-offs has emphasized that "often, studies of university spin-off processes are static, only providing a snapshot of the processes that lead to spin-off formation" (Bathelt et al., 2010: 522). The authors subsequently advanced the following proposal:

> *"A dynamic research perspective that focuses on the nature of knowledge flows, in contrast to a static study of the spin-off phenomenon, is preferable as it allows for the examination of the dynamic processes university spin-*

offs/start-ups experience during different stages of their life-cycle" (Bathelt et al., 2010: 522).

According to Mustar et al. (2006: 304), most of the university spin-off typologies developed are also based on a static view:

> *"(...) most classifications [or typologies] have been designed to analyze spinoffs at a given point in time so they focus on static categories and overlook the dynamic processes underlying firms' emergence and growth. As firms evolve, their resources will change and they may develop a different business model."*

Therefore, for a better understanding of the heterogeneity of research-based spin-offs, Mustar et al. (2006: 304) suggest the investigation of "how firms develop iteratively over time in terms of their resource endowment, strategy and link with the PRO [Parent Research Organization]".

These statements call for *longitudinal field research designs* that capture the evolution of the phenomena over time, as Geenhuizen & Soetanto (2009) suggest. Markman, Siegel, & Wright (2008) similarly emphasize the relevance of longitudinal studies over considerable periods of time to understand research and technology commercialization. In addition, they argue that the use of *mixed methods* – combining quantitative and qualitative techniques – could provide further insight on the phenomena. More recently, Rasmussen (2011: 465) contends that:

> *"Multilevel longitudinal studies following spin-off projects as they evolve may be particularly well suited to developing a more precise model of the entrepreneurial process in the university setting."*

Hence, the demand for longitudinal studies has been clearly and frequently stated in recent studies of university spin-offs.

Other authors suggest that further research should attempt to better investigate the issue of *university spin-off performance*. In particular, Harrison & Leitch (2010: 1256) have recently contended that "the identification of the

determinants of the overall performance of university spin-offs over the long run, and of variations in that performance, is an important area for further more detailed research." Similarly, Shane (2004) suggests research avenues towards enhancing the understanding of university spin-off formation and the various factors that influence their *performance*. In his own words:

> *"Further research is clearly needed to provide more (...) information about university spin-offs so that we can develop explanations of the factors that influence their formation and performance."* (p. 301)

> *"Research to date has only explored the effect of two aspects of spin-off company strategy on performance – focus and adaptability. (...) More research is needed to identify the aspects of strategy that influence the performance of university spin-offs."* (p. 308)

In their study of research-based start-ups, Heirman & Clarysse (2004: 266) suggest a more detailed look at the evolution of these firms during their early stages: "An interesting direction for future research would be to explore how these different types of firms evolve during their early growth path".

Researchers have also been claiming that more *theoretically-driven studies* are needed.

> *"More work is needed to explore and develop theories which can explain the spin-off venturing process, as neither the stage models nor the resource-based view seem fully able to capture the irregular and complex patterns described in qualitative spin-off studies"* (Rasmussen, 2011: 449-450).

The last sentence of Rasmussen's (2011: 466) article clearly reflects the author's hopes of a theoretical stance: "Hopefully this framework will inspire more theory-driven and multilevel studies on the spin-off process" (Rasmussen, 2011: 466). Van Burg et al. (2008: 118) have similarly recognized that "some of the empirical findings regarding university spin-offs still lack theoretical explanation". They suggest the adoption of other theories to provide a deeper understanding of the process of university spin-off formation, such as *organizational justice theory* (e.g.,

Hosmer & Kiewitz, 2005), *complexity theory* (e.g., Cilliers, 2002; Kauffman, 1996), and *organizational culture theories* (Schein, 1996).

The next section concludes this literature review. It presents a brief summary of the topics discussed, describes limitations of extant research, and identifies directions suggested by the various scholars in the field.

2.6 CONCLUSION

This chapter reviewed extant literature on business models and university spin-offs. This subsection summarizes key points, and describes the limitations of these two streams of research that motivated the research questions of this study.

2.6.1 Summary of Key Points

Researchers have advocated that in increasingly fast-moving environments characterized by high technological and market uncertainty, business models cannot be anticipated in advance (Andries & Debackere, 2007; McGrath, 2010). These high levels of uncertainty induce more business model changes (Andries & Debackere, 2007), as the entrepreneur gains experience and new knowledge, developed through engagement with others and involvement in entrepreneurial activities (Druilhe & Garnsey, 2004). In fact, viable business models seem to emerge from an interactive process involving the entrepreneurs' vision and interactions with potential customers and sources of funding (Chesbrough & Rosenbloom, 2002). Sustainable business models appear to be learned over time, through experimentation (Blank & Dorf, 2012; Murray & Tripsas, 2004; Ries, 2011) or "learning by doing" (Vohora et al., 2004). However, there are very few longitudinal studies examining the *process of business model change*, and approximately half of them have been published in 2013. Apparently, longitudinal multiple case studies examining the process of business model change in real time, for new ventures, are inexistent at the time of writing[10].

[10] 24th of December of 2013.

Many authors argue that choosing the right initial business model configuration (Chesbrough & Rosenbloom, 2002; Kaplan et al., 2009) or design (Zott & Amit, 2007) and managing its adaptation over time (Andries & Debackere, 2007) has a critical impact on *entrepreneurial firm performance*. In fact, authors argue that despite market opportunities, entrepreneurial firms may fail if they adopt the wrong business model (Chesbrough & Rosenbloom, 2002). Andries & Debackere (2007) found that the impact of adaptation in the performance of technology-based businesses is highly dependent on the sector and on the origin of the firm. The authors claim that adaptation is beneficial in immature, high-velocity industries, but detrimental in mature, stable industries. Morris et al. (2006) have also stated that the *elements of a business model* are highly interdependent, with changes in one element having implications on the other elements. Nonetheless, there is still no clear understanding on the dynamics of this system of business model elements.

For many firms, adaptation seems to be especially critical during *earlier stages*. In fact, Kaplan et al. (2009) argue that the core business model is defined during the early stage of a firm's development, since after that stage they suffer only minor modifications for an extended period of time (Schindehutte et al., 2008). Therefore, this suggests that the early-stage may be a fertile period in terms of business model change.

Literature on the specific topic of university spin-offs argues that founders of these firms are often academics, and face more challenges than founders with industrial backgrounds: they have lower market knowledge, and no previous investment experience (Bower, 2003). These firms develop through an irregular, iterative, non-linear and complex process (Druilhe & Garnsey, 2004; Rasmussen, 2011; Vohora et al., 2004; Wright et al., 2007), rather than strictly following a staged process (Levie & Lichtenstein, 2010). This development process involves iterations with many actors at different levels (Rasmussen, 2011). In fact, many spin-offs start without a clear idea of their business models, and during early growth they refine them and convince experienced people to join (Heirman & Clarysse, 2004). The spin-off development process includes two important activities: technology development, and developing a market for the technology (Shane, 2004). Authors

contend that access to finance is the most relevant constraint for spin-off development (Shane, 2004; Wright et al., 2007). The lack of appropriate human capital, investment knowledge (Wright et al., 2007), marketing and sales knowledge, market credibility, and problems with managing uncertainty (Van Geenhuizen & Soetanto, 2009) are also important bottlenecks in the university spin-off process.

2.6.2 Limitations of Extant Literature

In their research work on business models and university spin-offs, scholars have pointed out the limitations of their studies and suggested several avenues for further research.

In the business model literature, scholars have called for further insights into the *process of business model change* (Morris et al., 2005; Zott & Amit, 2007, 2008), and on the factors that influence this process (Chesbrough & Rosenbloom, 2002). To better understand how business models are shaped over time, Svejenova et al. (2010) recommended the use of *longitudinal research methods and process studies*. George & Bock (2011) also suggested longitudinal analysis of business model structures.

University spin-off researchers similarly argue that most studies in university spin-offs are static and present snapshots of the development process, overlooking its inherently dynamic nature (Bathelt et al., 2010, Mustar et al., 2006). Therefore, researchers suggest the examination of how spin-offs form and develop iteratively over time (Shane, 2004; Mustar et al., 2006; Wright et al., 2007). Several authors have also suggested the use of *longitudinal field research designs* to capture the evolution of the phenomena over time (Markman et al., 2008; Van Geenhuizen & Soetanto, 2009), thus enabling the development of a more precise model of the *entrepreneurial process in university spin-offs* (Rasmussen, 2011).

Moreover, some authors suggest a focus on the *early-stage* of development. For instance, George & Bock (2011: 105) recognize the challenge of researching early-stage entrepreneurial activity, and suggest "longitudinal analysis of business model structures at firms to determine how structures change". In the university spin-

off domain, Heirman & Clarysse (2007) claim that an interesting direction for further research would be to explore how research-based start-ups *evolve during their early stages*.

Business model researchers have also recently emphasized the importance of better understanding *business models* and their role on *entrepreneurial firm performance* over time (Teece, 2010; Zott & Amit, 2007, 2008). In a similar fashion, Mustar et al. (2006) argue that a little examined topic is the impact on firm performance of differences in the business models of research-based spin-offs. Wright et al. (2007) also claim that:

"There is a clear need to build insights into the dynamic capabilities which these companies develop over time and which make them different from each other in terms of performance." (Wright et al., 2007: 196)

Shane (2004: 301) has also emphasized the need for more "information about spin-offs so that we can develop explanations of the factors that influence their formation and performance". In fact, Andies & Debackere (2007: 97) compared business model adaptation and performance on new technology based start-ups and business units, and stated that "it would also be interesting to look at spin-outs of universities and research institutes". Therefore, scholars have repeatedly suggested that further research should attempt to better understand the impact of *business model change on the performance of firms*, including university spin-offs.

Scholars also emphasize the need to research on the *interactions between business model elements over time*. Morris et al. (2006) suggested that future investigations should focus on the relationships between variables that constitute the elements of the business model, and on factors that drive changes in business model elements (Chesbrough & Rosembloom, 2002). In sum, authors have claimed that further insights are needed on the interaction and dynamics of business model elements, or dimensions, over time (George & Bock, 2011; Morris et al., 2005).

Zott et al. (2011) have argued that future studies on business models should aim for more *theoretical consolidation*, and for a better understanding of the

mechanisms through which business models work. Some empirical findings regarding university spin-offs also lack theoretical explanation (Van Burg et al., 2008). Therefore, researchers have claimed that more *theory-driven and multilevel studies* on the business model and spin-off venturing process are needed (Rasmussen, 2011; Van Burg et al., 2008; Zott et al., 2011).

In conclusion, researchers in business models and university spin-offs have called for studies using longitudinal designs aiming to better understand the processes of change over time. They emphasize the need to understand the factors driving business model change (inputs), the mechanics of the process of change over time (process), and the subsequent impact on firm performance (output). Since business model changes appear to occur more frequently on early-stages of venture development, researchers have recommended focusing in this period. Due to the typical atheoretical nature of studies on business models and university spin-offs, researchers have continuously pointed towards more theoretical consolidation. Additionally, researchers suggest more multi-level studies, also considering interactions over time at the level of business model element. Hence, given what is known about business models and university spin-offs, and following the recommendations above, this thesis asks: (1) How does the process of business model change unfold in early-stage university spin-offs?, (2) How does business model change link to performance in early-stage university spin-offs?, and (3) How do business model elements change and interact over time in early-stage university spin-offs?

3 METHODOLOGY

3.1 INTRODUCTION

The aim of this chapter is to describe and justify the research methodology adopted to explore business model change in early-stage university spin-offs, and to investigate the potential impact in firm performance.

As a point of departure, this chapter details the philosophical assumptions of the study (Section 3.2), addressing the author's ontological and epistemological positioning and the philosophical paradigm chosen to inform this thesis. Section 3.3 describes and justifies the research design chosen for this thesis, followed by Section 3.4, which presents the research setting and the rationale for case selection. Section 3.5 details the data collection process of the pilot interviews and main case study. Section 3.6 explains how relevant constructs for sampling and analysis were operationalized. Section 3.7 details the steps followed for the data analysis process, and Section 3.8 addresses the quality of the research, evaluating its strengths and identifying limitations, and debates ethical issues. Finally, the concluding section summarizes the main points of this chapter.

3.2 RESEARCH PHILOSOPHY

This section discusses the philosophical positioning underpinning this thesis. Philosophical assumptions are fundamentally rooted on the researcher's personal beliefs and on the nature of the research itself. This section starts by describing my ontological and epistemological standpoint. This standpoint is relevant, since it directly influences the ground assumptions of the research enquiry (Morgan, 1983). The last part of this section discusses the appropriateness of the chosen philosophical paradigm for the purpose of this thesis.

In my view of the natural world, "a tree in the forest is a tree, regardless of whether anyone is aware of its existence or not" (Crotty, 1998: 8). Thus, I believe that meaning exists in objects independently of any consciousness. In terms of

epistemology, this reflects an objectivist position. Additionally, I am convinced that *natural* reality exists outside the mind, i.e., "reality is of an objective nature" (Burrell & Morgan, 1979: 1), thus implying a realist position in terms of ontological assumptions. This set of epistemological and ontological assumptions point to the theoretical perspective of positivism.

However, having studied physics as an undergraduate, I am aware of Heisenberg's uncertainty principle and Bohr's probabilistic approach to quantum mechanics. Both scientists challenge certainty, objectivism, and determinism. I also share the perspective of Popper (1959: 8) "that every discovery contains *an irrational element*, or *a creative intuition*", i.e., that the process of searching for universal laws is not purely rational. Additionally, I subscribe the temporary validity of scientific truths (Popper, 1959).

In a similar fashion, I concur with Kuhn's view of history of science as an alternation between periods of *normal science* and periods of *scientific revolution*, in which human interests and values play an important role (Kuhn, 1996), and with Feyerabend's anarchic view of scientific progress. These reflections soften both the extreme objectivist epistemology and realist ontology, even in natural science. Thus, I am urged to exclude radical forms of objectivism and realism and adopt less extreme epistemological and ontological positions. Such a philosophical position seems to be aligned with post-positivism, which embodies my view of the natural (or physical) world.

However, I believe that when we study the human (or social) world, our set of epistemological and ontological assumptions may be different. When dealing with the human world, I tend to embrace a more subjective stance. For instance, trees may exist independently of our perception that trees are out there. In opposition, some social phenomena are dependent on our perception of them. Social reality is seen and recognized differently by different *eyes*. I come from a relatively warm country, and my perception of *cold* is very distinct from my flatmate's perception of *cold* (since he comes from a colder country). My body feels it differently and I live it differently. Also, influenced by distinctive cultural backgrounds, the meanings we attribute to similar gestures are disparate. In reality, the gesture is out there and it is the same –

but our interpretations are distinct, inducing different feelings and different internal realities.

In sum, I believe social reality is more of a "product of individual cognition" (Burrell & Morgan, 1979: 1) rather than a given *out there*, which reflects a more subjectivist ontology, closer to nominalism (Burrell & Morgan, 1979). Moreover, in my opinion, social knowledge is "of a softer, more subjective (…) kind, based on experience and insight of a unique and essentially personal nature" (Burrell & Morgan, 1979: 1-2), as opposed to "being hard, real and capable of being transmitted in tangible form". This belief reflects an anti-positivist (Burrell & Morgan, 1979) or constructivist (Crotty, 1998) epistemology. Furthermore, I believe that the observer may frequently *dissolve* himself in the observed reality, and that science is not purely value-free but often driven by human interests. According to Burrell & Morgan (1979) and Morgan & Smircich (1980), this set of ontological and epistemological assumptions reflects a subjectivist approach to social science.

The previous paragraphs attempted to establish my general philosophical positioning for both natural and social sciences, which is clearly different for these two branches of science. This discrepancy does not generate any kind of conflict, since this thesis is well bounded by the management discipline (in particular strategy and entrepreneurship), which is often classified as a branch of social science. I now turn to the specific objective of this thesis to discuss the choice of philosophical paradigm.

This thesis aims at understanding how business models are constructed over time, and how this process impacts firm performance. It intends to investigate the totality of each situation (holism as opposed to reductionism) and to develop ideas through induction of data, which strengthens the argument for a more subjectivist approach (Easterby-Smith, Thorpe, & Lowe, 1991). In addition, this thesis intends to understand the process through which individuals in university spin-offs co-create business models by interacting with each other and their surrounding environment (also constituted by individuals). This kind of *processual* knowledge about co-creating shared realities by human actors calls for the perspective of 'social constructionism' (Morgan & Smircich, 1980). Moreover, the cohort I dealt with

(university spin-offs), are typically companies based on new technologies, whose market may not exist – it has to be socially constructed both by external actors (such as customers) and venture founders.

Social constructionism can be traced back to the nineteenth century as a reaction to the dominant positivist view of science, and is fundamentally rooted on two disciplines – social psychology and sociology (Chell, 2000). Social scientists claimed "that individual and social phenomena had to be studied through the subjective minds of individuals [and] not only through observable behaviour" (Lindgren & Packendorff, 2009: 29-30). Nevertheless, the formal term "social constructionism" appears to be coined by Berger & Luckmann (1966) to emphasize the shared processes by which individuals and groups construct their reality. Social constructionism approaches the described complex social phenomena with a holistic view and provides knowledge about these interaction processes, implying a "focus on the study of (…) longitudinal processes of social interaction" (Lindgren & Packendorff, 2009: 29).

Downing (2005: 198) has similarly employed the perspective of social constructionism to explore the role of narrative and dramatic processes amongst entrepreneurs and their stakeholders, and found that "very successful companies coproduce their business models by an extended iterative process of dialogue and action". This study seeks to better understand this process over time and therefore adopts a similar philosophical paradigm.

Having described the philosophical stance of this thesis and presented the reasons governing that choice, I will now discuss the research design adopted to address the research questions of this thesis.

3.3 RESEARCH DESIGN

Scholars have argued that much of the reviewed literature in business models is quite recent and only a few contributions have appeared in top journals (e.g., Zott et al., 2011). Moreover, "the literature is widely divergent (...) [and] the business

model remains a theoretical underdeveloped (...) concept" (Zott et al., 2011: 1038). This view is shared by Teece (2010), who also contends that the business model construct lacks theoretical grounding. In addition, Zott and Amit (2008: 20) state that "little research has been conducted so far on how business models evolve", thus implying an insufficient understanding on the *process of business model change*. The lack of theoretical development and processual understanding suggests that "research on business models remains in a nascent stage" (George & Bock, 2011: 107).

The description above overlaps with Edmondson and McManus's (2007) archetype of nascent theory research. According to them, such archetype encompasses "topics for which little or no previous theory exists" (Edmondson & McManus, 2007: 1161). Additionally, the types of research questions conduce to inductive theory development, and may focus on understanding how a process unfolds. Since little is known about the topic, this type of research calls for rich, detailed, qualitative data to shed light on the phenomenon, and methods such as interviews, open-ended questions, and longitudinal investigations are appropriate. Therefore, given the state of prior theory and research on business models, and given the exploratory, processual nature of the research questions, an inductive, longitudinal research design, mostly based on qualitative data, was adopted.

I recall the three research questions that drove this study, put forward in the Introduction chapter:

RQ1: How does the process of business model change unfold in early-stage entrepreneurial firms?

RQ2: How does business model change link to performance in early-stage university spin-offs?

RQ3: How do business model elements change and interact over time in early-stage university spin-offs?

The adoption of a social constructionist philosophical paradigm to explore these research questions, among other reasons and circumstances enumerated and

explained below, pointed towards *case studies* as a preferred research method for this thesis.

First, the nature of this thesis research questions is both exploratory and explanatory. Questions of this nature require tracing operational links between constructs over time, leading to the use of case studies as a preferred research method (Yin, 2009).

Second, the aim was to trace business model evolution over time, without intending to interfere with its deliberate course of action. As opposed to an experimental or quasi-experimental design, in which the investigator has some degree of control over behavioural events, I had almost no influence on the natural course of action of these companies, which again reinforced the use of case studies (Yin, 2009).

Third, I intended to study these university spin-offs as they were being formed, i.e., as crucial events and milestones were occurring over time, and was interacting with 'live' persons involved in those events. Thus, this research focuses on "a contemporary phenomenon within a real-life context" (Yin, 2009: 2). The historical method would be more appropriate when dealing with 'dead' past, i.e., when there are no relevant persons alive to report the phenomena, which was not the case.

Fourth, and according to (Yin, 2009: 11), "the case study's unique strength is its ability to deal with a full variety of evidence – documents, artefacts, interviews and observations – beyond what might be available in a conventional historical study". In fact, a key strength of the case study method is that it involves multiple sources and techniques in the data gathering process. This statement again argued in favour of a case study approach, since I used several data sources, such as documents, archives and interviews.

Fifth, to answer the research questions it was crucial to develop an extensive and in-depth description of the evolution of business model elements in early-stage university spin-offs. This evolution involves complex social phenomena. My

intention was to devise a research design that allowed me "to understand what is happening… (by looking) at the totality of each situation" (Easterby-Smith et al., 1991: 27), retaining in this way the holistic and meaningful characteristics of the interactions that I sought to study. Hence, a case study approach was appropriate.

This line of enquiry is compatible with *social constructionism*, in which entrepreneurial processes are seen "as open-ended series of events in which people create/develop things together" (Lindgren & Packendorff, 2009: 35). Such events are continuously emerging, as complex interactions take place. As a result, "if we are interested in development, change and critical moments we need to follow processes in a longitudinal way and preferably in real time" (Lindgren & Packendorff, 2009: 35).

Hence, since I attempted to study the holistic evolution over time of the dynamic, non-linear processes that characterize the social phenomena described above, an *inductive, longitudinal multiple-case research design* was chosen. As previously stated, this design is appropriate when investigating how certain elements change over time (Yin, 2009) and for theory building, since the propositions generated are grounded in varied empirical evidence (Eisenhardt & Graebner, 2007).

According to Eisenhardt (1989b: 534), "*case studies* typically combine (…) methods such as archives, interviews, questionnaires, and observations". These methods, which require the researcher to be part of the process, are in harmony with the *social constructionist* approach (Lindgren & Packendorff, 2009).

Multiple-case studies, like single-case studies are just variants of case study designs (Yin, 2009). Though conducting multiple case studies may require more resources, including time, the evidence from them is often considered more compelling, and the overall study is usually seen as more robust (Yin, 2009). Multiple cases are effective because they enable collection of comparative data, and so are likely to yield more accurate, generalizable theory than single cases (Eisenhardt, 1991; Ozcan & Eisenhardt, 2009; Yin, 2009).

Inductive studies are especially useful for developing theoretical insights when research focuses on areas that extant theory does not address well and when the research questions are about processes. This inductive study used a mix of both qualitative and quantitative evidence, extending somehow the narrow but common view of the case study design as a sole form of qualitative research, which I do not personally endorse. Qualitative data is very useful to develop a deeper understanding of a certain phenomenon and to understand underlying relationships, though it can (and should) be complemented and corroborated by quantitative data (Eisenhardt, 1989b).

According to Eisenhardt (1989b), using multiple case studies to build theory provides many advantages. Different cases are then treated as experiments, with each one corroborating or refuting inferences drawn from the others (Yin, 2009). This replication logic contributes to building a more robust and generalizable theory than would be possible with single case studies (Eisenhardt & Graebner, 2007). The investigation of multiple cases of entrepreneurial processes where the researcher is a real-time observer of the social processes is a suitable methodology within social constructionism (Lindgren & Packendorff, 2009).

Since the research objective is to study real-time change, a *real-time longitudinal design* is appropriate. The time intervals between different data collection points should be defined in a way that embraces "the anticipated stages at which the changes should reveal themselves" (Yin, 2009: 49).

Another fundamental component of a research design is its *unit of analysis*. The cases selected and studied are university spin-offs. But whilst in previous studies the unit of analysis has been the entrepreneurial firm, or the business model as an aggregate entity, this thesis also studies the evolution of the business model at the *element level*, i.e., tracks changes over time for each of the distinct elements that constitute the business model framework. Therefore, this thesis has three units of analysis: (1) business model (primary unit of analysis), (2) business model element (subcomponent of the business model), (3) and firm performance, permitting induction of rich and reliable models (Eisenhardt, 1989b).

Since the topic under study is rather unexplored in previous studies, it is legitimate not to include any propositions *a priori* (Yin, 2009). The absence of initial propositions is typical of more exploratory studies, though there is an evident purpose and guiding line behind this research, as detailed previously.

3.4 RESEARCH SETTING AND CASE SELECTION

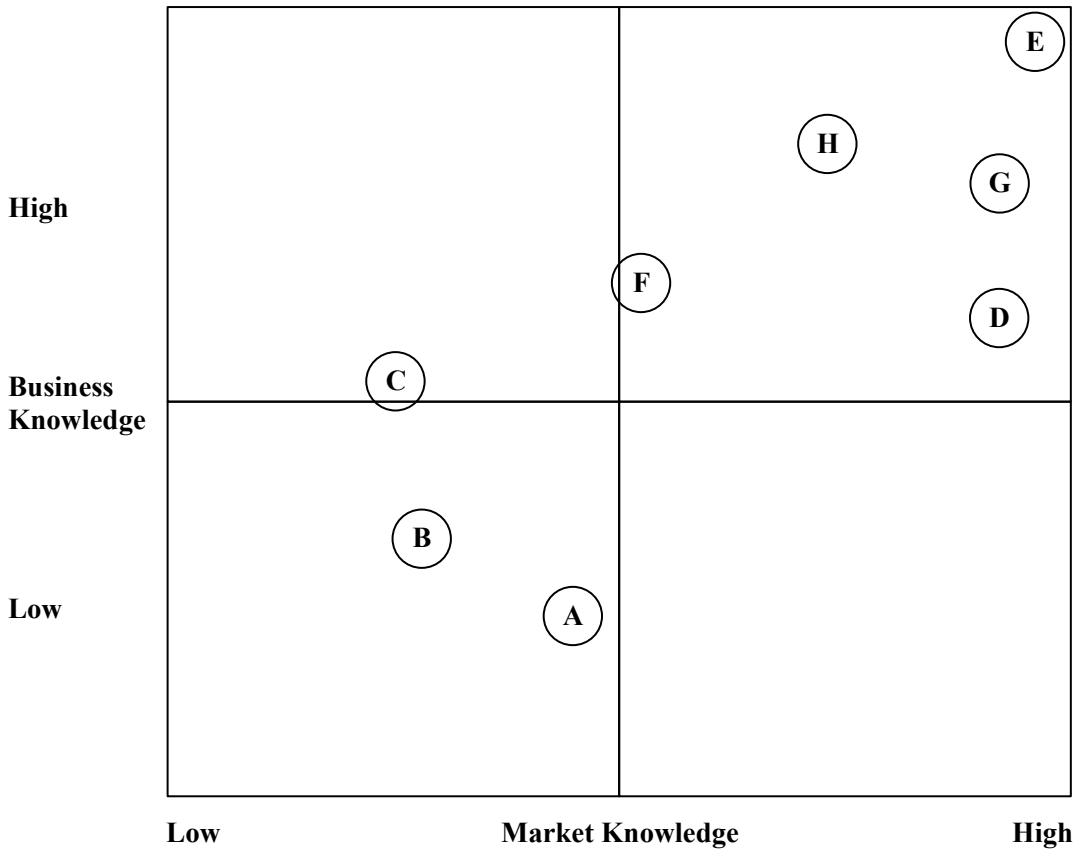
The research setting was early-stage university spin-offs from a single university in the UK to control for university policy and practice concerning spin-off activity. Early-stage firms combine uncertainty, time limits, and drive: a promising setting for observing business model change (Gersick, 1994). University spin-offs tend to have less market knowledge than corporate spin-offs at start-up (Clarysse, Wright, & Van de Velde, 2011). Their original founding teams tend to have less business experience (Costa, Fontes, & Heitor, 2004), requiring more corrections to decisions made at earlier stages (Conceicao, Fontes, & Calapez, 2012). Thus, this setting is attractive for the purposes of this study.

Multiple-case studies should follow a *replication* logic, rather than a *sampling* logic, more usual on other research designs, such as survey research. According to Yin (2009: 54), "each case must be carefully selected so that either (a) predicts similar results (a *literal replication*) or (b) predicts contrasting results but for anticipatable reasons (a *theoretical replication*)". An important theoretical sampling approach is 'polar types,' "in which a researcher samples extreme (e.g., very high and very low performing) cases in order to more easily observe contrasting patterns in the data" (Eisenhardt & Graebner, 2007: 27). Given the aim of linking business model change and firm performance, I selected university spin-offs with varied values (low to high) on the dimensions known to affect future performance: market knowledge, managerial knowledge, and entrepreneurial knowledge (see Section 3.6 for more detail on these dimensions). Such choice ensures theoretical replication.

A positioning matrix (see Figure 3.1 below) was depicted to map the cases according to the dimensions selected as references for theoretical sampling, i.e.,

market knowledge, managerial knowledge, and entrepreneurial knowledge (see Section 3.6). Managerial and market knowledge were averaged, and represented as 'business knowledge'. This transformation allowed the representation of the cases in a bi-dimensional matrix with regards to the dimensions of market knowledge and business knowledge.

Figure 3.1 Case Positioning Matrix according to Market Knowledge and Business Knowledge* (Cases A to H)



* business knowledge = average (managerial knowledge, entrepreneurial knowledge)

Source: See Table 4.29 on Section 4.11 for data

A common question when dealing with multiple-case design has to do with the number of cases considered necessary or sufficient for the study. This issue is

critical in research designs using a sampling logic that usually emphasizes the use of statistical techniques in the research process. But according to Yin (2009: 58), since "a sampling logic should not be used, the typical criteria regarding sample size also are irrelevant". Instead, the number of cases should be chosen according to the number of literal and theoretical case replications that one would need or like to have in the study. Since two dimensions are being used for theoretical sampling, it would be ideal to have 4 polar cases (i.e., one case per cell of the 2x2 matrix) to ensure theoretical replication. Moreover, to protect the study against unexpected events (e.g., firm dissolution, sudden unavailability of the main informant), and to conform to the literal replication strategy, a minimum of 2 firms for each cell of the 2x2 matrix would be necessary, yielding a total of 8 cases. However, the university spin-offs had to follow specific criteria, which limited their availability. They had to be: 1) originated from the same parent university, 2) in the early-stage of development, 3) willing to participate in the study, and 4) able to provide access to rich data.

Therefore, from an initial pool of 13 university spin-offs, a total of 8 case firms that maximized the variance across the two-dimensional space of market and business knowledge, were selected in September 2010. Figure 3.1 above represents the positioning of the cases across these dimensions and Table 3.1 summarizes their various characteristics. Consistent with the definition of early-stage businesses, these spin-offs were active for less than three and a half years (Kelley, Singer, & Herrington, 2012), with incorporation dates between November 2007 and April 2010.

3.5 DATA COLLECTION

The following sub-sections outline the data collection process carried out for the purpose of this investigation. Table 3.2 summarizes the main steps of this process, which are then detailed below.

Table 3.1 Description of Case Data

Case	A	B	C	D	E	F	G	H
Industry	Electronics, software and mechanical engineering	Consumer electronics	Semi-conductors	Biotechno-logy	Biopharma-ceutical	Electronics	Energy	Biotechno-logy (subgroup: diagnostics)
Specific domain	Structural inspection	Energy efficiency	LEDs	Bacteria phage sector	Anti-infective medicines	Decision support systems	Renewable energy	Global microbiolo-gical food testing sector
Main informant	CEO and Founder	CEO and Founder	CEO and Founder	CSO and Founder	CBO and Founder	CSO and Founder	Director and Founder	CSO and Founder
Other informants	Product Developer	Project Manager	Lead engineer	Lead researcher	CFO	Founder and VP R&D	CEO and Founder	n/a
Nr of interviews	13	12	11	14	12	13	14	11
Nr of employees *	1	3	5	4.5	4	7	2.25	26
Initial research	2003	2007	2001	1993	2007	2005	2001	1995
Business idea	2008	2007	2005/2006	2009	2007	2007	2008	2005
Incorporation	Apr 2010	Nov 2007	Nov 2009	Feb 2010	Jul 2009	Nov 2007	Oct 2009	Jul 2009
Normal operations **	Not started	Apr 2011	July 2010	Dec 2010	Sep 2009	Jun 2010	Sep 2010	Jul 2009
Status	Dormant	Active	Active	Active	Active	Active	Active	Active

* Number of employees in FTE (Full Time Equivalent) in May 2012

** Normal operations: date when company initialized *normal* operations (e.g., initial funding, first transaction)

Table 3.2 Main Steps in the Data Collection Process

Steps	Description
Initial investigation	Pilot case study Internet search and website reading Conversations with the university's technology transfer office (TTO)
Case selection	Define criteria and select main cases accordingly Identify prospective case informants
Initial contact	First e-mail to prospective case informants First telephone call to prospective case informants First meeting with case informants
Documentation / archival data collection	Exhaustive and detailed collection of written documents and/or other media: - Internal sources (business plans, presentations, internal reports, etc); - External sources (press articles, company websites, databases).
Interviews	First interview with main informants to gather case generic data First interview of the *longitudinal* study to collect retrospective information about the business model (BM) Subsequent interviews, over a 12 month period, with a monthly frequency, to trace changes in the BM (*Month 1* to *Month 12*) Retrospective interview with a second informant focused on BM changes (between *Month 0* and *Month 12*) Final interview focused on various dimensions/indicators of firm performance, and their evolution over the 12 month period

3.5.1 Pilot Interviews

As a point of departure, some pilot retrospective interviews were conducted to refine my "data collection plans with respect to both the content of the data and the procedures to be followed" (Yin, 2009: 92). In particular, these pilot interviews were helpful for the following reasons: 1) to get a feeling of potential outcomes; 2) to refine the research questions; 3) to improve questionnaire design; 4) to practice the skills of interviewing, recording, transcribing and analysing data; and 5) to improve the research design in general.

The interviews were conducted with six university entrepreneurs that were awarded the Enterprise Fellowships scheme in 2010. These entrepreneurs broadly matched the profile of typical spin-off entrepreneurs from universities. The pilot cases were selected based on convenience, access, and geographic proximity (Yin, 2009), since the entrepreneurs were conveniently located in my research department

for two days, and were willing to share their experiences and knowledge in the form of a 10-minute pilot interview. The interviews were made on the 5th and 6th of May of 2010 between 1pm and 2pm, at the *Hunter Centre for Entrepreneurship*, during the lunch break of the *Supercoach Entrepreneurial Training* that the entrepreneurs were attending.

The scope of the pilot study was slightly broader and less focused than the ultimate case study (Yin, 2009). The interviewing process was less structured and the questions more open, allowing the interviewees to have more control over time and structure of the interviews. Since the pilot study was undertaken in parallel with the literature review, the ultimate research design was then simultaneously informed by the relevant literature, including extant theories, and by empirical observation, materialized with the pilot study. This guaranteed the relevance of the research questions posed, both in terms of theoretical contribution and practical implications.

3.5.2 Main Case Study

Following the pilot interviews, I selected a new set of spin-off cases to study. I gathered archival data from internal sources such as business plans, company websites, presentations, internal reports, videos, and others. External sources included media articles contained in the Nexis UK database, and additional data available in the Companies House, Fame and Key Note databases (data services and official documents in PDF format). There are several examples of studies based on multiple cases using such research methods (e.g., Ozcan & Eisenhardt, 2009; Santos & Eisenhardt, 2009).

I conducted 12 months of longitudinal (monthly) semi-structured interviews with the founders of eight spin-offs, totaling 98 interviews (see Appendix 8.1 for more detail on interview guides). Retrospective interviews were conducted with additional informants. The interview process started in April 2011 and ended in July 2012. The interviews were all taped and transcribed *verbatim* by the author, a laborious process that took three months. Although the task of transcribing was fatiguing and lengthy, it gave the researcher a greater understanding of the data, and

allowed a deeper immersion into the information gathered (Byrne, 1998). Table 3.3 describes the data sources used, the number of transcribed pages (for the interviews), and the number of pages collected (for the other internal and external data sources).

The main informant was typically the CEO or the CSO. The first interview (60 to 90 minutes) was used to match with the data identified in the archival material (see Appendix 8.1.1), thus triangulating to strengthen research quality (Yin, 2009). The second interview (15 to 45 minutes) gathered information on how the business model had evolved up to that moment (see Appendix 8.1.2). To structure the interviews and data collected, the *Business Model Canvas* (Osterwalder et al., 2010) was used. The third and subsequent interviews (15 to 45 minutes, monthly) gathered information about changes in the business model, funding, and goals (see Appendix 8.1.3). The interview guide for the third and subsequent interviews had three main parts. The first part focused on changes to the specific business model elements, funding, and goals. The second part consisted of open-ended questions (how and why) concerning the changes occurred. The third and last part consisted of open questions about additional changes not covered previously, and on emerging topics worthwhile exploring. In the two final months of interviewing (June and July 2012) relevant information to assess performance was collected, and retrospective interviews were conducted with additional informants to triangulate data.

While conducting the first interviews, I recognized that entrepreneurs where often talking about reality, but also frequently addressing intentions in their discourse. Such intertwining of reality and intentions in describing their business models was a source of increased complexity, and began to introduce unexpected ambiguity and "noise" in the study. It became necessary to clarify with the interviewees, during the subsequent monthly sessions, whether they were referring to their actual business models or the business models they intended to have in the near future. Also, such situation urged me to decide whether to capture the actual business models or the entrepreneurs' intentions for their business models. After much thinking, and since they both seemed relevant and insightful, I decided to capture and map over time both the *realized* business models (already implemented) and *intentions* for the business models (residing in the entrepreneur's mind, and

Table 3.3 Number of Pages of Data for each Data Source, by Case

Case	A	B	C	D	E	F	G	H	Total
Interview type									
Initial (first)	12	9	9	12	12	9	9	15	**87**
Longitudinal (monthly)	48	117	108	129	57	129	60	102	**750**
Performance (final)	12	12	12	12	12	12	12	12	**96**
Other informants	6	6	6	6	6	6	6	6	**48**
	78	**144**	**135**	**159**	**87**	**156**	**87**	**135**	***981***
Internal Sources									
Company websites	0	12	39	24	15	27	39	27	**183**
Business plans	59	39	0	54	0	0	0	0	**152**
News	0	9	0	0	6	33	6	3	**57**
Others (e.g. presentations)	0	51	0	6	1	0	0	0	**58**
Videos	0	0	0	0	0	0	1	0	**1**
	59	**111**	**39**	**84**	**22**	**60**	**46**	**30**	***451***
External Sources									
Nexis UK: All news	0	78	30	36	123	69	39	6	**381**
Nexis UK: Company profiles	12	33	57	33	27	24	69	45	**300**
Companies House	3	3	3	3	3	3	3	3	**24**
Fame	0	0	0	0	0	0	0	36	**36**
Key Note: data services	33	33	36	33	33	39	33	36	**276**
Key Note: official docs (PDF)*	6	16	23	11	10	21	24	13	**124**
	54	**163**	**149**	**116**	**196**	**156**	**168**	**139**	***1141***
Total number of pages									**2573**

Date: 16 January 2013; All pages in Times New Roman (12 pt), double-spaced

*Represents the number of official documents available (e.g. annual accounts, annual returns, appointments), and not the number of pages

reflecting his plans for the business model of the firm).

Potential informant bias (Eisenhardt & Graebner, 2007) was addressed by using at least two knowledgeable informants who viewed the focal phenomena from different perspectives. I also combined retrospective and real-time longitudinal data collection of interviews to mitigate retrospective sense-making and impression management. Finally, I combined interview data with archival data.

3.6 OPERATIONALIZATION OF CONSTRUCTS FOR SAMPLING AND ANALYSIS

This section explains how core constructs were operationalized in the thesis for the purpose of theoretical sampling (for case selection) and data analysis. Due to the intended link with firm performance, some factors that are known to affect performance were considered. It is well known that the presence of entrepreneurial *commitment*, defined as "the emotional, intellectual, and physical energy that is employed in order to reach the ventures' main objective", is key for venture generation and performance (Erikson, 2002: 282). In his work with academic spin-offs, Shane (2004: 241) has also identified management knowledge, including experience in creating spin-offs, knowledge of markets, and commitment of the entrepreneurs, as important dimensions that affect future spin-off performance:

> *"More motivated and committed firm founders, with better knowledge of management, firm formation and the industry in which they plan to operate, are more likely than other firm founders to create companies that survive and grow."*

Therefore, measures of commitment, market knowledge, managerial knowledge, and entrepreneurial knowledge were developed. Previous studies in entrepreneurship, management, and marketing have also included measures of entrepreneurial commitment (e.g., Erikson, 2002), market knowledge (e.g., De Luca & Atuahene-Gima, 2007), managerial knowledge (e.g., Drazin & Rao, 2002), and entrepreneurial knowledge (e.g., Haynie, Shepherd, & Patzelt, 2012). The measures

used for this study include objective indicators (e.g., number of years, number of spin-offs created), and subjective indicators (e.g., self-assessment). Such a technique using both objective and subjective indicators has been used elsewhere (e.g., Sapienza, Smith, & Gannon, 1988; Walter, Auer, & Ritter, 2006). The list of objective and subjective indicators is presented in Table 4.28, Table 4.29, and Table 4.30 in Section 4.11 (Measurement of Constructs).

The operationalization of the construct of performance was based on a comprehensive review of studies on performance in entrepreneurial firms and small businesses. Authors contend that performance is a multidimensional construct, and suggest the integration of various indicators (Wiklund & Shepherd, 2003b; Wiklund & Shepherd, 2005). Hence, to capture this multiplicity, they combine measures of growth and financial performance (e.g., Wiklund & Shepherd, 2005), though access to financial indicators is difficult and their value is questionable in young firms (Delmar, 1996). Some authors simply focus on firm survival (e.g., Wennberg, Wiklund, & Wright, 2011).

Growth is usually measured using employment and/or sales (or turnover) calculated in absolute and/or relative terms (Delmar, 1996; Delmar, Davidsson, & Gartner, 2003; Wennberg, Wiklund, & Wright, 2011; Wiklund, 1998; Wiklund & Shepherd, 2003a). Wiklund & Shepherd (2003a) suggest also capturing growth aspirations. Other common indicators/measures of growth are physical output, assets, profits, and market share (Delmar, Davidsson, & Gartner, 2003). Financial or "business efficiency" measures (Delmar, 1996) include indicators such as market value, gross margin, profit, cash flow, return on assets and investment, and debt-equity ratio (Delmar, 1996; Wiklund, 1998). Wiklund & Shepherd (2003a) use also self-reported measures (i.e., asked to respondents) of gross margin, profitability, and cash flow. Several authors develop additional performance indicators based on comparisons with key competitors.

Delmar & Shane (2003) also used measures such as the level of product development, and the level of venture organizing activity. Similarly, Samuelsson & Davidsson (2009) employed the concept of progress in the venturing process, while Reynolds & Curtin (2008) used the concept of prevalence of certain start-up

activities. Several other studies examining performance in the context of entrepreneurship (Clarysse et al, 2011; Dahlstrand, 1997; Smith & Ho, 2006; Walter, Auer, & Ritter, 2006) have additionally used assets, patents, and funding as measures. They have also combined objective measures with subjective measures such as customer orders, estimated revenues, and self-perception of firm progress.

The operationalizations of the constructs of commitment, market knowledge, managerial knowledge, entrepreneurial knowledge, and spin-off performance follow below.

Commitment: percentage of working week hours dedicated to the spin-off in relation to the total working week hours (refers to the member of the management team that dedicates more time to the spin-off).

Market knowledge: number of years in contact with the specific market of the firm (refers to the sum of years for all members of the management team and/or founders with active participation in the spin-off).

Managerial knowledge: number of years working in medium or big companies (refers to the sum of years for all members of the management team and/or founders with active participation in the spin-off).

Entrepreneurial knowledge: number of years starting up companies or running small businesses (refers to the sum of years for all members of the management team and/or founders with active participation in the spin-off).

Spin-off performance. Inspired by the studies reviewed above, I selected the following objective measures for spin-off performance, most of them referring to two points in time (May 2011 and May 2012): company value (absolute and relative growth), sales (absolute and relative growth), number of employees (absolute and relative growth), number of patents (filed and accepted), financing (self-financing, private equity, and grants), manifestation of interest in buying the business, licensing, or partnering, stage of product development, and start-up organizing activities (Reynolds & Curtin, 2008). Subjective measures of performance were gathered at the end of the data collection period and included self-perception of overall performance,

satisfaction with spin-off progress, customer orders, estimated sales for the next 12 months, and anticipated annual sales and number of employees for year 5.

3.7 DATA ANALYSIS

This section provides an overview of the data analysis process carried out for the purpose of this study. A summary of the main steps followed is presented below in Table 3.4.

All the interviews were carefully transcribed by myself, a process that took 3 months, and resulted in a detailed account of 981 pages, in Times New Roman 12 pt, double space font. A first pass was performed, using a foot pedal, the free software ExpressScribe, Microsoft Word 2011, and Mac Operating System. A second pass was done, focused mostly in hearing and correcting small inaccuracies from the first pass. At this stage, many comments, annotations and memos were registered. After browsing through the massive amount of data collected, and going back to methodology readings, I felt the need to eliminate unnecessary redundancy. Thus, data was reduced very carefully, to make it more manageable for further analysis (Miles & Huberman, 1994). Data reduction was performed in both internal and external raw data. The transcriptions of the interviews were also processed by discarding "huhs", "ers", pauses, mispronunciations, incomplete and repeated sentences, thus providing a smoother, more straightforward narrative (Miles & Huberman, 1994).

The next step was to organize the reduced data, in order to provide a better data structure, enhancing its *visibility* for further analysis. Therefore, case histories, tables synthesizing relevant firm data, and detailed chronological sequence of key events (related to the different business model elements) were then created for each firm. Tables with performance indicators, and other relevant dimensions were also built. Finally cross-case tables for the sake of easier comparison were developed. Both the interviews and the archival data (from external and internal sources) were used to build the case histories, the chronological sequence of key events, and all

other tables (Miles & Huberman, 1994). Using different sources allows for data triangulation, therefore improving the robustness of the study (Yin, 2009).

Table 3.4 Main Steps in the Data Analysis Process

Steps	Description
Data transcription	Full transcription (1st pass) of the interviews (from digitally recorded files) Second pass through the audio files to correct inaccuracies
Data reduction	Eliminating unnecessary redundancy in archival data / documentation both from internal and external sources Discarding "huhs", "ers", pauses, mispronunciations, incomplete and repeated sentences from interviews
Case description and mapping events over time	Writing narratives about the spin-off, blending the archival data with the interviews. Focus on: - generic spin-off information with potential relevance for the study - business model (BM) changes (at the BM element level) - factors driving those BM changes - actors involved in those BM changes - spin-off performance indicators - and any other relevant events/dimensions
Structuring and synthesizing the data	Developing structured tables with: - generic firm information (*within-case*) - chronology of key events related with the BM, including time, actors, and other critical events (*within-case*) - *cross-case* synthesis
Coding, memoing, and annotating	First-level open coding of the interviews (paper and pencil) First-level open coding of the interviews (QSR Nvivo 10) First-level selective coding on emerging themes (QSR Nvivo 10) Second-level coding to aggregate codes
Matching theoretical concepts	In-depth analysis of each case on the light of the research questions Cross-case analysis, comparing findings from each case with the other cases, to identify consistent patterns Working with theory and data in an iterative process Discussing with other researchers on the field Attempt to identify relationships and patterns

Before approaching the data with Nvivo 10, I performed first order open coding of the transcribed interviews with paper and pencil. This analysis proved to be extremely useful to restructure the Results and Analysis chapters that follow (Chapters 4 and 5, respectively). I then performed first and second level coding of

changes to business model elements and other related emergent categories (see Appendix 8.2 for coding structure and sample interview transcripts). For this task I used QSR Nvivo 10, running under a virtual machine of Windows XP, installed in VirtualBox 4.2.16 for Mac OS (Mountain Lion, version 10.8.4). I proceeded with first-level open coding, annotating and memoing, focusing on how and why business model elements changed. This allowed for the emergence of drivers of change of the business model elements, and other related themes worthwhile exploring (e.g., realized vs. intended business models, market-pull vs. technology-push, causation versus effectuation, resource constraints). I continued with first-level selective coding, and subsequently with second-level coding to aggregate the previous codes in more general themes (Glaser, 1978; Glaser & Strauss, 1967; Miles & Huberman, 1994; Strauss & Corbin, 1998).

Firm performance was assessed by a composite measure combining objective indicators (e.g., sales, number of employees, company value) and subjective indicators (e.g., self-perception of spin-off progress). I searched the business model maps, the coded data, and the performance indicators for patterns, and induced propositions from these patterns (Eisenhardt, 1989a; Eisenhardt & Graebner, 2007). Each case was thoroughly analysed, in order to identify relationships between constructs, and cases were compared with each other, in the sense of progressively developing a richer theoretical framework. Along this process I went frequently back to literature, attempting to relate findings with extant theories (Miles & Huberman, 1994). To minimize the error introduced by investigator's subjectivity, multiple researchers were involved in parts of the coding process (Snow & Hambrick, 1980).

To deepen the understanding of particular phenomena and to provide more insight, different analysis techniques were occasionally employed when examining different themes. For example, *open coding* was employed to examine the drivers of business model change (see Section 5.2), while *selective coding* was used to investigate causation, effectuation, and business model change (see Section 5.6) or resource constraints and business model change (see Section 5.7). The selective coding was performed using different coding structures that were developed specifically for the different themes. Other analysis techniques usually classified as

'quantitative', such as *frequency analysis*, where also employed (see, for instance, Section 5.4). More details regarding the specific analysis procedures used to investigate each of these themes are provided in the respective sections of the Analysis chapter (e.g., the specific analysis procedure employed to investigate the theme of causation vs. effectuation is detailed on Section 5.6).

3.8 QUALITY OF THE RESEARCH AND ETHICAL CONSIDERATIONS

3.8.1 Quality of the Research Design

Though some scholars have compared the quality of "qualitative research on organizations" to story-telling (Miles, 1979: 600), other scholars have been showing "that case studies can be conducted systematically" (Yin, 1981). According to Yin (2009: 40), the quality of exploratory case studies is usually assessed by three tests:

> *"Construct validity: identifying correct operational measures for the concepts being studied*
>
> *External validity: defining the domain to which a study's findings can be generalized*
>
> *Reliability: demonstrating that the operations of a study – such as the data collection procedures – can be repeated, with the same results."*

Several tactics can be used to deal with these tests. The tactics employed in the present study are shown in Table 3.5. To fulfil the first test of *construct validity*, it is required that the investigator defines clearly the constructs involved in the study and identifies correct operational measures for these constructs, ideally citing published studies that address both the constructs and the measures (Yin, 2009). This has been done, namely in what concerns the constructs of business model, business model elements, university spin-offs, early-stage, as well as other related constructs. Tactics for dealing with construct validity involve using multiple sources of evidence, establishing a chain of evidence, and having key informants reviewing the draft case study report. According to Yin (2009: 115), "the most important advantage of using multiple sources of evidence is the development of *converging lines of*

inquiry". This process of triangulation may be classified in four different types (Patton, 2002 in Yin, 2009): 1) data triangulation, 2) investigator triangulation, 3) theory triangulation, and 4) methodological triangulation.

Table 3.5 Quality of the Research Design

Test	Case study tactic	Phase of research
Construct validity	Use of multiple sources of evidence, i.e., triangulation:	
	- of data sources (*data triangulation*): archival data and interviews	Data collection
	- among different evaluators (*investigator triangulation*): conversation with research colleagues, presentations in conferences	Multiple phases
	- of perspectives to the same data set (*theory triangulation*)	Multiple phases
	- of methodology (*methodological triangulation*): combination of longitudinal and retrospective interviews	Research design
	- of different informants for the interviews (*informant triangulation*)	Data collection
External validity	Establish a chain of evidence	Data collection & analysis
	Have key informants review draft case study report;	Data analysis
	Prolonged engagement with the field (*longitudinal design*).	Data collection & analysis
Reliability	Use of multiple case studies (*replication logic*)	Research design
	Thorough report of all steps performed	Multiple phases
	Case study database (records, transcriptions, etc.)	Multiple phases

Adapted from (Yin, 2003).

To address the first issue of *data triangulation*, the present study used multiple sources of evidence. As referred previously, these sources were interviews, documents and archival data. The need for using multiple sources of evidence was twofold: a) to triangulate the data (from different sources) addressing the same facts; b) to collect data (from different sources) addressing different facts. The documentation and archival records were used to triangulate the data collected from the interviews on the same facts, but also to provide a complementary means to obtain information on facts not covered on the interviews. According to Eisenhardt (1989: 538), "the triangulation made possible by multiple data collection methods provides stronger substantiation of constructs and hypotheses". Such strategy

enhances *construct validity*, since these different sources of evidence provide multiple measures of the same event (Yin, 2009).

To address the second issue of *investigator triangulation*, I engaged frequently in conversations with research colleagues about my ideas and main concerns, presented this study in conferences as it evolved, and submitted it to blind review processes. According to Eisenhardt (1989: 538), the use of "multiple investigators have two key advantages. First, they enhance the creative potential of the study. (...) Second, the convergence of observations from multiple investigators enhances confidence in the findings".

To address the third issue of *theory triangulation*, I looked at the phenomena through a different spectrum of theoretical perspectives, aiming to identify patterns and commonalities, as well as potential dissonances with established theories.

To address the fourth issue of *methodological triangulation*, I used variations of the same research design. According to Eisenhardt & Graebner (2007: 28), a "key approach to mitigating bias is to combine retrospective and real-time cases". I performed initially a retrospective pilot multiple case study, followed by a subsequent longitudinal multiple case study. Also, I conducted additional retrospective interviews at the end of the study.

In addition to these four types of triangulation, a fifth type was performed: *informant triangulation*. This strategy mitigates the bias characteristic of interview data by "using numerous and highly knowledgeable informants who view the focal phenomena from diverse perspectives" (Eisenhardt & Graebner, 2007: 28). Therefore, at the end of the longitudinal period (12 months), retrospective interviews with second informants were conducted for each case. These interviews focused on how the business model framework had evolved throughout the 12-month period, and thus were checked against the longitudinal interviews conducted with the main informants.

The second test of *external validity* deals with the issue "of knowing if a study's findings are generalizable beyond the immediate case study" (Yin, 2009: 43).

Some critics argue that case studies are a poor basis for generalizing, using the analogy of *samples* and *universes*, common in studies leading to *statistical generalization*. Nevertheless, statistical generalization differs from *analytic generalization*, typical of case studies, in which "the investigator is striving to generalize a particular set of results to some broader theory" (Yin, 2009: 43). The use of theory and a replication logic, in which the theory developed is tested and refined in subsequent cases (Eisenhardt, 1989, 1991), constitute two essential tactics to strengthen external validity. This is the fundamental reason for including a strong theoretical layer in the present study and for a multiple case design, rather than a single case design (Dyer & Wilkins, 1991).

The third test of *reliability* is that "if a later investigator followed the same procedures as described by an earlier investigator and conducted (exactly) the same case study all over again, the later investigator should arrive at the same findings and conclusions" (Yin, 2009: 45). For this to happen it is crucial to document clearly all the procedures followed throughout the case study – without this it wouldn't be possible to repeat it. Thus, the two fundamental tactics to enhance reliability are the use of a case study protocol and the development of a case study database (Eisenhardt, 1989). Therefore, to increase the reliability of the present study, I created a case study database. This database is electronic, in the sense that it consists of an organised set of computer files and directories. Table 3.6 presents the directory structure of this database, and the description of the contents of each directory.

In order to further increase the reliability of this study, a chain of evidence was maintained. First, the dissertation itself contains sufficient references to the relevant portions of the case study database – it cites all the literature, case study documents, interviews and archival records used. Second, Table 3.6 presents the structure of the database, thus clarifying and identifying the path to follow in order to retrieve specific information cited in the text. Third, upon inspection of the database, relevant and detailed information about the case study can be found (i.e., time, place and duration of a particular interview). A considerable effort was made to record "the actual evidence and also indicate the circumstances under which the evidence was collected" (Yin, 2009: 123). Fourth, these circumstances are consistent with the

research methodology, the specific procedures and questions that were outlined previously. Finally, by reading the methodology chapter of this dissertation, it is possible to identify the link between the research procedure used and the initial study questions. Thus, this study was performed in a way that allows one to move from one part of the study to the other, with clear links between those distinctive parts.

Table 3.6 Case Study Database

Directory	Subdirectories	Size (Mb)	Description
\Papers	Many	1,905	Paper database, containing Endnote X7 file and most papers in PDF format.
\Literature Review	e.g., Business models; University spin-offs; Theoretical perspectives	807	Folder containing additional papers, organized by topic of research (e.g., business models, university spin-offs). Contains also papers relevant for the Theoretical Framework of the thesis.
\Methodology	Many	55	Contains several notes from different sources (meetings, conferences, thoughts) concerning methodological issues, and additional papers considered relevant for the study's methodological nature.
\Data Collection	Pilot interviews; Cases A; (…); Case H; Questionnaires	810	Contains all audio files from the interviews, transcribed material, documentation, archival data, and notes taken.
\Results	None	8	Contains tables, charts, notes, and presentations used for the results chapter
\Data Analysis	Raw Data; Reduced Data; Case Summaries; Tables; (…)	1,083	Contains the raw data, and the data after reduction. Contains the detailed case summaries, and all the tables for within-case analysis, and cross-case analysis. Contains performance indicators, the Nvivo 10 files, emerging codes and themes, and papers on emerging theories.
\Write Up	Dissertation; Figures and tables; My papers and presentations; Feedback; Papers arising; Exemplary papers	283	Contains all the evolving versions of the PhD dissertation, as well as tables and figures. Contains papers and slides that I prepared to present in conferences, and feedback I received from my supervisors, colleagues, and conference attendees. Contains additional papers discovered along the writing process, and some exemplary papers.

3.8.2 Ethical Considerations

Since this is a study of "a contemporary phenomenon in its real-life context" (Yin, 2009: 73), important ethical practices had to be considered and followed in relation to the persons and organizations involved in this research, and to those who may be affected by its results.

The following guidelines were used to keep a sound relation to the information sources and to avoid negative consequences (Lewis, 2003; Yin, 2009). First, I clearly informed potential interviewees about the aim and nature of the case study, and how the information would be used. Second, their participation was explicitly and formally requested. Third, informed consent was achieved from all the persons who agreed to be part of the study, before information was gathered. Fourth, privacy and confidentiality were protected, according to each participant's specific requests (e.g., changing the company name, changing participants' names, not showing business plans to third parties, etc.). Fifth, I refrained from revealing or quoting specific information outside the public domain without explicit consent from the sources. This includes secure handling and storage of the information collected.

As integrating part of the University's ethical procedures, I had to complete the University's Ethics Application Form, which had to be signed by the main researcher, main supervisor, and head of department. This form contained relevant and detailed information on all the actors involved in the study, its location and duration, funding bodies, research objectives, nature of the participants and forms of consent, methodology, data collection, data storage and security, potential risks or hazards, among many other issues.

Fraud and plagiarism is a serious concern among scientists, and can be considered as ethical dishonesty, if not properly addressed. Throughout the thesis, I adopted the practice of using a considerable number of citations, with the aim of both acknowledging the authors' original works, and of simultaneously providing the reader with sources for further reading. Finally, as a researcher I have been financed by the University of Strathclyde (a studentship financed by the University, the Department, and the Strathclyde Business School), and by the Portuguese FCT - Foundation for Science and Technology (public institution). Such investment is expected to provide a return to society. Hence, it has been my main objective, since the beginning of this study, to conduct research that is useful, has tangible contributions for stakeholders, and may enhance society in some form.

3.9 CONCLUSION

The aim of this chapter was to describe the research methodology adopted to explore business model change in early-stage university spin-offs, and to explain the rationale that justifies that choice.

Given the nature of the research questions, and the state-of-art of the research in the field, an inductive, longitudinal multiple-case study strategy was adopted. A total of eight university spin-offs were carefully and purposefully selected. Data was collected mainly from three data sources: documentation, archival data, and longitudinal in-depth interviews with firms' founders. Various triangulation tactics have been used to ensure consistency of information and high research quality. A total of 98 interviews were conducted with spin-off founders (CEOs, CBOs, CSOs, among others). The interviews were recorded with the interviewees' consent, and then transcribed *verbatim*, yielding approximately 981 pages of data. The interviews were semi-structured, allowing for unexpected but relevant topics to emerge.

The next chapter starts by exploring and describing the cases individually, and concludes with cross-case comparisons to facilitate the reader in building an integrated, holistic vision of the cases' attributes, similarities and differences.

4 RESULTS

4.1 INTRODUCTION

The previous chapter described the research methodology adopted for this thesis. A total of eight firms were selected, as previously described. Table 3.1 above outlines and compares some characteristics observed in these eight cases.

This chapter presents the results of the thesis, exploring and describing each case company in detail. Sections 4.2 to 4.9 present the within-case descriptions of the eight selected cases. Each case description has the same basic structure, starting with a case summary, followed by an outline of the changes to all business model elements throughout the interviewing period. Following the descriptions of each individual case, Section 4.10 provides cross-case comparisons, often in the form of cross-case displays, of attributes considered relevant for the purpose of this thesis. Section 4.11 explains how the previously operationalized constructs (see Section 3.6) of market knowledge, managerial knowledge, entrepreneurial knowledge, commitment, and spin-off performance were measured. Section 4.12 concludes the chapter with a short sum-up.

The cases are explored in alphabetical order. Due to confidentiality requests from participants, the cases are anonymized throughout the dissertation, and some of the factual information has been slightly adjusted. Confidentiality has allowed the collection of a richer set of data and more open narratives from the participants.

4.2 CASE A

4.2.1 Case Summary

The initial research that led to Firm A's creation started approximately in 2003, as Founder AA recalls: *"There's been research going into this area for 8 years, and we're now trying to commercialise it."* At that time, the research centre got the first grant to develop the technology, and they have been working on it since then. Founder AA became involved in the project around 2006-2007, as a PhD

student, and the idea to form a spin-off company occurred in 2008. He continued with a research fellowship in 2009 and 2010 to further develop the technology and work on the spin-off process. Founder AA describes how he came up with the idea of forming the spin-off company:

> *"I wanted to decide what I was going to do after my PhD. And I've seen interest in the technology. The industrial people that are funding some of the research were very keen. So, it seemed like a good opportunity to capitalise on the research. (...) I like working for sort of small start-up companies. I quite liked working for one in America, and I liked the idea of creating another one here."* (First interview)

He decided to register the company in April 2010, but according to him, that incorporation was premature. Therefore, the founders decided to modify the status of the company to "dormant".

> *"I broke the rules by registering before we have been through the university spin-off process. You're not supposed to do that until the end [of the spin-off process]. So, I suppose I own the company 'in the name', but from the university's point of view it doesn't exist and isn't allowed to exist."*

In order to support the launch of the spin-off, the founders applied for a Technology Strategy Board (TSB) grant from a UK's innovation agency. They didn't succeed in getting that specific grant, but with the aid and involvement of the university's technology transfer office, they applied for a £1 Million grant to co-develop the technology with an established big multinational company and a medium-size firm.

> *"If we get that money, that would really help us to create a good product from our prototypes. But how that will be turned into a company, I'm not sure… it might even be another 2 years. And it's looking like we might get to the stage where we have the product almost ready to sell, and then form the company at that point, rather than trying to form the company and do the R&D in the company."* (First interview)

In March 2011, when the first interview was conducted, the company wasn't trading yet, and did not have permission to, as Founder AA describes:

> *"The company isn't trading, is what I would say. Actually, my role is more of an employee at the university, but I will probably be the future Managing Director or Chief Technology Officer (CTO) of the company. (...) We registered the company, but we're not allowed to start trading."*

The most critical resource to develop the opportunity was financial capital, in the form of his enterprise fellowship, which provided him one year to work on the project.

> *"Money [laughs]. Money so you can actually do stuff. So, I mean, the fellowship. The fellowship gave me a year to work on it [spin-off project]."* (First interview)

The initial founding team was composed of two academics: one lecturer (Founder AB) and his PhD student (Founder AA). At the time of founding, they also partially involved an external market researcher and two other PhD students (engineers). Founder AA has a degree in Electrical & Mechanical Engineering, and worked as a development engineer at a SME in California, USA. He then returned to the UK to study for a PhD in ultrasonic sensor platforms, and following this was awarded an enterprise fellowship to commercialise his research. Founder AB is a lecturer and has many years of scientific project management. His experience also entails detailed technical analysis and presentation of customer measurement results, and supervision of technical and support staff.

The interviewee rates the founding team's managerial knowledge as low, but expresses his wish to bring a more experienced individual on board:

> *"I would probably rate it [managerial knowledge] as quite low: for that we need someone. We'd quite like to bring a managing director type of person. We should be able to do it through the university, through the CEO Designate Program."* (First interview)

Founder AA also rates the founding team's entrepreneurial knowledge as low:

> *"The company I worked [previously] at was a start-up. So, I got quite a lot of experience there, and mentoring from the founder about entrepreneurship, but I didn't start the company or anything. So, I have not really worked as an entrepreneur. (...) He's [Founder AB] not really an entrepreneurial type of guy. He has worked at big companies, and as a lecturer. (...) He's more of a kind of technical advisor."* (First interview)

The initial funding came from Founder AA's enterprise fellowship, and they are also applying for grants through the university to develop the technology. Additionally, they obtained contract research through the university to provide a bespoke system to a national laboratory, for a total of £ 69K, milestone driven.

> *"We delivered them our system. So, they were like our first customer, but they were a customer of the university, not of the spinout. But if we were to get a second order, then the spinout would be the more obvious entity to provide it. So, the spinout would provide future sales."* (First interview)

At the end of the interviewing period, the founding team was still developing the technology. As mentioned above, the spin-off obtained their first "informal" customer order through the university. However, this cash inflow was not considered as spin-off revenue, since the laboratory paid to the university instead. More recent information from Companies House database shows the status of the company as dissolved since September 2012.

Table 4.1 Characteristics and Properties of Case A (March 2011)

Generic information	
Position of the interviewee (spin-off)	CEO
Additional roles of the interviewee	Research Fellow at the Engineering Faculty
Status of the company	Dormant

Original department / research institute	Electronic and Electrical Engineering Department, Centre for Ultrasonic Engineering
Industry	Engineering (electronics, software and mechanical engineering)
Specific domain	Structural inspection, non-destructive testing (NDT) or evaluation (NDE)
Business description	Firm A provides industry-leading automated solutions to structural inspection problems. Their technology combines robotic systems with a range of NDT sensors including ultrasonic, electromagnetic and optical techniques for inspection of plant components as well as 3D mapping of unknown environments.
Date of incorporation	April 2010
Date of normal operations*	n/a (firm in dormant status, didn't start operating yet)
Company status (Mar 2011)	Dormant
Approximate date of initial research	2003
Approximate date of business idea	2008
Opportunity identification and development	
Most critical resource for opportunity development	Financial capital (research fellowship)
Source of basic technology and competence	University research
Context of the initial idea	While doing the Phd in the field, he identified interest in the technology from the industry. Thus, he saw an opportunity to capitalise on the research.
Founding team	
Number of founders	2
Roles of the founders (spin-off)	Future CEO (Founder AA); Lead technical consultant (Founder AB)
Other roles (founders)	Researcher (Founder AA); Lecturer (Founder AB)
Year of birth (founders)	Founder AA (1982)
Background (founders)	Founder AA has a degree in Electrical & Mechanical Engineering, worked as development engineer at a SME in USA, PhD at a UK university; Founder AB is a lecturer, has many years of scientific project management, and professional experience in the field.
Number of other individuals involved	3
Role of the other individuals	1 external market researcher; 2 PhD students (engineers)
Market knowledge (0-10)**	7
Market knowledge (years)	4 years (Founder AA); 10 years (Founder AB)
Managerial knowledge (0-10)**	3
Managerial knowledge (years)	2 years (Founder AA); 14 years (Founder AB)
Entrepreneurial knowledge (0-10)**	2
Entrepreneurial knowledge (years)	1.5 (Founder AA); 1.5 (Founder AB)
Entrepreneurial knowledge (nr of firms created)	0
Commitment of the founding team (%)	50% (Founder AA); 5% (Founder AB)

Technology and market development	
Major performer of technology development	Founder AA at the university
Other performers of technology development	National laboratory; Multinational company; Medium-sized company
Major roles in market development	Founder AA; External market researcher
Funding	
Initial funding	Enterprise fellowship
Self-funding	No
Major source of funding	Research Fellowship; Applying for grants through the University
Additional funding sources	GBP 69K from a national laboratory
Company performance	
Estimated time-to-market	2 years
Date of first sales	Consultancy service through the university (Nov 2009 - May 2010)
Date of first customer order	Nov 2009 (again, through the university and not through the spin-off)
Estimated date of first customer order	2 years (Mar 2013)

* When company actually initiated activity
** Self-assessed by the participant

4.2.2 Business Model Changes

Firm A's prediction, as stated in their February 2011 version of the business plan, is that the business model will evolve over time, initially focusing on grants, collaborations and bespoke development projects that will serve to build Firm A's products, its team and credibility in the industry. Once its core product has reached a state of maturity, repeat sales that require minimal R&D will become a significant source of revenue. In the longer term, these repeat sales will be licensed out to subcontractors who will use Firm A's technology to perform routine inspections. Firm A will continue to develop new technology moving it through this pipeline.

Table 4.2 and Table 4.3 show the evolution of the business model elements, funding and goals over the period comprised between April 2011 and April 2012. This case did not suffer many changes, when compared with other cases in the cohort. As mentioned in the previous section, the company's status is dormant, and the lead entrepreneur is half-committed (50%) to the spin-off project. Such facts may

justify the lower number of changes faced. The elements that suffered some alterations during the course of the interviews were the customer segments, revenue streams, key activities, funding and goals. Some of them might not be considered as business model changes, and such judgement will be left to the analysis section.

Table 4.2 Changes in Business Model Elements (CS to KR): Firm A

Interview Dates	Customer Segments	Value Proposition	Channels	Customer Relationships	Revenue Streams	Key Resources
Apr 2011	- Nuclear *- Power generation*	Small vehicles with sensors and software packages, aiming to: - Reduce costs - Improve quality - Improve safety	- Direct sales of the inspection service *- Direct sales of the device* *- Indirect sales through inspection companies*	Dedicated personal assistance (face-to-face, phone, email)	- Adhoc inspections [contract with Nuclear Lab] *- Sales of equipment* *- Engineering consultancy*	- Human resources (staff) - Equipment at the university
Jul 2011	- Nuclear *- Power generation* *- Oil & gas (petrochemi-cal)*					
Sep 2011						
Oct 2011						
Nov 2011						
Dec 2011						
Jan 2012					*(+)* *- Trying to secure another project*	
Feb 2012						
Mar 2012						
Apr 2012						

Intentions for the business model are represented in italic style

A new intended customer segment (petrochemical: oil and gas) was added in July 2011, as a consequence of getting interest from someone in this sector. In terms of revenue streams, in January 2011, Founder AA verbalized the firm's intention of securing an additional project with the national laboratory to bring in additional income.

Table 4.3 Changes in Business Model Elements (KA to Goals): Firm A

Interview Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
Apr 2011	- R&D (80%) - Customer relationships (speaking to people, 10%) - Grant applications (10%)	- University of Strathclyde - National Nuclear Laboratories (NNL) - Alba Ultrasound - Doosan Powersystems	- Personnel (90%) - Consuma-bles (10%)	- Grant funding	For the next 4 years: - 10 employees - Own offices - Steady revenue streams - Good products
Jul 2011	- R&D (90%) - Customer relationships (speaking to people, trying to bring in money, 10%)				Short-term goal: - Generating revenue - Generating first product (by the end of Dec 2011) Long-term goal: - Spin-out from university (to revisit)
Sep 2011					
Oct 2011	- R&D (85%) - Customer relationships (speaking to people, 10%) - Going after grants (5%)				
Nov 2011					
Dec 2011					Short-term goal: - Generating revenue - Generating a more representative demo by the end of 2011; Long-term goal: - Spin-out from university (to revisit)
Jan 2012					Short-term goal: - Generating revenue - Secure an additional project Long-term goal: - Spin-out from university (to revisit)
Feb 2012				Grant funding: - Got TSB (330k GBP) - RCERC (100k GBP, running 4 yrs)	
Mar 2012					
Apr 2012	- R&D (95%) - Customer relationships (5%)				

Intentions for the business model are represented in italic style

Key activities have been undergoing some adjustments throughout the interviewing period. In April 2011, Firm A's activities were R&D (80%), customer relationships (10%), and grant applications (10%). In July 2011, grant applications were dropped since Firm A got a new grant starting in the 1st of October. Therefore, they decided not to apply for additional funding, and re-focused their energy in developing the prototype. In October 2011, the team decided to go again after grants, and they successfully got additional grant funding in February 2012, which allowed them to drop again the grant application activity after that event. Firm A's goals have been quite volatile throughout the interviewing period. In April 2011, their goals were predominantly long term and focused on employee growth. As the founder started realising the required turnover to employ 10 people, in July he recalibrated his ambitions, and set shorter-term goals, such as developing the first product by December 2011 and generating some revenue. However, in December 2011, the founder A was still experiencing difficulties in developing the first product, and therefore reduced his ambitions to generating a more representative demo product. In January 2012, the representative demo was finally completed, and Founder AA set a new target of securing an additional project.

4.3 CASE B

4.3.1 Case Summary

Founder BA incorporated firm B in November 2007, soon after he had the business idea. He revealed that Firm B's incorporation might have been premature, and recalled that the first transaction of the company only occurred in January 2009.

> *"I setup two companies at the same time. (…) I mean, that was when we incorporated, that was when I had the idea. Possibly, the company could have been setup later. The first transaction on the account, when there was first money spent, (...) that would have been the right time to set the company up, and that day was January 2009. That was about a year later. (...) That's when things actually started happening. That's when we needed a company."*
> (First interview)

His background includes a bachelor degree in applied physics, and a masters degree in communications technology. Following that, he worked as a senior consultant at Oracle Corporation for more than 7 years, and there he managed a small time for about 5 years. Subsequently, he was awarded a 1-year enterprise fellowship to support the commercialisation of his business idea.

The business idea and research/product development coincided just before firm incorporation, around November 2007. Founder BA recalled the context of the initial idea:

> *"I just saw a problem, and then thought about a solution. [SC: What was this problem that you saw?] Lack of energy efficiency, appliances getting left on in rooms when there was nobody in the room."* (First interview)

The founder had also been realizing, for quite a long period, the emerging concern of people with saving energy. Such trend strengthened his belief on the new business idea. The most important resource to develop this opportunity was financial capital, as Founder BA recalls: *"Money, I think so. Without that, nothing was going to happen."* Founder BA quitted his job as a software engineer three years ago to develop the new product, which became recently available in prominent street and online retailers (e.g., Tesco).

> *"Product X has been developed primarily as a consumer product addressing needless energy waste in the home, so a release to the marketplace via the UK's leading retailer with such a strong online presence gives us the ideal springboard for it to become ubiquitous in homes across the country."* (Founder BA)

The founder of Firm B states that its product is more efficient than existing competing products, allowing higher energy savings.

> *"Current solutions on the market claim they can deliver up to £70 per year of energy savings, but we believe the Product X will comfortably exceed the amount of energy these products save. (...) It differs from rival products*

because it will be able to switch off fully-powered appliances when they are not in use, rather than just switch off those devices left on standby."

Founder BA, aged 37 years old, who has also had a career as a classroom teacher, secured funding to develop Product X via an enterprise fellowship. He also had research and development support from the university, which licenses the technology he developed to Firm B. A Professor from the department of electrical engineering at the university said:

"Founder BA and Firm B have combined engineering excellence with a real eye for design and business. (...) The staff in our department were delighted to work with Founder BA as he developed the technology and we are equally delighted at how the product and company are now progressing".

Firm B soon gained interest from prominent retailers, and has also been in sales negotiations with several leading hotel chains, additional retailers and distributors. Recently (about July 2012), Firm B signed a deal to distribute its product to hundreds of stores in the US. At about the same time, Founder BA revealed publicly his aspirations for the future of Firm B: *"I won't be happy until we are in a big office with 500 employees, but the company is expanding and we have had a lot of interest."*

Table 4.4 Characteristics and Properties of Case B (March 2011)

Generic information	
Position of the interviewee (spin-off)	CEO
Additional roles of the interviewee	n/a
Status of the company	Active
Original department / research institute	Electronic and Electrical Engineering Department
Industry	Consumer electronics
Specific domain	Energy efficiency
Business description	Firm B develops and designs consumer electronics for energy efficiency in the home and office; Provides low cost products for improved control of your electrical appliances; Lowers energy bills, CO2 emissions, and enhances safety.
Date of incorporation	November 2007

Date of normal operations *	January 2009
Company status (Mar 2011)	Active
Approximate date of initial research	2007
Approximate date of business idea	2007

Opportunity identification and development

Most critical resource for opportunity development	Financial capital ("money")
Source of basic technology and competence	University research
Context of the initial idea	Identified a problem (lack of energy efficiency, appliances getting left on in rooms when there was nobody in the room) and then thought of a solution.

Founding team

Number of founders	1
Roles of the founders (spin-off)	CEO (Founder BA)
Other roles (founders)	n/a
Year of birth (founders)	Founder BA (1974)
Background (founders)	Founder BA has a bachelor in applied physics, and a masters in communications technology; worked as a senior consultant for Oracle Corporation (almost 8 years); Enterprise Fellow for 1 year.
Number of other individuals involved	0
Role of the other individuals	n/a
Market knowledge (0-10)**	7
Market knowledge (years)	2 years
Managerial knowledge (0-10)**	7
Managerial knowledge (years)	5 years
Entrepreneurial knowledge (0-10)**	7
Entrepreneurial knowledge (years)	3 years
Entrepreneurial knowledge (nr of firms created)	2
Commitment of the founding team (%)	100%

Technology and market development

Major performer of technology development	Firm B
Other performers of technology development	Universities; Private industrial partners
Major roles in market development	Firm B (Founder BA)

Funding

Initial funding	Self-funding
Self-funding	Yes
Major source of funding	Public grants (enterprise fellowship)
Additional funding sources	Private investment (business angels), no venture capitalists yet

Company performance

Estimated time-to-market	Already in the market (took 3 years to get to market)
Date of first sales	23rd March 2011

Date of first customer order	23rd March 2011
Estimated date of first customer order	n/a

* When company actually initiated activity

** Self-assessed by the participant

4.3.2 Business Model Changes

Firm B experienced a substantial number of events with direct implications in its business model. As shown in Table 4.5, some changes occurred in the customer segment element: the introduction of street retailers (July 2011), and officially signing up a contract with a distributor (April 2012). Other changes occurred at the intentional level, such as removing the utilities companies, changing priorities, and the introduction of the public sector (January 2012). The value proposition underwent a few enhancements, and the introduction of product variations (October 2011). The channels experienced also some changes, both at the real and intentional level. Direct sales at shopping centres were experimented, though with limited success, and later direct sales through TV shopping was introduced (April 2012). Customer relationships and revenue streams were among the most stable elements in Firm B's business model, with the introduction of a CRM system (September 2011), and with the introduction of consultancy as a desired additional revenue stream.

Table 4.5 Changes in Business Model Elements (CS to KR): Firm B

Interview Dates	Customer Segments	Value Proposition	Channels	Customer Relation-ships	Revenue Streams	Key Resources
May 2011	- Retailers (web) *- Retailers (street)* *- Distribu-tors* *- Utilities* *- Companies (B2B)* *- Consumer (B2C)*	Reduced utility bills; Enhance green credentials; Reduced risk of electrical fire; Stylish gadget; Improved convenience - one touch control.	Commun-ication: - Newspapers, magazines, website, social networks, etc. Sales: - Indirect (retailers) *Sales: - Indirect (retailers and distributors); - Direct (web and sales force)*	- Personal assistance (face-to-face, phone, email, online) - Automated and self-service (website, forums and blogs)	- Product sales *- Licensing*	- Technical capability - IP - Manage-ment team - product road map - Directors and Sharehol-ders - Sales team

Jul 2011	- Retailers (street) (top) - Retailers (web) *- Utilities* *- Companies (B2B)* *- Consumer (B2C)*	Reliable supplier; Ease of use: 'set and forget' (simplicity); Money saving; Safety; Green.	*Priorities changed slightly between distributors and online distributors*.			(priorities changed)
Sep 2011	(changed priorities)		(+) Sales: - Direct (shopping centres) (priorities changed)	(note) added CRM System		
Oct 2011		(+) Product variations (family and solo pack, individual socket)				
Jan 2012	*(+) Public sector*		(-) Sales: - Direct (shopping centres off)			(+) - New director - New sales man
Feb 2012	- Retailers (web and street) *- Distributors* *- Companies (B2B)* *- Consumer (B2C)*				- Product sales *- Consultancy* *- Licensing*	(+) - PR and marketing manager
Mar 2012		*(+)* *- Looking for additional products abroad to increase product range*				*(+) - Intend to recruit electronic engineer* *- New premises (May 2012)*
Apr 2012	- Retailers (web and street) - Distributor (signed up) *- Companies (B2B)* *- Consumer (B2C)*		(+) Sales: - Indirect (signed up with distributor; TV Shopping)			*(+) - Intend to recruit internet technical resource*

Intentions for the business model are represented in italic style

Key activities was the element more affected throughout the interviewing period (see Table 4.6). Several new activities were added at each interviewing point, and investment activity was deleted in October 2011, since Firm B got a positive agreement from angel investors. Key partners have also changed throughout the

tracking period, such as the removal of the retail order fulfilment specialists, and the addition of a distributor.

Table 4.6 Changes in Business Model Elements (KA to Goals): Firm B

Interview Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
May 2011	- Product development - Supply cost reduction - Build strong team - Develop key partnerships - Managing out-sourced activities - Certifications - Marketing campaign - Investment	- U. of Strathclyde - Retailers - Retail order fulfilment specialists (e.g. DeeSet) - Turnkey manufacturer - Key Global distributors	- Cost of sale - Staff - Consultancy - Admin overheads	- Sweat equity	- Sell 10,000 (May 2013) - Orders from 3 of the top 6 Utilities (October 2011) - Orders from 3 of the top UK retailers (September 2011) - Orders from 7 online distributors
Jul 2011	(+) - Starting to develop the out-licensing (speaking to different manufacturers) - Sales and marketing plan (top priority)	*(+) - Endorsements (e.g. Energy Saving Trust)*		- Loans	
Sep 2011	(+) - Progress sales pipeline (CRM system)	(-) - Retail order fulfilment specialists			
Oct 2011	(-) - Investment	*(+) - Manufacturer to partner (Filex)*			Didn't achieve all goals described on May 2011
Jan 2012	(+) - Packaging design - Compliance - Web design		- Cost of sale - Staff - Consultancy - Compliance	- Loans - Angel invest-ment	- Send 20,000 units by Dec 2012 (retailers) - Develop another product by Aug 2012
Feb 2012	(+) - PR and marketing - Finding new premises - Generating new IP		(+) - PR and Marketing		(+) - Generate new IP
Mar 2012	(+) - John Lewis merchandising - Gadget show		*(+) - New premises*		
Apr 2012	(+) - Grant funding applications - Sourcing alternative manufacturer - Supporting customers	(+) - Widget (distributor) *- Home automation hub*		*(+) Grant funding (apply-ing)*	- Reduce cost of manufacture (target 40% margin) - Find products to increase product range

Intentions for the business model are represented in italic style

At the intentional level, there were also some transformations: Firm B looks forward to establishing partnerships with endorsements (due to regulatory

requirements), a suitable manufacturer (that allows them to reduce production costs, thus improving margins), and home automation hub, since this organization is developing a product that has good fit with Firm B's technology roadmap. The cost structure also endured some changes, namely the introduction of compliance costs (January 2012) and public relations and marketing costs (February 2012), as well the intention to move to new premises (March 2012). In terms of funding, changes have been substantial during the 12-month period. It started with sweat equity and a small amount of self-funding, and then contracted loans in July 2011. Angel investment was brought in January 2012, and Firm B started developing intentions towards getting grant funding and started submitting applications for that purpose (April 2012). Concerning goals, Firm B did not achieve all goals stated in May 2011. Therefore, in January 2012 a new set of goals was established. In February 2012, Firm B set up the new goal of generating additional IP, and after two months, to reduce the cost of manufacturing and find new products to increase the product range (April 2012).

4.4 CASE C

4.4.1 Case Summary

The initial research that led to Firm C's formation started in about 2001, at an industry-facing research institute specialized in photonics, within a university in the UK, as Founder CA claims: *"There is almost 10 years of research, 10 years of continued research into the LED technology within the institute."* The research team was led by a professor from that university, and by 2005/2006 they were involved in a proof of concept fund, to evaluate the technology and its potential for commercialisation. The mentioned professor later handed over this project, and continued to exercise his main professional activity as an academic. Therefore, the academic continued his involvement with the company in a support role, reducing his interference in business decisions.

Founder CA contacted the research institute by August 2009, because he became more aware of the LED. Just prior to that, he was looking at other technologies, such as solar cells and photovoltaics.

> *"So, you look at new exciting technologies and you look at market areas. And growing market areas were renewable energy, and the movement towards more efficient green technology, of which LEDs are seen to be one of them. There's a huge amount of investment going in there. So, I became aware of what the institute was doing in microLED, and it was only at that time that I started to understand more about how we could differentiate the capability to what was there."* (First interview)

Through the help of the technology transfer office, Founder CA became more intimate with the staff at the institute and with this specific project. He recalls the words of the business development planner from the research institute:

> *"He [business development planner] then said: "Oh, there's a scheme which is part European funded and locally funded where you can become a CEO Designate, where you can place yourself for 6 months within the university." And then there was 6 months, you can get a better understanding of the technology and form a business plan."* (First interview)

According to Founder CA, the people at the research institute had long realized that there was an opportunity in this area.

> *"They had know-how, they had IP, they had a core patent. So, there was a belief that there was a company to be formed. Now, one of the issues I faced when I came in to the university was trying to think about how you can take the technology and form a business through it. And in some way, the people at the technology transfer office were fantastic. (...) It was through them, backing me to do the CEO Designate, that all the block started following into place."* (First interview)

The founder CA was then brought into the project through the CEO Designate program. Therefore, he came from "the outside" to develop the business

opportunity. He then took around 6 months to look at the opportunity and related markets, and to actually form the business plan. Founder CA registered the company in November 2009, and he was the only founder. He maintained some of the academics as consultants, for some equity in the company. He recalls the challenges of attracting funding, and how his knowledge of the markets evolved.

> *"To get the funding took a lot longer, because I had to persuade investors that there was a real opportunity here. (...) I could see the bigger market opportunity in August 2009, but it really wasn't until I started about December 2009 that I identified specific areas where I thought the micro LEDs themselves would have a market edge, you know, that we could do things different to what other people had."* (First interview)

In the past, Founder CA had been involved in other technology commercialization projects. He was involved in a company in which the management team raised £ 11 Million, and then sold the company for £ 100 Million.

> *"My first company, we raised 11 Million pounds, and then we got 100 Million pounds for that company. (...) As I said, I was involved with the early funding of that, but the later funding I become more of a technology manager, rather than involved with the growth of the company. And then subsequently, I got involved with other ones [companies], which I started too."* (First interview)

Though Firm C was incorporated back in November 2009, it only started trading in July 2010, as the founder remembers:

> *"There's two things: you incorporate a company, but there's when you start trading as a company. (...) So, November 2009 is when we went to Companies House and we formed Firm C Limited. But it wasn't until July [2010] where we got our funding, and then started trading. (...) I wasn't taking any salary... I was doing everything through 'sweat equity' at that point to form the company."* (First interview)

Firm C maintains a close interaction with the initial research institute, which provides a beneficial symbiosis for both entities:

> *"They [research institute] do the research, and it's up to us [Firm C] to look at the development and new product introduction. So, there's a good fit. And the company itself is not sinking a lot of resource into research. What we are doing is, we are taking the fruits from that research, and trying to make it in a more routine, standard basis. And that's very helpful, actually, because we're a small company."* (First interview)

Technology development is done in collaboration with the institute and with two other universities, one in the UK and another in the US. Customers are also an important actor in product development, since they provide valuable feedback when testing demonstrator units. In addition, customers also provide market information to Firm C.

> *"I took a decision from early on, that we would try and get devices to customers as soon as we could, so that they can then provide feedback. (...) And what I also insist is that they provide more information on their market opportunity, and they provide market data to us. (...) They give us market intelligence, much better market intelligence than we could ever harvest as a small company."* (First interview)

However, the major actor in market development is the founder himself. He scans the markets for new applications, he disseminates Firm C's business activity, and he also deals with requests from interested parties.

> *"It's me doing business development. (...) I've got the strategy of looking at specific applications, thinking yeah, the platform could work with new applications. (...) I do articles in industry magazines or trade magazines, every two to three months. People will read the articles, and then they will come to us. (...) We've had about 50 enquiries in our first month of business... 50 different companies contacted us about our capabilities."* (First interview)

According to the founder, these contacts came from articles published, from academics giving presentations, and also from their website. Firm C sold its first bespoke demonstrator kit in October 2010, and expected to have a commercial product ready for large scale production in about month 25 (i.e., August 2012).

Table 4.7 Characteristics and Properties of Case C (March 2011)

Generic information	
Position of the interviewee (spin-off)	CEO
Additional roles of the interviewee	No additional roles
Original department / research institute	Research institute on applied photonics
Industry	Semiconductors
Specific domain	LEDs (Light Emitting Diodes)
Business description	Firm C provides unique systems suitable for a wide range of evolving market applications. It specialises in microLED technology to create a range of industry leading, high brightness micro-display platform solutions. Firm C's approach is designed to help system integrators to develop prototype and production units for industrial, medical and commercial purposes.
Date of incorporation	November 2009
Date of normal operations *	July 2010
Company status (Mar 2011)	Active
Approximate date of initial research	2001
Approximate date of business idea	2005/2006
Opportunity identification and development	
Most critical resource for opportunity development	Availability of capital (financial)
Source of basic technology and competence	University research
Context of the initial idea	The Founder was looking at new technologies and market areas. He became aware of the research conducted by the institute, and contacted them in August 2009. Through the help of the technology transfer office, Founder CA became more intimate with the staff at the institute, and decided to form a spin-off to commercialize institute's technology.
Founding team	
Number of founders	1
Roles of the founders (spin-off)	CEO (Founder CA)
Other roles (founders)	No additional roles
Year of birth (founders)	Founder CA (1969)

Background (founders)	Founder CA has been involved with high-tech start-up ventures for over a decade. He has held a variety of commercial and technical positions at companies such as Alcatel and Avanex. Founder CA has more than 40 technical publications and filed ten patents. He has a BEng (Hons) and a PhD from a UK University.
Number of other individuals involved	1
Role of the other individuals	Senior process engineer
Market knowledge (0-10)**	6
Market knowledge (years)	2 years
Managerial knowledge (0-10)**	6
Managerial knowledge (years)	13 years
Entrepreneurial knowledge (0-10)**	6
Entrepreneurial knowledge (years)	13 years
Entrepreneurial knowledge (nr of firms created)	3
Commitment of the founding team (%)	100%
Technology and market development	
Major performer of technology development	Founder; Academic consultants
Other performers of technology development	Major customers
Major roles in market development	Founder; Referrals from academic consultants
Funding	
Initial funding	Sweat equity plus small sum from CEO Designate scheme
Self-funding	Sweat equity
Major source of funding	Business angel funding, and government funds (match funding)
Additional funding sources	Early sales of bespoke systems ahead of forecast (since month 3)
Company performance	
Estimated time-to-market	Month 25 (for volume sales)
Date of first sales	October 2010
Date of first customer order	September 2010
Estimated date of first customer order	n/a

* When the company effectively started trading (e.g. first transaction, got funding - not necessarily sales)
** Self-assessed by the participant

4.4.2 Business Model Changes

According to Firm C's CEO, the changes that occur in certain business model elements have an impact in other elements. Hence, the CEO instinctively emphasizes the systemic nature of the business model.

> *"Everything is flooding from this to go over this, and that's having an impact on the others [elements]. Because you're finding more markets, you've now got different customers. So, you obviously get different customer relationships, different potential channels with them. We try to pull the activity as such as what we are making can go across different sectors. (...) And then what we're doing is we are trying to identify people who could become key partners."* (Month 0)

He also acknowledges that most changes have been driven by their wish for investment. Such wish or need has also influenced their strategic choices, in the sense that they want to convey a coherent proposition for potential investors, as the CEO later explains:

> *"Our strategy has changed hugely. So, we are going to be an embedded pico-projector company. But we're branding ourselves under the technology, rather than the markets. So that, when it comes to our investment proposition, our investors will see a consistent platform technology, and not get over the concern because we're talking about different markets."* (Month 8)

As Table 4.8 displays, the real customer segments in May 2011 were image capture and medical sector. These customer segments did not undergo any changes throughout the interviewing period. However, a considerable number of changes occurred at the intentional layer. High brightness micro display and backplane lighting markets were added to their target customer segments in January 2012, followed by OEM suppliers of mobile phone manufacturers in February 2012. The value proposition has equally suffered some adjustments. Firstly, Firm C developed an intention to increase IP, though it was restricted by insufficient funding (June 2011). Such intention was materialized into reality in November 2011, when the CEO claims to be filing patents, and effectively doing basic research in order to

increase efficiency of devices. In January 2012, Firm C asserts to be developing a family of products, with different generations. In terms of channels, changes happened at the intentional level: the firm intends to establish additional channels for their strategic markets, including suppliers of mobile phone manufacturers. The revenue stream element was quite stable during the interviewing period, contrasting with key resources, which underwent a considerable number of additions. New engineers joined at different points in time, new non-executive directors were appointed, financial and technical advisors were brought in, and a part-time CFO was recruited. In May 2012, Firm C intended to add to its team an engineering manager and a project manager.

Table 4.8 Changes in Business Model Elements (CS to KR): Firm C

Inter-view Dates	Customer Segments	Value Proposition	Channels	Customer Relation-ships	Revenue Streams	Key Resources
May 2011	- Image Capture - Medical (neurological) *- Semiconductor processing* *- Defense*	- Unique product offering to the market - A microdisplay, a high brightness pico projector - Intellectual capital from Strathclyde + IP	Communica-tion: - Website - Publications in specialized press (chip press) Direct sales: - Website - People having pain/problems (that contact mLED)	- Dedica-ted personal assistance (face-to-face, phone, email)	- Fee for develop-ment of customized product / solution *- Revenue from monochro-matic*	- Engineering team and non-exec direc. - Know-how and IP (Stratchlyde U.) - Local resources (e.g. specialized companies) - Financial capital (investment and grant funding) - Advisors (e.g. Chairman)
Jun 2011		*(+) Intending to increase IP, but constrained by funding*				(+) - New engineer joined - Financial + technology advisors (for angel/VC investment)
Jul 2011						
Nov 2011		(+) - IP intense (filing patents) - Basic research, leading to higher efficient devices				(+) - Another engineer - Appointed non-exec director (experience in startups)

Jan 2012	Tactical markets (next 2 years): - Image capture - Medical *- Semiconductor processing* *- Defense* *Strategic markets:* *- High brightness micro display* *- Backplane lighting*	(+) Developing family of products, with different generations	*(+)* *- Additional channels for Strategic Markets (distributors, etc.)*	*- Revenue from embedded pic-projector*	(+) - Appointed a second non-exec director (very senior professional who has been CEO of a big company)
Feb 2012	*(+) - OEM (suppliers of mobile phone manufacturers)*		*(+) Direct, B2B sales (suppliers of mobile phone manufacturers)*		
Mar 2012					(+) - Recruited a designate CFO (part-time)
May 2012					*(+) - Intending to recruit 2 more people (engineering manager and project manager)*

Intentions for the business model are represented in italic style

Table 4.9 shows the chronological sequence of key events related to key activities, key partners, cost structure, funding, and goals. In June 2011, investment was added as a key activity involving almost a third of the company's efforts. The subsequent changes concerned only variations in the resources (e.g., time) allocated to each of these three activities. In terms of key partners, three new partnerships became effective in November 2011. The remaining changes occurred at the intentional level: intention to partner with potential outsourcer to scale up production, and intention to partner with a big company in the mobile phone market, to get closer to and more involved with the supply chain of mobile phone manufacturers. The cost structure has been changing continuously, but more in terms of the relative weight of the different types of costs. However, new classes of costs were introduced, namely IP costs and investment overhead. Regarding funding, a few events occurred. In June 2011, the CEO stated that they were intending to get extra investment from angels or venture capitalists. Throughout the interviewing

period, new grants were achieved, at different points in time: grant with partners (November 2011), grant funding from a government agency (February 2012), and a prestigious award from an UK innovation agency (May 2012). At this point in time, the CEO disclosed that they were soon intending to receive a funding ground of £ 250 K. Firm C has also been quite active in changing their goals, which appear to be getting increasingly ambitious. In May 2011, the CEO was aiming to grow the business to 20 people in 3 years, whereas by March 2012 he was intending to grow to 49 employees. Raising additional investment, and extending the technology and product reach to bigger markets are goals that were added throughout the interviewing period. These goals are somehow related: as they aim for bigger markets, they need more people, and thus more investment; and to get more investment, their business plan has to appeal to investors.

> *"We're going for a bigger market. We're going for a much bigger opportunity, and need to do more development. So, we need to bring in more people (...). [And] we need to make it more exciting for the investors. It's part of the investment, but it's also to have a beacon for the company, an ambition for the company to be as successful as it can be."* (Month 10)

Table 4.9 Changes in Business Model Elements (KA to Goals): Firm C

Inter-view Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
May 2011	- Technology development (70%) - Market development (30%)	- Institute of Photonics - Technical advisory council (e.g. World Luminaries and Science) - Investors - Universities (Edinburgh, Stanford)	- Human Resources (40%) - R & D (40%) - Cost of goods (20%)	- Grants	To be commercially successful: - Trading internationally - Deliver to market - Demonstrate ability to deliver at cost - Grow the business to 20 people in 3 years - Plus financial indicators, i.e. turnover expectation, market penetration in 5 years (business plan)

Jun 2011	- Technology development (50%) - Market development (20%) - Investment (30%)		- Human Resources (55%) - R & D (35%) - Cost of goods (10%)	- Grants - *Angel / VC funding*	
Jul2011	- Technology development (45%) - Market development (5%) - Investment (50%)		- Human resources (55%) - R & D (25%) - Cost of goods, overheads (20%)		(+) - Raise additional investment by the end of the year [2011] for next phase
Nov 2011	- Technology development (40%) - Market development (5%) - Investment (55%)	(+) - VTT, IMEC and VUB (international government labs)	- Human resources (55%) - R & D (20%) - IP costs (20%) - Cost of goods, overheads (5%)	(+) - Additional grants with new partners	(+) - To extend the technology and product reach to sectors bigger than 5 billion dollars per annun
Jan 2012	- Technology development (40%) - Market development (10%) - Investment (50%)	*(+) - Intending to establish potential outsourcing partner*	- Human resources (40%) - Investment overhead (30%) - IP (15%) - R & D (10%) - Cost of goods (5%)		
Feb 2012			- Human resources (40%) - Investment overhead (30%) - IP (15%) - R & D (15%)	(+) - Additional grant funding from SE	(+) - Grow the business to 30 people in 3 years - Raise 2.4 million of funding this year [2012]
Mar 2012			- Human resources (40%) - Investment overhead (30%) - IP (5%) - R & D (25%)		- Revenue target 41 million pounds year 5 - Grow to 49 people - Raise 2.2 million (for series A) - Further raise of 5 million (for series B)
May 2012	- Investment (50%) - Technology development (45%) - Market development (5%)	*(+) - Intending to partner with a big company in the mobile phone market*	- Human resources (40%) - Investment overhead (20%) - IP (5%) - R & D (35%)	(+) - Additional grant funding (TSB) *- Intending to have interim funding round of 250k GBP [Jun 2012]*	

Intentions for the business model are represented in italic style

4.5 CASE D

4.5.1 Case Summary

Firm D develops antimicrobial products based on its patented technology for treatment and prevention of infection and bacterial contamination in medicine, food

safety, environmental sanitation and many other areas. The firm was incorporated in February 2010, *"but it was funded on the 23rd of Dec 2010, so we had outside investment at that point. Until then it was a company, but with no funds, it wasn't doing anything."* (Founder DA, first interview).

The initial technological idea emerged around 1993, coming out of a completely different project.

> *"The idea was about 93, the idea of the technology. The idea of making the company is much later. (...) The actual concept came out of a completely different project, which is so secret. (...) It went on the university for about 10 years, putting a lot of money into the university, 2 Million pounds. There were multiple centres throughout the world: the USA, Norway, England. So, at the end of the project, the idea reverted, and at that point, we thought we would test it, which is where this started."* (First interview)

According to Founder DA, it *"was a technology which was obviously applied. It was not great science, it was to make money."* The initial idea was to license the generic concept to people with expertise in various fields. In fact, they were approached by an external firm, which licensed the technology for several years. However, that avenue had some limited success. The licensee changed what they wanted to do, and eventually gave up.

> *"The clinical people have been trying to get money... Spinout was the only realistic option for the university and myself to get the technology out. So, that was really my decision to make a spinout company, so it came about quite late in the process. But it was plan C, not what we wanted to happen."* (First interview)

Therefore, the idea to form the company came later, in 2009. At that time, Founder DA and current CSO of Firm D, was struggling to get funding, and was, in collaboration with the university, looking for CEOs to form the spin-off company. He contacted a management company specialized in starting up small biotech businesses, and by the end of 2009, he managed to get a credible team together.

"I contracted a management company. (...) What that company does is to manage start-up biotech companies, they get them started. (...) [SC: But formally, are they founders of the company?] Yes, X Business Partners own shares. I own some shares, the university owns some shares, and obviously now, the investors own shares. But at the foundation there were essentially three: the university, myself, and X Business Partners. But we now have investors." (First interview)

The founding team was composed of three elements: one academic (Founder DA, the current CSO of the company), and two non-academics (professional managers). The most critical resource to develop the opportunity further was the CEO, as Founder DA recalls: *"You need a CEO who knows the technology sector, understands what the science is, and knows investors."* The source of technology and competence was the patent and the research expertise of the department, and the expertise and initiative of the Founder DA. He recalls the importance of bringing in a management team, especially in a situation where the scientists have limited knowledge of the markets:

"I'm not a business person. And, although I know quite a bit about it, I have limited market experience. And the reason we brought in the managerial team is because they have extensive market experience in the sector, which is extremely valuable, including bacteria phage technology, which is extremely rare. And they have general business experience of managing small companies, in this market sector." (First interview)

Prior to the spin-off formation, the technology was developed with the support of a research fund, and a proof of concept government fund. At the time of spin-off formation, there was no funding available. Funding came after a few months, in December 2010, with half of the investment from a venture capital company and the other half from government match funding.

Founder DA believes it will take around 2 years to have a product ready to commercialise, since product development is done in collaboration with partners.

"It's probably going to be about 2 years till there is a product. The reason for this is that the business model is a co-development one with partners with existing products. So, I think it will take about a year to get a research partner, 2 years to develop the initial product, and get the licensing agreement, get all the bits in place. (...) I guess that at that, it's about another year of development to integrate our technology with their existing products." (First interview)

Hence, Firm D did not make any sales yet. In fact, in the short term, Firm D intends to collect revenue streams from licensing the technology, rather than selling products.

"A sale will actually be a license, not a true sale, because we're not been making anything, at least in the foreseeable future. (...) We're not making products. We're licensing a technology, and co-developing it to a product. The product will be a partner's product, not our product. (...) At least at the first instance, till we've got lots of money. Then we can start in various sectors making our own products, but at the moment there is no way." (First interview)

Table 4.10 Characteristics and Properties of Case D (March 2011)

Generic information	
Position of the interviewee (spin-off)	CSO (Chief Scientific Officer)
Additional roles of the interviewee	Honorary Lecturer at the pharmacy department
Original department / research institute	Institute of Pharmacy and Biomedical Sciences (Faculty of Science)
Industry	Biotechnology
Specific domain	Bacteria phage sector
Business description	Firm D develops antimicrobial products based on its patented technology for treatment and prevention of infection and bacterial contamination in medicine, food safety, environmental sanitation and many other areas.
Date of incorporation	February 2010
Date of normal operations *	December 2010 (got investment)
Company status (Mar 2011)	Active
Approximate date of initial research	1993

Approximate date of business idea	2009
Opportunity identification and development	
Most critical resource for opportunity development	CEO who knows the sector, the science and investors
Source of basic technology and competence	Patent and the university research expertise
Context of the initial idea	The business idea emerged from research carried out since 1993. The initial idea was to license the technology, but such initiative had limited success. In 2009, the leading scientist decided to form a spin-off company.
Founding team	
Number of founders	3
Roles of the founders (spin-off)	CSO (Founder DA, academic); 2 professional managers (non-academics)
Other roles (founders)	Research scientist in the university (Founder DA); Director in companies (Founder DB and CEO); Business manager (Founder DC, CFO)
Year of birth (founders)	Founder DA (1942); Founder DB (1960); Founder DC (1943)
Background (founders)	Research scientist and former lecturer in pharmacy and biosciences (Founder DA, CSO); Director of companies, holds PhD and MBA (Founder DB, CEO); Financial director in 9 companies, and still active in 5 of them (Founder DC, CFO)
Number of other individuals involved	0
Role of the other individuals	n/a
Market knowledge (0-10)**	10
Market knowledge (years)	10 years (Founder DA); 20 years (Founder DB); 20 years (Founder DC)
Managerial knowledge (0-10)**	9
Managerial knowledge (years)	10 years (Founder DB); 10 years (Founder DC)
Entrepreneurial knowledge (0-10)**	9
Entrepreneurial knowledge (years)	10 years (Founder DB); 10 years (Founder DC)
Entrepreneurial knowledge (nr of firms created)	9
Commitment of the founding team (%)	100% (CSO); 100% (CEO); 25% (CFO)
Technology and market development	
Major performer of technology development	CSO (Founder DA)
Other performers of technology development	Senior scientist and other contract researchers
Major roles in market development	CEO (Founder DB)
Funding	
Initial funding	Research fund and government fund (to develop the technology). At the time of spin-off, no funding.
Self-funding	No
Major source of funding	Venture capital (50%) and government match funding (50%)
Additional funding sources	No

Company performance	
Estimated time-to-market	"2 years from now" (read: March 2013)
Date of first sales	n/a
Date of first customer order	n/a
Estimated date of first customer order	"2 years from now" (read: March 2013)

* When the company effectively started trading (e.g., first transaction, got funding - not necessarily sales)
** Self-assessed by the participant

4.5.2 Business Model Changes

> *"We were well aware there were a huge number of segments, this is a generic technology we've got, and it applies to a vast number of segments. You can do human medicine, dental, animal medicine, plants, you can go in to decontamination, etc., anywhere where antibacterial activity is valuable. What we are trying to avoid is having so many applications. It is the danger. So, you got to focus on one opportunity, but in fact there are a large number of other opportunities."* (CSO, Month 0)

The statement above was verbalized by the CSO of Firm D, right at the beginning of the 12-month interviewing period. It clearly demonstrates the struggle to maintain a narrow focus in face of a generic technology with a multiplicity of potential applications. Although the CSO firmly argues that it is necessary to focus on one opportunity only, the evolution of the customer segment element illustrates how difficult is to be faithful to this principle. As Table 4.11 shows, Firm D's only intended customer segment was advanced wound dressing companies (May 2011). As Firm D had not performed any sales until that moment, customer segments were nothing but intentions for future transactions. In June 2011, the CSO revealed that a new target customer segment was added to the list: antimicrobial therapy companies. After three months, four more customer segments were added: oil & gas, packaging, food safety, and water quality. By December 2011, Firm D performs its first actual "sale": a collaborative development contract with a company in the chemical industry, which therefore becomes a "real" customer segment. At the intentional level, Firm D adds defence industry as a new customer segment. In February 2012,

the company decides to target also two new customer segments: food hygiene and food wrapping.

Table 4.11 Changes in Business Model Elements (CS to KR): Firm D

Inter-view Dates	Customer Segments	Value Proposition	Channels	Customer Relation-ships	Revenue Streams	Key Resources
May 2011	*- Advanced wound dressing companies*	- Immobilized Bacteria Phages that antibacterial properties to surfaces, targeting specific bacteria. - Enhance the value of customers' existing products	Communica-tion: website, press releases and other media Direct sales: - Approached by companies (mainly) - Firm D approaches pot. customers	- Dedi-cated personal assistance (face-to-face, phone, email) - Co-creation of products	*- Royalties from licensing* *- Collaborative development (research contracts)* *- Selling Firm D to big company (e.g. J&J)*	- Knowled-geable people (expertise) - IP
Jun 2011	*(+) - Antimicrobial therapy companies*	*(+) - Enable the creation of novel products (secondary, longer term offering)*				(+) - Appointed another senior scientist *- New lab in July*
Jul 2011						(+) - New lab
Sep 2011	*(+) - Oil & gas* *- Packaging* *- Food safety* *- Water quality*					(+) - Another employee - 2 consultants
Oct 2011	No changes					
Nov 2011	No changes					
Dec 2011	(+) - Chemical industry *- Defence industry applications*				- Collaborative development (realized, got 1st contract) *- Royalties from licensing* *- Selling Firm D to big company (e.g. J&J)*	
Jan 2012	No changes					
Feb 2012	*(+) - Food hygiene* *- Food wrapping*					(+) - Added 3 consultants (total 5 consultants)
Mar 2012						(note) Filed another 3 patents (5 or 6 total now)

May 2012	Note: 2nd development contract (providing test samples another chemical manufacturer)

Intentions for business model are represented in italic style

Throughout the whole year, the value proposition was fairly stable. However, a subtle intentional change was revealed: rather than just enhancing the value of customers' existing products, Firm D also intends, as a longer term aspiration, to enable the creation of novel products. Channels and customer relationships did not suffer any change throughout the interviewing period. In opposition, revenue streams and key resources were enduring a more considerable transformation. In May 2011, Firm D intended to collect revenues either from royalties (licensing) and research contracts (collaborative development), or from a single transaction, i.e., selling the firm to a big pharma company. The research contracts revenue stream became effective in December 2011, when Firm D signed a collaborative development contract with a customer in the chemical industry. By May 2012, the firm succeeded to sign one more collaborative research contract with a new customer in the chemical sector.

Firm D classified its key resources in May 2011 as knowledgeable people (expertise) and intellectual property (IP). In the following month, another senior scientist was appointed, and the intention of moving to a new lab was revealed. The new lab became effective in July 2011. Between July and September, another employee and two consultants were added to the team, due to the necessity of bringing more expertise to the company. Again in terms of human resources, three more consultants were added around February 2012. In terms of intellectual property, Firm D filed three additional patents in March 2012.

Table 4.12 shows the events related to the elements ranging from key activities to goals. The key activities of Firm D were, in May 2011: 1) marketing, sales and public relations (80%); and 2) research lab work and developing new ways

of applying the generic technology (20%). These activities remained fairly the same throughout the interviewing period.

Table 4.12 Changes in Business Model Elements (KA to Goals): Firm D

Interview Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
May 2011	- Marketing, sales, public relations (80%) - Research lab work and developing new ways of applying the generic technology (20%)	- Customers (co-developing the technology) - Partners for co-development of polymers - Partners for co-development of corona discharge	- Salaries (60%) - Laboratories (25%) - IP costs (15%)	- Private equity (37.5%) - Match funding (37.5%) - Grants (25%)	- Get signed contract (significant one, around 1 Million GBP) by the end of the year [2011] - Enter into negotiations with at least one or two other major players
Jun 2011		(+) - Academic partner for antimicrobial therapeutic development			
Jul 2011				(+) - Additional grant funding to create new technology	
Sep 2011					
Oct 2011	No changes				
Nov 2011	No changes				
Dec 2011					(+) - Instead of end 2011, the goal is now updated to 1st half of 2012
Jan 2012					
Feb 2012					
Mar 2012				(+) - Additional private funding (completing negotiations on 2nd round of equity funding)	
May 2012					

Intentions for the business model are represented in italic style

To the existing partners as of May 2011, a new key partner was added in June 2011: academic partner for antimicrobial therapeutic development. Besides that

event, no new partners were added to the business model, nor did the interviewee reveal any intention in attracting additional partners. The cost structure suffered no changes during the 1-year period. In terms of funding, their main sources in May 2011 were private equity (37.5%), funding from a government agency to match the previous investors (37.5%), and grants (25%). In July 2011, Firm D was awarded an additional grant to create a new technology, and in March 2012 they completed negotiations on a second round of equity funding. The only change that occurred in Firm D's goals was an update in their target date: instead of aiming for a significant contract (above £ 1 Million) by the end of 2011, that deadline moved to the first half of 2012.

4.6 CASE E

4.6.1 Case Summary

Firm E is a biopharmaceutical company established in 2009 to develop a completely new class of anti-infective medicines. The founding team has prior experience in both pharma and biotech sectors, and is focused initially in the development of small molecules with specific antibacterial effects against resistant bacteria. The initial idea emerged around 2007, at an informal meeting in a local pub in the Netherlands, as Founder EA and current Chief Business Officer (CBO) recalls: *"A beer, I and Founder EB. That's what it was. It was a glass of Beck's beer in Heidelberg, that's exactly when it started."* In that same day, Founder EB asked the future CBO whether he wanted to start a company together, motivated by past experience and from the desire to start up a new business properly and from scratch.

> *"Founder EB said: "I want to start a company. Do you want to work with me?" I said: "Yes, absolutely." So, that was the very beginning of our endeavours. (...) That would be probably June 2007. (...) Quite simply, Founder EB felt, and I agreed, that we both had sufficient experience in big companies, and subsequently in biotech, to know what was best practice, what was the best way to do things. And he said he'd learned a lot from there, and he wanted, before he retired, to do it properly and well himself. And I*

said: "I absolutely share the same opinion, what shall we do?" So, we wanted to try to put our experience into a very focused company, trying to match what he did best and what I did best." (First interview)

Following this decision of working together, they started looking for partners and technologies on their own.

"We turned on the radar and we said: "Right, we got to find something that's exciting, let's look." And I think we must have looked to something like 100 different potential partners and technologies. (...) And we did that on our own money (...), what you call sweat equity." (First interview)

Originally, they were looking to start a company with two oncology programs and one infectious diseases program, but they needed to raise about £11 Million, which was difficult given the economic context. When they started their due diligence for other potential technologies, they soon discovered the work of a Professor from a chemistry department at a university in the UK.

"When I saw it, I was particularly interested, because I knew the people a long time ago, and also I recognised that it was probably the best thing that we could put our effort behind. So, we took a license to the technology from the university. (...) The university were happy to do this, because we told them what we were going to do, and we paid a modest upfront fee, and we undertook to raise the cash, because as you can imagine, there's a chicken and egg here, Sergio. Unless we had the license, no investor would come with us. (...) So, we got it. And then we managed to raise the appropriate funding with a big angel group in the UK. So, we then formed Firm E in July 2009. So, technically this was not something the university did. We met the university, we liked the technology, and we took a license." (First interview)

The opportunity is also related to the difficulty of the university in performing product development, which allowed Firm E to provide this complementary capability.

"Academia is excellent at research. But when it comes to development, which involves animal testing and then human testing, clinical testing, that's not something universities are good at. (...) So, that's where we were the natural next player in the chain. So, it was a combination of what we were able to do next that the university did not." (First interview)

According to the CBO of Firm E, the most critical resource to develop further the initial opportunity was financial capital: *"It's funding, it's financing. Nothing would happen if we didn't have sufficient funds to do this. That's why it took it so long from first concept to actual start up the company."* The founding team was composed of three non-academics, which then became the CEO, the CBO, and the CFO. They then brought in a full-time project manager to work exclusively for the spin-off. The founders all have extensive market, managerial and entrepreneurial experience in pharma and biotech, as the CBO recalls:

"We've all been in big pharma, we've all been in biotech. Founder EC has taken a company on to the London Stock Exchange, he has raised 100 Million pounds. Founder EB was behind a big pharma company, and worked for other big companies. I have been in the pharma industry since 1978, I went straight to the industry from the University. Went into the commercial side, with Glaxo. (...). So, my network is very strong. And this is actually what the investors like. (...) So, there is a very strong record of managerial experience across the 3 of us." (First interview)

Firm E is using a semi-virtual model, since they do not have a large internal team. Hence, the major developers of technology are the founders and the project manager, who manages external contractors. These external contractors, the university, and the strategic advisory board play an important role in developing the technology further.

"There's an internal piece [founding team and project manager], which is like the brains. The arms and legs are our industrial partners. One of our partners is actually the university, because they have continued to do other things in the lab paid by our supporters (...). As part of the business model,

(...) we have 3 Professors on our Strategic Advisory Board. We [also] have a cluster of contractors that are doing toxicity testing, animal testing, formulation, chemistry. We have an extended network outside the company, (...) and the project manager is managing the whole thing." (First interview)

Market development is mainly performed by the CBO, as he details:

"I am in constant communication with the major pharmaceutical companies who are in this market. I know exactly what they want, what they don't want, and when they want it. And, what I'm prepared to do is (...) [to] drive this project to generate one or possible more than one partner, a major industry partner. We're talking someone like Pfizer, J&J... And they will take the project further into the really expensive, and very complicated stages of final development and commercialisation." (First interview)

The main source of initial funding was angel investment and government match funding, since the typical traditional venture capital groups look for later stage opportunities to back. Additionally, all of the founders became also investors. Self-funding was suggested by the angel investors, because this commitment gives them increased comfort. Firm E does not intend to sell the drugs directly, because they would need a substantial organisation to be able to perform it. They will develop the drug, and then license it to a large partner. Firm E expects to start human clinical trials in 2012, and estimates to have the product ready to license in 2016. Hence, the first revenue stream coming from licensors' royalties to the company and the university should occur in the exact same year.

Table 4.13 Characteristics and Properties of Case E (March 2011)

Generic information	
Position of the interviewee (spin-off)	Founder and Chief Business Officer (CBO)
Additional roles of the interviewee	Consultant for biotech startups
Original department / research institute	Department of applied chemistry
Industry	Biopharmaceutical
Specific domain	Anti-infective medicines

Business description	Firm E is a biopharmaceutical company established in 2009 to develop a completely new class of anti-infective medicine. The company has an experienced team from both pharma and biotech sectors and is dedicating its focus initially to the development of small molecules with specific antibacterial effects against resistant bacteria.
Date of incorporation	July 2009
Date of normal operations *	September 2009
Company status (Mar 2011)	Active
Approximate date of initial research	2007
Approximate date of business idea	2007
Opportunity identification and development	
Most critical resource for opportunity development	Financial capital ("funding, financing")
Source of basic technology and competence	The university research
Context of the initial idea	The initial idea emerged in 2007 at an informal meeting in a local pub with two of the founders, the future CEO and the future CBO. Encouraged by past experience, they decided to start a company together, and then looked for technologies and partners on their own, through 'sweat equity'.
Founding team	
Number of founders	3
Roles of the founders (spin-off)	CBO (Founder EA, non-academic); CEO (Founder EB, non-academic); CFO (Founder EC, non-academic)
Other roles (founders)	Consultant of biotech startups (Founder EA, CBO); Technical consultant in drug development (Founder EB, CEO); Financial manager in biotech firms (Founder EC, CFO)
Year of birth (founders)	Founder EA (1957); Founder EB (1949); Founder EC (1955)
Background (founders)	Graduate chemist with 30 years experience in the industry (Founder EA, CBO); 30 years experience in clinical practice, medical science and drug development, PhD in Pharmacology, MD, MSC, author of numerous scientific papers, senior development positions at various multinationals, completed around 100 clinical trials (Founder EB, CEO); 25 years experience as senior financial officer in biotech, experience in financial management of growth companies from early development through to revenue generation or exit, completed an IPO, and several fund-raising rounds to >£100M (Founder EC, CFO).
Number of other individuals involved	1
Role of the other individuals	Senior project manager
Market knowledge (0-10)**	9
Market knowledge (years)	20 years (Founder EA); 20 years (Founder EB); 20 years (Founder EC)
Managerial knowledge (0-10)**	9

Managerial knowledge (years)	20 years (Founder EA); 20 years (Founder EB); 20 years (Founder EC)
Entrepreneurial knowledge (0-10)**	9
Entrepreneurial knowledge (years)	12 years (Founder EA); 12 years (Founder EB); 12 years (Founder EC)
Entrepreneurial knowledge (nr of firms created)	4 (Founder EA); 4 (Founder EB); 6 (Founder EC): Total = 14
Commitment of the founding team (%)	100% (Project manager); 80% (CEO); 60% (CBO); 20% (CFO)
Technology and market development	
Major performer of technology development	Founders and project manager
Other performers of technology development	Strategic advisory board and external contractors
Major roles in market development	CBO (Founder EA)
Funding	
Initial funding	Angel investment
Self-funding	Yes (all the founders)
Major source of funding	Angel investment (50%) and government match funding (50%)
Additional funding sources	The founders
Company performance	
Estimated time-to-market	2016
Date of first sales	Firm E will not sell the drugs directly, they will license to a large partner
Date of first customer order	Idem
Estimated date of first customer order	Idem

* When the company effectively started trading (e.g., first transaction, got funding - not necessarily sales)
** Self-assessed by the participant

4.6.2 Business Model Changes

The business model of Firm E is a rather odd one when compared to standard service or production firms, but it is quite typical for a pharmaceutical or biotechnology start-up, as the Chief Business Officer (CBO) explains:

> *"Our exit is that we want to basically out-license or have our technology acquired by a large company or a partner. So, our immediate customer, if you like, is going to be somebody like GlaxoSmithKline, Merck, Pfizer. Now, the ultimate customer is going to be a patient who is ill [end user] (...). So, we're taking the first 100 metres, we're passing the technology into the hands of a larger organisation who will continue to develop it and ultimately*

commercialise it. So, we'll not be involved other than collecting royalties, or milestones. (...) One of the things that we are trying to do in our model is to demonstrate that there is more than one compound. Because if we do that, there is an opportunity for an M&A exit. If we have simply one asset [compound], then it could be cheaper for our partner to simply have a license deal. So, what we're trying to do is demonstrate what I call plurality, that we have more than one antibiotic." (Month 0)

Hence, as Table 4.14 shows, Firm E's intended customer segment is a large pharmaceutical organization, which will either license or acquire their technology, or eventually perform a staged acquisition of the whole firm. These pharmaceutical organizations will then produce and sell the drugs to intermediary customer segments such as governments, health authorities, and health organization groups. At the end of the chain, the drug will be delivered to the end user, who would typically be an ill patient. These intermediary customer segments remained fairly crystalized until February 2012. By that time, a new intended customer segment was added, as the CBO describes:

"Well, it was partly through the networking. Developing the relationships I mentioned before, where in these discussions the point was made to us that we should be interested in working with the animal health sector. (...) So, in particular, one company pursued us. This is Merck. And they said: "We're very interested in this. Can you tell us all about it?" (...). So, since then I have started to broaden my base, and talk with other animal health groups. And they are telling us the same thing. So, I can't ignore that. There's an obvious market interest, a market demand there." (Month 10)

In May 2012, the researchers started to understand that some of the latest results where relating to malaria, hepatitis and other viral diseases. And typically, for these sorts of markets, partnerships with charities have always been a crucial ingredient for success. Therefore, Firm D added medical charities as an intended, though longer term, intermediate customer segment.

Table 4.14 Changes in Business Model Elements (CS to KR): Firm E

Inter-view Dates	Customer Segments	Value Proposition	Channels	Customer Relation-ships	Revenue Streams	Key Resources
Apr 2011	*Direct customer:* *- Large pharma organisation (e.g. GSK)* *Indirect customers:* *- Government* *- Health authorities* *- Health insurance groups* *Users: - Ill patients*	- Novel class of drugs to kill Clostridium Difficile - Novel intravenous drug to kill gram-positive bacteria (MRSA)	Communi-cation: website, conferences, meetings *Direct sales:* *- Close interface with large pharma or biotech organisations*	Dedicated personal assistance: - Very personal relation-ships (few potential customers)	No sales yet ("just burning money")	- Entrepreneurial and managerial experience - Strong networks with large pharma companies - Know-how in R&D, and in turning research into product development - Experience in administration, and financial management
Jul 2011						
Oct 2011		(note) MRSA program in "stasis" (not enough resources)				
Nov 2011						- Lost one project manager, and recruited another
Jan 2012		(note) Restarting MRSA program				(note) Started new project manager
Feb 2012	*(+) Direct customer:* *- Animal health companies (veterinary market)*		*(+) Distribution:* *- Looking at global partners (e.g. GSK)* *- Looking at regional partner, especially in China*		*From licensees:* *- An upfront fee;* *- Additional tranches at milestones* *- Royalties, generating income of 20% of net sales*	
Mar 2012	No changes					
May 2012	*(+) - Direct customer:* *- Medical charities*	*(+) - Parasitic applications (e.g. Malaria, Hepatitis, viral diseases)*				

Intentions for the business model are represented in italic style

The value proposition was nearly unchanged during the tracking period. The MRSA drug program was stalled in October 2011, but restart again in January 2012, when they were awarded additional grant funding. In May 2012, Firm E revealed their intention to develop parasitic applications to incorporate in their value proposition. Channels changed only at the intentional level. Such intention, as stated in February 2012, comprised looking for global partners (e.g., GSK), and looking for a regional partner, especially in China. The CBO details the reasons behind this change in their intentions:

> *"We will be entering clinical trials, and that starts to get rather more expensive. And we do not have current funding for that. (...) But, there's a very nice way of going forward, which involves getting a regional partner, who will then drive the necessary clinical trials forward themselves, with us in a support role, rather than a resource role, so we don't come out of our R&D budget. I call this piggy-back development. (...) And as you can imagine (...) the Chinese companies have lots of money. And they also have a very strong hunger for upgrading their R&D capabilities. (...) So, it's a non-dilutive way to get further progress for the company."* (Month 10)

Customer relationships did not suffer any changes throughout the interviewing period. Concerning revenue streams, the CBO states in April 2011 that they were *"just burning money"*. Their intended revenue streams became clearer in February 2012: they would eventually come from licensees in the form of an upfront fee, cash milestones, and royalties (20% of net sales). Though key resources suffered a few adjustments (lost one project manager, but recruited another), their nature remains the same.

Table 4.15 shows the key events throughout the 12-month period in key activities, key partners, cost structure, funding, and goals. In April 2011, key activities comprised R&D (90%), and operational tasks (10%). In July 2011, they initiated early commercial discussions, and this activity became more prominent in October 2011. Key partners stayed nearly the same during the whole period – only in May 2012 a key partnership was established with a government agency, as a consequence of a grant award.

Table 4.15 Changes in Business Model Elements (KA to Goals): Firm E

Interview Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
Apr 2011	- R&D (90%) - Operational tasks (monitoring the cash flow, keeping relationships with shareholders, etc.) (10%)	- Strategic Advisory Board (3 Professors) - External consultants in animal model and toxicology - Network of external contractors (University, and 5 or 6 companies worldwide) - Investors	- External R&D costs (bigger cost) - Intellectual Property - Low personnel costs (4 employees, but just one full-time) - Low rent (office)	- Angel investment (50%) - Match funding: SE (50%) - Total amount committed of 2.2M GBP (in 3 tranches)	Exit: - Through a (multiple) licensing deal - Or a staged acquisition
Jul 2011	- R&D (55%) - Early commercial discussions (35%) - Operational tasks (10%)				
Oct 2011	- R&D (45%) - Early commercial discussions (45%) - Operational tasks (10%)				- Single licensing, but ideally with funded research collaboration in parallel - Or a staged acquisition
Nov 2011				*- Intending to get grant funds (to develop 2nd product)*	
Jan 2012				- Angel investment (48%) - Match funding: SE (48%) - Grant funding: TSB 100k (4%)	
Feb 2012				*- Looking for additional grant funding (FP7 and/or Welcome Trust)*	- Multiple-licensing (more probable now, due to field and geography licensee split) - Or a staged acquisition
Mar 2012					
May 2012		(+) - Business Gateway, Scottish Enterprise (managed account company)		*- VC: intending to raise max. 10M GBP (for clinical proof of concept)* *- Development funds from medical charities*	

Intentions for the business model are represented in italic style

The cost structure did not experience any significant changes. In opposition, a few events occurred concerning funding. Firm E's major sources of funding were angel investment (50%) and match funding from a government agency (50%), totalling a committed amount of £ 2.2 Million. In November 2011, the CBO revealed their intentions of getting grant funds to develop their second product (MRSA drug). In fact, a technology grant from an innovation agency was effectively awarded to them around January 2012. In February 2012 the CBO released their intentions of getting additional grant funding from specific programs. In May 2012, he also revealed their aspiration of raising venture capital funding for clinical proof of concept, and getting development funds from medical charities. Firm E's goals varied throughout the period, but they returned to their initial idea: either multiple licensing (through field and/or geography split), or an exit via a staged acquisition.

4.7 CASE F

4.7.1 Case Summary

Firm F is a technology company that makes monitoring equipment for the agricultural sector. Their skills are in the electronics design, software and data analysis. They currently build a small box, which is mounted on a cow via a collar, and measures the cow's changes in behaviour patterns. The first product release notifies the farmer when the cow is ready to be inseminated. The approximate date of the initial idea was around 2005. The opportunity emerged from a piece of market research undertaken by a government agency that supports high potential companies, who then funded the electronic engineering department to develop a solution. The company was then formed in November 2007, though it only effectively started operating/trading in June 2010. The most critical resources to develop the initial opportunity was R&D funding from a government agency and revenue streams from their first customer, as Founder FA and current Principal Researcher at Firm F recalls:

> *"We got Research and Development funding from the Government Agency. It was part of a large program. There was £5 Million worth of R&D. And that*

allowed us to demonstrate Proof of Principle. And then after that, the most significant piece of funding came from our first customer." (First interview)

The source of basic technology and competence was a mix between university research and extensive industry experience. *"We've all worked in the technology area for 30 years, you know. So, it comes from domain experience, from 30 years of working in the university and working in start-ups."* (First interview)

The founding team was composed by 3 academics, researching and lecturing in the electronic engineering department at the university. Founder FA, current principal researcher at Firm F, is a Reader at the university. Before co-founding Firm F, he has managed several research programs in wireless communications. He was also senior manager at the government agency that provided funding to the research project that led to Firm F's formation. Prior to that, he was Senior Engineer in a start-up company on the telecommunications sector. He holds a PhD in optical communications, has authored approximately one hundred papers, and holds several patents. Founder FB is a Director and Chief Technology Officer (CTO) of Firm F. He is a recognized data communications expert, and a Professor at the university, where he instigated the four-year, £4.75 million research effort that resulted in the concept for Firm F's platform. He has been principal investigator on several funded projects in advanced communications, has edited two books and authored/co-authored over 230 journal and conference papers. He was also a member of a government agency, and of a group of organizations created to bridge the gap between basic research and company growth. Prior to co-founding Firm F, he was co-founder, Director, and CTO of a high growth technology start-up. He holds a BSc and PhD. Founder FC is a Chief Engineer of Firm F. Before co-founding Firm F, he held a research appointment at the university, where he developed wireless sensor networks for low power and long-range applications. Prior to his appointment at the university, he was a research engineer at another company. He holds an Engineering Doctorate in data storage techniques.

As their background suggests, and as stated by Founder FA, the founding team had considerable market knowledge at the time of spinning-off:

"The reason I say that [high market knowledge] is that the technology was specifically developed to meet a market need. It's a market-driven company, it was not a technology company looking for an opportunity. It was setup, and all of the R&D was done in response to detailed market analysis that had already been done." (First interview)

Founder F also rates their managerial experience as substantially high, since they all had prior industrial experience in that specific field. *"We've all had experience of working in small start-ups previously. And we recruited a management team that was appropriate, because they had the skill set for internationalization. So, again, I would say we're pretty high up."* (First interview). In fact, soon after firm foundation, the team brought in an experienced manager to work as CEO of Firm F. They had also created two high technology start-ups before founding Firm F.

The major performers of technology development are the founding team and the new engineers that were brought on board. Market development is performed by the CEO and some key strategic partners.

"Our CEO has extensive experience of bringing high technology to market. And we have formed a number of strategic partnerships with people who are the sales channel into the agricultural sector." (First interview)

The spin-off did not receive any type of external funding at the time of formation. However, as mentioned above, there was a funded R&D activity that preceded the spin-off formation, and subsequently led to it. After incorporation, the firm's activity has been supported entirely by sales to a key partner, who paid upfront: *"That's through a strategic relationship with our key partner, because basically they paid upfront for the initial order."* (First interview)

Firm F does not use university's R&D or physical administrative facilities, and maintains little involvement with the TTO.

"Yeah, it's involved, but not really… obviously, the university has a shareholding in the company. And the TTO is present as a result of that, but we do not get any specific guidance from them." (First interview)

As stated previously, Firm F's product is in the market since June 2010, date of their first sale. They have a strategic partnership with a distributor, which has an exclusive distribution/sales right for the UK, and are Firm F's sales channel to the end user.

Table 4.16 Characteristics and Properties of Case F (April 2011)

Generic information	
Position of the interviewee (spin-off)	Founder and Principal Researcher at Firm F
Additional roles of the interviewee	Senior Lecturer at Electronic Engineering Department
Original department / research institute	Electronic Engineering Department
Industry	Electronics
Specific domain	Electronics design, software and data analysis (decision support platforms)
Business description	Firm F is a technology company that makes monitoring equipment for the agricultural sector. Their skills are in the electronics design, software and data analysis. They build a small box, mounted in a cow via a collar, and measures the cow's changes in behaviour patterns. The first product release notifies the farmer when the cow is ready to be inseminated.
Date of incorporation	November 2007
Date of normal operations *	June 2010
Company status (Mar 2011)	Active
Approximate date of initial research	2005
Approximate date of business idea	2007
Opportunity identification and development	
Most critical resource for opportunity development	Financial capital ("capital generated through sales")
Source of basic technology and competence	University research an industry experience
Context of the initial idea	The opportunity emerged in 2005 from a piece of market research undertaken by a government agency that supports high potential companies, who then funded the electronic engineering department to develop a solution.
Founding team	
Number of founders	3
Roles of the founders (spin-off)	Principal Researcher (Founder FA, academic); CTO (Founder FB, academic); Chief Engineer (Founder FC, academic)
Other roles (founders)	Reader at the university (Founder FA, Principal Researcher); Professor at the university (Founder FB, CTO)
Year of birth (founders)	Founder FA (1961); Founder FB (1957); Founder FC (1981)

Background (founders)	Reader at the university, managed several research programs, senior manager at a government agency, Senior Engineer in a start-up company, holds a PhD, has authored approximately one hundred papers, and holds several patents (Founder FA); Recognized data communications expert, Professor at the university, has been principal investigator on several funded projects, has edited two books and authored/co-authored over 230 papers, a member of a government agency, was co-founder, Director, and CTO of a high growth technology start-up, holds a BSc and PhD (Founder FB). Held a research appointment at the university, was a research engineer at a company, holds an Engineering Doctorate in data storage techniques (Founder FC)
Number of other individuals involved	0
Role of the other individuals	n/a
Market knowledge (0-10)**	9
Market knowledge (years)	6 years (Founder FA); 6 years (Founder FB); 6 years (Founder FC)
Managerial knowledge (0-10)**	8
Managerial knowledge (years)	12 years (Founder FA); 12 years (Founder FB); 8 years (Founder FC)
Entrepreneurial knowledge (0-10)**	8
Entrepreneurial knowledge (years)	12 years (Founder FA); 12 years (Founder FB); 8 years (Founder FC)
Entrepreneurial knowledge (nr of firms created)	2
Commitment of the founding team (%)	100% (CEO); 100% (Founder FC); 30% (Founder FA); 30% (Founder FB)
Technology and market development	
Major performer of technology development	Firm F (the founding team and other engineers brought on board)
Other performers of technology development	No
Major roles in market development	CEO and key partners
Funding	
Initial funding	No external funding (but prior to the spinout, there was an R&D fund)
Self-funding	Yes
Major source of funding	Sales
Additional funding sources	None
Company performance	
Estimated time-to-market	n/a (already in the market)
Date of first sales	June 2010
Date of first customer order	June 2010
Estimated date of first customer order	n/a (already in the market)

* When the company effectively started trading (e.g., first transaction, got funding - not necessarily sales)
** Self-assessed by the participant

4.7.2 Business Model Changes

One of the founders and current principal researcher at Firm F explained that their business model has been quite static since they initiated their activity until the moment of the first longitudinal interview. However, he also reveals that there might be changes occurring in a near future.

> *"Nothing has really changed (...), because we had to obtain and establish the relationship with key partners to perform the supply chain, to build the product that we need. And we have got a key customer who is our channel to market. And all of our efforts this year have been geared at putting all that in place. So, there hasn't been a significant change to that as yet. There might be, in a near future. But at this point in time, I would say that everything has gone pretty much as we intended over the course of the year."* (Month 0)

In fact, by observing Table 4.17, one can see that few changes have occurred, over the course of time, in the six business model elements displayed. In terms of customer segments, changes only took place at the intentional level, with the addition of a new target customer segment: beef cattle (November 2011). Such change in intentions was triggered by customer request, as the founder describes:

> *"We're beginning to look at putting the collars onto beef cattle, because some farmers are inseminating beef cattle. So, we have one herd that has got collars on. We've got another few farms that are asking for it. (...) We have to modify slightly how the product works, because beef cattle are managed differently. They're way off out on the field. So, what we have to do is to engineer a longer transmission range solution."* (Month 6)

The value proposition has not been changing dramatically, but there were significant enhancements performed to it. In November 2011, the engineering team increased the product sensitivity, and released an updated version of the product interface. In January 2012, two important functionalities were being developed: 1) giving birth prediction, and 2) illness prediction.

Table 4.17 Changes in Business Model Elements (CS to KR): Firm F

Interview Dates	Customer Segments	Value Proposition	Channels	Customer Relationships	Revenue Streams	Key Resources
May 2011	- Dairy farming: milk production	Monitoring system which improves the accuracy of determination of when the cow is ready to be inseminated, thus increasing overall milk yield	Indirect sales: Distribution through key partners to the farms (customers)	- Dedicated personal assistance (performed by key partners - Visits to farms (CR is handled by key partners, Firm F provides level 2 support)	- Sales of units (100% through key partners)	- Engine-ering team (human resources) - Marke-ting team (human resources)
Jul 2011	No changes					
Sep 2011	No changes					
Oct 2011	No changes					
Nov 2011	*(+) - Beef cattle*	(+) Product enhancement: - Increased sensitivity - Changed / updated product interface (version 2.14)				(note) Employed new engineer
Dec 2011	No changes					
Jan 2012		(+) - Giving birth prediction (in development) - Illness prediction (in development)				
Feb 2012						
Mar 2012						
Apr 2012	No changes					
May 2012						

Intentions for the business model are represented in italic style

According to the founder, the addition of such features was already planned in their technology roadmap.

> *"This was always in our roadmap. (...) The product is out and is stable, and it's beginning to ramp up. And so, these are just new features that we always intended to integrate. And now we have the time to do them."* (Month 8)

The channels, customer relationships, and revenue streams experienced no changes throughout the interviewing period. At the first longitudinal interview (May 2011), the key resources, as described by the founder and principle researcher, were the engineering team and the marketing team. The only event that occurred related to human resources was the introduction of a new engineer in the development team (November 2011).

Table 4.18 displays the events over the 12-month period affecting key activities, key partners, cost structure, funding, and goals. In terms of key activities, these experienced substantial changes in November 2011. Previously, in May 2011, key activities were research and engineering development, operational management, and product installation. In month 6, as the venture developed, research decreased and the focus switched to engineering development, marketing strategy and management of outsourced operations (supply chain, production, and sales). Firm F had basically three key partners in May 2011: an intermediate to end customers, an outsourced manufacturer, and its customers, who provide valuable feedback for product development and enhancement. In November, the interviewee stated their intention to get additional partners to help with geographical expansion. In February 2012, Firm F attracted a new partner, which sells fertility services to farms, and embeds Firm F's product into the service they provide. In May 2012, they established a partnership with a fertility management specialist, which acts as Firm F's channel to market in Germany. The cost structure was fairly stable throughout the interviewing period. Some residual administrative costs were added in November 2011, and in March 2012, the costs with human resources increased slightly in relation to costs with materials. In terms of funding, Firm F has been financed 100% through sales until March 2012. At this point, they were awarded a grant from a UK innovation agency to support the development of additional product features. Firm F's goals changed in November 2011, with a noticeable emphasis on growth via more volume in the same markets, and by entering additional geographical markets.

Table 4.18 Changes in Business Model Elements (KA to Goals): Firm F

Interview Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
May 2011	- Research and engineering development - Operational management - Product installation (just in the beginning, first 20 installations)	- National Milk Records (NMR) (intermediate to end customer) - Dynamic EMS (subcontract manufacturing facility) - Customers (farmers)	- Materials (70%) - Human resources (30%)	- No funding (100% sales)	- Survival - 20,000 collars 1st year (Jul 2011 - Jul 2012)"
Jul 2011					
Sep 2011					
Oct 2011					
Nov 2011	- Engineering development - Marketing strategy (key element) - Managing supply chain (subcontracted) - Production (outsourced to 3rd party) - Sales (outsourced to key partners)	*(+) - Intending to get new partners to expand geographically*	(+) - Small facilities costs, running office, admin (residual)		(+) - Stable product - Market growth: a) via more volume in the same markets, and b) entering additional geographical markets
Dec 2011					
Jan 2012					
Feb 2012		(+) - Genus ABS (provide a service to farmers using Firm F's technological solution)			(update): - Instead of stable products, "product enhancements" - Intended expansion to overseas markets in 3 different geographies
Mar 2012			- Materials (60%) - Human Resources (40%)	- Grant funding (got TSB grant + SMART award to develop additional product features)	
Apr 2012					
May 2012		(+) - Semex (Fertility management specialist in Germany)			

Intentions for the business model are represented in italic style

4.8 CASE G

4.8.1 Case Summary

Firm G's business description entails two mutually exclusive parts. The primary purpose is the development and production of technical solutions to generate electricity from current flows, which occur naturally in the world's oceans, seas, and estuaries – that is the R&D side of the activity. The second part of the business description is the development, instalment, exploitation and management of tidal farms – that is the "tidal farm developer" side of the business activity. The tidal farm development will then naturally allow the generation of electricity.

The initial research that motivated Firm G's formation started about 20 years ago, in the context of research in wind energy that the professor (founder and current CEO) was leading at the university.

> *"It goes back 20 years. We were doing a lot of work in wind energy, and by the year 2000, wind was a mature technology. So, the R&D challenges were less, and it was more of an optimization challenge. We recognized that in the renewable sector there needed to be additional technologies coming on board. So, we identified that tidal power was a research challenge that if harnessed could provide 'firm' power: you know how much energy you're going to get, and you know when it's going to be delivered, because you know when tides will occur for the next 100 years."* (First interview)

Existing technologies for tidal energy were adaptations of wind turbine technology, which was not an optimum solution, and did not fully harness the potential of tidal energy.

> *"We looked at the types of technologies that were being developed for harnessing this energy. And we recognized that these technologies were basically wind turbines that were modified to run on the water. (...) That's not an optimum solution. We then set about developing what we foresee to be the optimum solution. That optimum solution is maximizing energy performance,*

minimizing capital cost of production, and also reducing the operational cost associated with maintenance and access." (First interview)

Therefore, in 2001, the research team focused on developing a more effective technology to generate energy from tidal power. The technology development process went through a number of different phases, and by 2008 they started thinking of developing a company, which was then incorporated in October 2009 and became fully funded in September 2010.

"The first phase, going back to 2001, is the fundamental research to see whether this novel approach (...) was advantageous or not. And that was computational based. The second phase was the development of prototypes systems, and testing these prototype systems in a controlled test environment (...). The third phase was then scaling these tests into real sea conditions. So, that's a 7-year evolution there. And then (...) is the development of the company to take that forward, which would then be phase 4 of the evolution." (First interview)

Hence, the team went through the research phase into a technical development phase. At the end of the technical development phase, when they were testing the prototype systems, they had very positive results, in terms of engineering performance, and in terms of first stage economic analysis. At that point, they realized that there was a potential business opportunity. The most critical resources to take that opportunity forward were knowledge and financial capital as the CEO explains:

"All university spinout companies are very expensive to take to the market [due to] long leading times, 5, 6, 7 years, and is also very expensive to build large scale prototype systems to demonstrate to the commercial market their full validity. (...) The first phase is knowledge based. The second challenge is (...) financing the company to that level of investment in order to actually give resources for you to build the prototypes. (...) So, knowledge-based first of all, but very much capital intensive." (First interview)

The founding team was constituted by one academic (Founder GA and current CEO) and one non-academic (Founder GB and current Director). The CEO held the post of senior lecturer at the department of mechanical engineering at the university, and is a director of the energy research unit. He has conducted extensive research into tidal power extraction, and has investigated the performance optimization of tidal turbine systems. He is involved in energy institutes and in the management teams of European energy projects. Founder GB and current director is a person with extensive business knowledge, and with experience in taking university start-up companies to the market. He has more than 25 years' experience in the energy industry, chairs known multinational groups in the energy sector, and previously held leading positions such as CEO. He was president of an American oil service company that was quoted in the stock exchange. He is a geophysicist, and has an MBA. This description rates the founding team as very high in terms of market, managerial and entrepreneurial knowledge.

> *"The founding team has a very high level of market knowledge, because, specifically myself, I've been working at the forefront of the technology development for the last 10 years in this area. (...) Before I came to work at the university, I worked in the industry (...). So, I've got a good overview of what technologies are being developed, and what business models are being used to bring them to a commercial marketplace. And Founder GB has got a lot of knowledge on the energy sector, because he came from the oil industry, and has a lot of knowledge in the business models to be used in developing a new energy sector. (...) Founder GB has already taken a (...) company into the London Stock Exchange. (...) So, between us we have a lot of complementary knowledge."* (First interview)

The initial research phase was performed by the research group from 2001 to 2008. At that point in time, the development and refinement of the technology started being done and led by the company itself, but maintaining partially the collaboration with the research unit. Two key partners in the supply chain also played an important role in product/technology development. Market development is performed by the company, mainly by its Director, who has a strong network in the energy sector.

A private industrial investor, who finances oil & gas start-ups, provided the initial funding of £5 Million, which was the investor's first financing in the renewable energy sector. This investor is still the major source of funding. Firm G does not have additional funding sources, though they will look for grant support from government agencies.

Firm G's business model is based on building tidal farms, which the firm sets up in each geographic area. These tidal farms are new companies partly owned by firm G, and partly owned by local partners or investors. These farms need to buy devices to Firm G to generate electricity, and the electricity generated is then sold to the energy utilities companies, thus providing an additional revenue stream to Firm G. The tidal farms are enormous capital projects, requiring the company to raise tens of millions of pounds. The two founders envision their business as acting in a global industry and market, and they hope to capture a significant share of the world's tidal generation market. They have looked at sites in Canada, The United States, Chile, India, Korea and China, and they are already receiving requests from projects in some of these countries.

According to the CEO the estimated time-to-market for demonstration is about 1 year from the interview date, i.e., in the Spring of 2012. The estimated date of first customer order and subsequent sale is in Autumn 2012.

Table 4.19 Characteristics and Properties of Case G (March 2011)

Generic information	
Position of the interviewee (spin-off)	Founder and CEO of Firm G
Additional roles of the interviewee	Lecturer at the mechanical engineering department
Original department / research institute	Mechanical engineering (research unit focused on energy)
Industry	Energy
Specific domain	Renewable energy
Business description	1) Development and production of technical solutions to generate electricity from current flows, which occur naturally in the world's oceans, seas, and estuaries; 2) Development, instalment, exploitation and management of tidal farms. The tidal farm development will then naturally allow the generation of electricity.

Date of incorporation	October 2009
Date of normal operations *	September 2010 (became fully funded)
Company status (Mar 2011)	Active
Approximate date of initial research	2001
Approximate date of business idea	2008
Opportunity identification and development	
Most critical resource for opportunity development	Knowledge and financial capital
Source of basic technology and competence	Research group at the university
Context of the initial idea	The initial research for tidal technology started in 2001, followed by the development process, which went through a number of different phases. By 2008, when testing the systems in sea conditions, they got very good operational and economic results, and identified a business opportunity.
Founding team	
Number of founders	2
Roles of the founders (spin-off)	CEO (Founder FA, academic); Director (Founder FB, non-academic)
Other roles (founders)	Senior lecturer and head of research at the university (Founder GB, CEO); Director of companies (Founder GB, Director)
Year of birth (founders)	Founder GA (1966); Founder GB (1958)
Background (founders)	Senior lecturer at the university, director of the energy research unit, has conducted research in tidal power extraction and performance optimization of tidal turbine systems, involved in energy institutes and in the management teams of European energy projects (Founder GA, CEO). Extensive business knowledge, experience in taking university spin-offs to the market, more than 25 years in the energy industry, chairs known multinational groups in the energy sector, held leading positions such as CEO, was president of an American oil service company, has spent over ten years at a multinational group working in a variety of technical and commercial roles in numerous countries, is a geophysicist, and has an MBA (Founder GB; Director).
Number of other individuals involved	0
Role of the other individuals	n/a
Market knowledge (0-10)**	10
Market knowledge (years)	20 years (Founder GA); 20 years (Founder GB)
Managerial knowledge (0-10)**	10
Managerial knowledge (years)	3 years (Founder GA); 30 years (Founder GB)
Entrepreneurial knowledge (0-10)**	9
Entrepreneurial knowledge (years)	3 years (Founder GA); 20 years (Founder GB)
Entrepreneurial knowledge (nr of firms created)	6
Commitment of the founding team (%)	100% (CEO); 60% (Director)

Technology and market development	
Major performer of technology development	Now: Firm G (80%), Research Unit (20%); Initial R&D (100% Research Unit)
Other performers of technology development	Supply chain partners
Major roles in market development	CEO (40%); Director (60%)
Funding	
Initial funding	Industrial investor in oil & gas (5 Million pounds)
Self-funding	Yes
Major source of funding	Industrial investor
Additional funding sources	None (though they will look for government grants)
Company performance	
Estimated time-to-market	Spring 2012
Date of first sales	Not yet
Date of first customer order	Autumn 2012
Estimated date of first customer order	Autumn 2012

* When the company effectively started trading (e.g., first transaction, got funding - not necessarily sales)
** Self-assessed by the participant

4.8.2 Business Model Changes

According to the director of firm H, when interviewed in May 2011, their business model had been experiencing little change since incorporation: *"Everything else is pretty much where we thought it would be."* Most changes had been occurring according to plan, and in certain aspects, they were even ahead of plan:

> ***"****We are closer to revenue now than we thought we would be at this stage in business. Originally, we thought we would spend the first year or even two years on developing the systems, rather than on actually promoting them to [potential] customers and trying to sell them."* (Director)

When asked why they were ahead of plan on that issue, the director said that they were experiencing a lot of customer interest. He commented further:

> *"I think customers are dissatisfied with the alternatives that are available to them. So, they're quite actively looking for solutions. And we offer a different type of product. We offer, in some ways, a disruptive technology, that perhaps meets their needs a lot better than the competitors we have in the industry."*

Table 4.20 presents a detailed evolution of each of the business model elements (customer segments to revenue streams). In May 2011, the intended customer segments were Single Purpose Vehicles (SPVs), and energy utilities. The former are tidal power stations that firm H sets up in each geographic area, which are new companies partly owned by firm H, and partly owned by local partners or investors. These SPVs need to buy devices to generate electricity, and thus are one potential customer segment. The electricity generated is then sold to the energy utilities companies, which are the other potential customer segment. Their intentions in terms of customer segments remained the same throughout the interviewing period, and a similar situation happened with the value proposition. Channels also remained constant, apart from a slight addition to their intentions: besides selling devices indirectly through the manufacturer, Firm G might also sell devices directly to organizations that might request them. Customer relationships and revenue streams did not endure any sort of transformation during the 12-month tracking period. In terms of key resources, Firm G hired their first employee in May 2012, a masters graduate engineer who will be responsible for managing their immediate project of testing a full scale device.

Table 4.21 depicts key events through the same period in key activities, key partners, cost structure, funding, and goals. A quick observation of the table reveals that most changes occurring to Firm G's business model were linked to their key activities and key partners. In fact, the only key activity in May 2011 was managing the engineering and development of the device. In June 2011, raising money for SPVs was added. In September 2011, approximately one third of the effort was direct to developing one more SPV. In October 2011, some of the founding team's time was directed towards hiring people and dealing with legal issues related to setting up SPVs. In May 2012, detailed project planning was added to their list of key activities, task that was allocated to the new engineer they had employed by that time.

Firm G had two supply chain partners in May 2012: one focused on the mooring and packing of the device; and the other collaborating in the development of the generator. In June 2011, Firm G added an investment partner to help with the process of raising funds for SPVs that were setup.

Table 4.20 Changes in Business Model Elements (CS to KR): Firm G

Interview Dates	Customer Segments	Value Proposition	Channels	Customer Relationships	Revenue Streams	Key Resources
May 2011	*- SPVs (buy devices)* *- Utilities (buy energy)*	Innovative tidal device which allows lower cost in electricity generation	Communication: website, networks, news, etc. *Sales & Dist.: Indirect (through SPVs and manufacturer)*	Dedicated personal assistance (face-to-face, phone, email)	*- Share of sales* *- Dividend payments*	- IP (device) - Strategy
Jun 2011			*S&D: Might also sell directly, if asked to*			
Jul 2011	No changes					
Sep 2011						
Oct 2011						
Nov 2011	No changes					
Dec 2011	No changes					
Jan 2012						
Feb 2012						
Mar 2012	No changes					
Apr 2012	No changes					
May 2012						- IP (device) - Strategy - Employee

Intentions for the business model are represented in italic style

Between January and February 2012, a considerable number of partners were added: a supplier to develop the blade of the device, a partner to aid with the management of development, and a government agency, as consequence of government match funding they got in January 2012. In May 2012, Firm G partnered with a company that provides accredited open-sea testing facilities, in order to test the device. In terms of funding, Firm G was supported by a single industrial in May 2011. In February 2012, Firm G attracted private equity funding, and a grant from a government agency that matched the private investment. In May 2012, the Director of Firm G revealed that they were intending to get additional grant funding.

Table 4.21 Changes in Business Model Elements (KA to Goals): Firm G

Interview Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
May 2011	- Managing the engineering and development (performed mainly by KPs)	Supply Chain: - MS, Scotland (mooring & packing) - SM, Norway (generator)	- Third party supply costs	- Private equity (industrial investor)	Vision: Tidal energy as an affordable way of generating electricity: 1. Build and deploy devices cost-effectively 2. Long-term reliability 3. Take a significant share of off shore wind market
Jun 2011	- Managing E&D (85%) - Raising money for SPVs that were setup (15%)	Supply Chain: MS; SM Investment: - EIG (fundraising for SPVs)			
Jul 2011					
Sep 2011	- Managing E&D (60%) - Developing one more SPV (30%) - Raising money (10%)				
Oct 2011	- Managing E&D (60%) - Developing one more SPV (30%) - Hiring people and legal issues for setup SPVs (10%)				
Nov 2011					
Dec 2011					
Jan 2012		Supply Chain: MS; SM Investment: EIG Others: - RES Offshore (management of development)			
Feb 2012		Supply Chain: MS; SM; AB (designer of the blade) Investment: EIG, SE (grant) Others: RES *Additional supply chain partners to operate the device*		- Private equity - Grant funding (Scottish Enterprise)	
Mar 2012					
Apr 2012					

May 2012	- Managing E&D (40%) - Developing one more SPV (20%) - Hiring people and legal issues for setup SPVs (5%) - Raising money (10%) - Detailed project planning (25%)	Supply Chain: MS; SM; AB; EMEC (facility to test the device) Investment: EIG, SE (grant) Others: RES	- Third party supply costs - Salaries (employees)	*- Expecting more grant funding*

Intentions for the business model are represented in italic style

4.9 CASE H

4.9.1 Case Summary

Firm H is specialised in the rapid detection of food pathogens using innovative diagnostic products. The company's intellectual property is based on a combination of chemistry, immunology and microbiology, as well as novel bacteria detection methods. The original idea that led to the spin-off formation extends from research done in the department of immunology at the university, back in the year 1995. In the following years, the lead researchers involved in the project approached the university several times to form a company, but the university showed no interest.

> *"The original idea was in 1995, the university was approached. (...) The university had no interest, didn't want the Intellectual Property. (...) It took us from 1995 to 2007 to get a company, because the university was not interested at all."* (First interview)

Hence, by 2005 the two founders finally decided to form a company outside the university. The company was then officially incorporated in July 2007, in the incubator centre, and was initially funded with a government award. According to Founder HA, it was his prior knowledge of the markets that facilitated the identification of the opportunity.

> *"It's the identification of the opportunity that's actually in there. (...) I already had been working on Multinational Company X, so I could make the connection that we have something that is far better than they have got. (...)*

The knowledge of the market and everything, (...) I knew what the markets would actually want." (First interview)

The company was formed in 2007, but later they had to replace the CEO. When the new CEO was appointed, new investors were brought in, and they did not fully align with the company's technology. However, they were interested in a particular type of technology, and therefore a new company – Firm H – was incorporated in July 2009.

"We had to replace the Managing Director, because he was useless, and I went to the university (...). They came forward with the present MD, and when he came we brought a funding organization in, who were not interested in a lot of the things that X Limited [first company] were interested in. But they were interested in one type of rapid technology, so they wanted another company formed, which was formed in 2009 [Firm H], which took part of the Intellectual Property of the first company. The first company is in fact now dissolved." (First interview)

The founding team of the first company was composed by 2 Professors and a Managing Director (MD). The founding team of the second company, Firm H, comprises one of those Professors and a new MD. At the time of Firm H's formation, the founding team already had substantial market, managerial and entrepreneurial experience. Founder FA and current CSO has over 30 years of expertise in developing diagnostic systems, holds several patents, and published more than 200 scientific publications. He initiated the immunology department at the university and took it to RAE (Research Assessment Exercise) five star status. He was consultant for pharmaceutical multinational companies for more than 19 years, and research director at another multinational for 7 years. Founder FB and current CEO is an experienced entrepreneur with 15 years' experience in venture capital backed technology companies, business development situations, and university spin-offs. He sold his own manufacturing company in 2006, after 10 years of running it, and owns a management consultancy business. He has a degree in physics and mathematics.

The most critical resource to develop further the initial opportunity was Founder HA's knowledge of the technology and markets.

> *"I suppose it is my knowledge. Otherwise the financer would not have wished to be involved. (...) I founded Company X in the university in 1995. It's now part of a French multinational group. I was the research director there for 12 years. (...) So, that's why I have a very good knowledge of the food area, the intricacies, the people, the companies. And in between time, I have worked with, as a consultant, a number of other companies. (...) So, I have a very intimate knowledge of the whole subject areas."* (First interview)

Another critical competence to take the company forward was the management and entrepreneurial expertise, grounded in many years of performing management roles at multinational companies, and of creating and fostering technology start-ups.

> *"Founder HB has been a managing director of a number of start-up companies. And I have been involved in 5 start-up companies, right at the beginning. (...) I worked at Multinational Company X from '85 till '97, so that's 12 years."* (First interview)

The technology development is mainly performed by the founding professor (CSO) and his team. The former founder of the first company also contributes to the instrumental aspect of the product, since he is a physics engineer. The market development is mostly conducted by a distribution company that Firm H is acquiring.

> *"We are going to buy a distributor who already has £4 Million sales in the UK. So, they will develop the market for us. We are buying them now, it hasn't been announced yet. So, the market development is that particular team. (...) We've got the science, we've got the production, we've got the IP, and they've got the marketing and distribution."* (First interview)

The initial funding was private equity from a venture capitalist, which came right at the beginning, and continues to be the major source of funding. Additionally, they were able to get a government award in a competition for innovative new

businesses. Firm H estimates to go to market in 6 months (September 2011) from the first interview date (March 2011). That prediction is dependent on the trial results, and on the timing of the acquisition process of the mentioned distributor.

> *"About 6 months from now [time-to-market]. We should be going into trial in 3 months. (...) As long as you get through, then we can start selling immediately. (...) As we're buying a distribution network, as soon as our kits are ready, we switch all their kits for our kits. So, we already have our first orders now. (...) Because that organization will stop selling the kits they buy from Denmark, and will sell ours, because ours are theirs."* (First interview)

Table 4.22 Characteristics and Properties of Case H (March 2011)

Generic information	
Position of the interviewee (spin-off)	Founder, Director, and Chief Scientific Officer (CSO) of Firm H
Additional roles of the interviewee	Professor in the pharmacy and biosciences department at the university
Original department / research institute	Pharmacy and biomedical sciences department
Industry	Biotechnology
Specific domain	Global microbiological food testing sector
Business description	Firm H is specialised in the rapid detection of food pathogens using innovative diagnostic products. The company's intellectual property is based on a combination of chemistry, immunology and microbiology, as well as novel bacteria detection methods.
Date of incorporation	July 2009
Date of normal operations *	July 2009
Company status (Mar 2011)	Active
Approximate date of initial research	1995
Approximate date of business idea	2005
Opportunity identification and development	
Most critical resource for opportunity development	Professor's (Founder HA) technical and market knowledge
Source of basic technology and competence	University research an industry experience
Context of the initial idea	The original idea extends from research done in the department of immunology at the university in1995. By 2005, two founders decided to form a company outside the university. They stumbled into/identified an opportunity, due to their knowledge of the technology and to their prior

	market knowledge, coming from professional/industrial experience in the sector.
Founding team	
Number of founders	2
Roles of the founders (spin-off)	CSO (Founder HA, academic); CEO (Founder HB, non-academic)
Other roles (founders)	Professor at the university (Founder HA, Principal Researcher); Management consultant (Founder HB, CEO)
Year of birth (founders)	Founder HA (1943); Founder HC (1961)
Background (founders)	Has over 30 years of expertise in developing diagnostic systems, holds several patents, published more than 200 scientific publications, initiated the immunology department at the university and took it to RAE five star status, was consultant for pharmaceutical multinational companies for more than 19 years, and research director at another multinational for 7 years (Founder HA, CSO). Experienced entrepreneur with 15 years experience in venture capital backed technology companies, business development situations and university spin-offs. Sold his own manufacturing company in 2006, after 10 years of running it, and owns a management consultancy business. Has also undertaken interim CEO roles, and has a degree in physics and mathematics (Founder HB, CEO).
Number of other individuals involved	0
Role of the other individuals	n/a
Market knowledge (0-10)**	9
Market knowledge (years)	25 [=(35+15)/2] years (Founder HA); 4 years (Founder HB)
Managerial knowledge (0-10)**	9
Managerial knowledge (years)	12 years (Founder HA); 15 years (Founder HB)
Entrepreneurial knowledge (0-10)**	10
Entrepreneurial knowledge (years)	15 years (Founder HA); 15 years (Founder HB)
Entrepreneurial knowledge (nr of firms created)	5 (Founder HA); 5 (Founder HB)
Commitment of the founding team (%)	100% (CEO); 60% (CSO)
Technology and market development	
Major performer of technology development	Professor and his team
Other performers of technology development	Former founder (1st company)
Major roles in market development	Distributor they acquired
Funding	
Initial funding	Venture Capital
Self-funding	Yes
Major source of funding	Venture Capital
Additional funding sources	Government award
Company performance	

Estimated time-to-market	6 months (September 2011)
Date of first sales	October 2011
Date of first customer order	March 2011
Estimated date of first customer order	n/a (already have orders)

* When the company effectively started trading (e.g., first transaction, got funding - not necessarily sales)
** Self-assessed by the participant

4.9.2 Business Model Changes

Firm H's intended customer segments in May 2011 were the food industry and private food laboratories. After acquiring the distribution company in June 2011, Firm H started selling immediately, and therefore these customer segments became effective or realized. A few months later, Firm H was given a grant of € 1.5 Million from the European Community to do automatic testing of caucuses in abattoirs, part of a collaboration with abattoirs in France and Denmark to automate the testing process. Thus, the meat industry (namely abattoirs) became an intended customer segment as well. In April 2012, a new intended customer segment was added: government laboratory testing. According to the CSO, this was a deliberate attempt from Firm H to enter the legislation area, i.e., legislated area of government testing, due to its business attractiveness.

> *"Simply because it's potentially so profitable. It's a very profitable area, and I believe that we can actually make the materials far cheaper than the existing competitors. There's very little competition, there's only about two companies in the world."* (Month 12)

The value proposition has also been receiving some additions throughout the interviewing period. In June 2011, the possibility of renting equipment (luminometers and robots) rather than just selling it, was added. Firm H realized that some food companies or testing organizations did not intend to invest large sums of money on capital equipment. Therefore they prefer the rental option. In October 2011, an automatic testing system for slaughter houses started being developed. In March 2012, the R&D team started also to develop mycotoxin assays.

Table 4.23 Changes in Business Model Elements (CS to KR): Firm H

Interview Dates	Customer Segments	Value Proposition	Channels	Customer Relation-ships	Revenue Streams	Key Resources
Apr 2011 (NOTE: Acqui-red another compa-ny between May 2011 and June 2011)	*- Food industry* *- Private food laboratories*	- Innovative research - New diagnostic kits (assays, 2x fast and sensitive than competition) - Develop and offer luminometers - Provide 2 types of products: consumables (assays) and equipment (luminometers and robots)	Communi-cation: Advertise-ment, website, exhibitions, attending conferences, phone *Sales: Direct (sales force, phone, web sales).*	Dedicated personal assistance: - Face-to-face in food companies (big companies, 70%) - Phone contact for (smaller companies, 30%)	- Selling consumables (assays)	- Human capital ("scientific brains") - Innovative research (knowledge generated) - Financial capital ("money")
Jun 2011	CS become realized	(+) VP includes selling consumables (assays), and sell or rent equipment (luminometers and robots)	Sales channels become realized		(+) - Selling and/or renting equipment (luminome-ters and/or robots)	(+) - Sales and marketing staff - Robot technical staff - Production plant
Jul 2011	No changes					
Sep 2011			*(+) Looking at additional distributors in European countries*			
Oct 2011		(+) - Automatic testing system for slaughter houses	*(+) Looking for potential distribution/s ales in China, US, and Canada*			*(+) - Moving to new production premises* *- New CEO appointed (old CEO becomes non-exec. Director)*
Nov 2011	*(+) - Meat industry (Abbatoirs)*					(+) - New appointed director
Jan 2012			*(+) Looking for potential distribution/s ales in India*			
Mar 2012		(+) - Started to develop mycotoxin assays				(+) - Recruited new staff member and a student
Apr 2012	*(+) - Government laboratory testing*					(+) - Recruited new technical manager - Recruiting more production personnel

These incremental additions have been strengthening and widening the scope of Firm H's value proposition. In terms of channels, what were intentions in April 2011, became effective in June 2011, after the acquisition of the distribution company. In September 2011, as the company intended to expand geographically, they started looking for additional distributors in European countries. In October 2011 Firm H started looking for potential distribution/sales in China, US, and Canada, and later, in January 2012, also in India. The customer relationships were always based on dedicated personal assistance, and suffered no modifications throughout the 12-month period. In terms of revenue streams, Firm H was intending to sell assays before, but after the acquisition in June they started selling consumables, and also selling or renting equipment (luminometers and robots).

There were a considerable number of events occurring in the resources domain. In April 2011, key resources were very much the resources of a typical research-oriented enterprise: human talent, the knowledge generated with it, and financial capital to sustain the research activity. The acquisition of the distribution company, with a somehow complementary activity, brought in new crucial resources: sales and marketing team, technical staff to deal with the equipment, and a production plant. By October 2011, the CSO disclosed their intentions of moving to new premises, and to recruit a new CEO, who was effectively appointed in November 2011. In March 2012, a new staff member and a student were recruited, and in April 2012, a new technical manager was brought in. At that point, they were in the process of interviewing more production personnel, to sustain the increasing volumes of production.

Table 4.24 displays the evolution of key activities, key partners, cost structure, funding, and goals. Initially, key activities were problem solving, R&D, and fundraising. In June, after the acquisition, two activities were added: sales, and trials to get accreditations. With increasing production, this became a key activity in March 2012. In April, as they completed the third round of private investment and

had already enough money to sustain Firm H's activity, they stopped fundraising, and consequently this was removed as a key activity.

Table 4.24 Changes in Business Model Elements (KA to Goals): Firm H

Interview Dates	Key Activities	Key Partners	Cost Structure	Funding	Goals
Apr 2011 (NOTE: Acquired another company between May 2011 and June 2011)	- Problem solving - R&D - Get investment money (fundraising)	- University - Scottish Enterprise (seed funding, and match funding) - Anglo Scientific (private equity)	- Salaries - Laboratory (cost of rental) - Cost of consumables - Cost of capital equipment	- Private equity (Anglo and SE) - Grant funding	To become a major player in the food diagnostic world, as a "total" organisation from supply of initial products, to sales of final products
Jun 2011	(+) - Trials to get accreditations - Sales		(+) - Production plant related costs		
Jul 2011				(notes) Additional private investment	
Sep 2011			- Salaries (50%) - Laboratory (cost of rental, 10%) - Capital equipment (20%) - Consumables (20%)	(notes) Additional grant funding (1.3 Million grant from Euro-stars EU program)	
Oct 2011					
Nov 2011		*(+) - Looking for future distribution partners in US, Canada and China*		(notes) Private equity: got last round of 750k GBP	
Jan 2012		*(+) - Looking for future distribution partners in India*			
Mar 2012	(+) - Production			(note) last round of private equity	
Apr 2012	(-) - Fundraising (private equity) phase finished			(note) Fundraising finished (private equity)	

Intentions for the business model are represented in italic style

In terms of key partners, none were effectively added during the interviewing period. Nevertheless, in November 2011, the CSO disclosed their intention of establishing future partnerships with distributors in the US, Canada and China. And in January 2012, this intention extended to India as well. The cost structure only suffered a transformation during the tracking period, with the addition of costs related to the production plant, mainly due to the acquisition of the production/distribution subsidiary. Initially, funding comprised private equity and government match funding, and the type of financing did not change during the interviewing period, though there were additions in terms of quantity. In July 2011, Firm H got additional private investment, and in September 2011 they got additional grant funding (€1.3 Million) from a European program. Between November 2011 and April 2012, Firm H got their third and last round of private equity. Firm H's goal was in April 2011 *"to become a major player in the food diagnostic world, as a total organization from supply of initial products, to sales of final products"* (Month 0). Such goal has endured throughout the whole interviewing period.

4.10 CROSS-CASE DISPLAYS

In the previous sections, each case was explored and described in detail. In order to deepen the global understanding of the cases, the current section presents cross-case displays in the form of tables. These tables outline the data in a condensed and synthesized fashion, providing a more holistic view on relevant properties concerning the whole cohort. Such integrated view facilitates case comparison, and eases the identification of similarities and/or differences across the cases (Miles & Huberman, 1994).

Table 4.25 displays the main characteristics and properties of the cases, such as the main informants and their current roles in the firms, the parent department or research institute that originated the university spin-off, and a short business description. The same table also shows the most critical resources for opportunity development, the sources of basic technology and competence, and how the founders came up with the initial ideas.

The main informants throughout the interviewing period were predominantly the CEOs (3 cases) or occupied a scientific/research position within the firm (CSO or Principal Researcher, 3 cases). In the remaining 2 cases, the main informants performed a supportive market/externally-oriented role (Chief Business Officer and Executive Director). The most common additional role carried out by the main informant was that of a typical academic professional (researcher/lecturer/professor, 5 cases). The main informants from firms B and C performed no additional roles, and the main informant from firm E was a consultant of biotechnology startups.

The department that originated more spin-offs was the electronic and electrical engineering department (3 cases), followed by the institute of pharmacy and biomedical sciences (2 cases). The remaining 3 cases had their origins in an institute on applied photonics, in the department of applied chemistry, and in the mechanical engineering department. A short business description of each of the cases is display on Table 4.25. In terms of critical resources for opportunity development, 6 of the cases referred *financial capital* as the most critical one. Firm D and H referred that their most critical resources were the CEO's knowledge of the science and investors, and the founding team's technical and market knowledge, respectively. All the cases stated that their source of basic technology and competence was the university research. Three cases mentioned additional sources: patent (Firm D), and industry experience (Firms F and H). The contexts of the initial ideas are quite idiosyncratic, and brief descriptions of them are included in the last line of the table.

Table 4.26 shows the most relevant founding team properties for the current study. In this cohort, the number of individuals in the founding team ranges from 1 to 3: Firms B, and C (1 founder); Firms A, G, and H (2 founders); Firms D, E, and F (3 founders). In the firms founded by 1 individual, the founder occupied the CEO role (Firms B and C). In the firms with more than one individual in the founding team, it is typical that some of the founders will perform other roles outside the firm, such as researcher, lecturer, director, manager, and/or consultant. The age of the founders is quite varied, exhibiting an amplitude of 40 years. The date of birth of the oldest founder is 1942 (69 years old at first interview date), and the date of birth of the youngest founder is 1982 (29 years old at first interview date). Five of the cases did

Table 4.25 Main Characteristics and Properties of the Cases

Case	A	B	C	D	E	F	G	H
Main informant	CEO and Founder	CEO and Founder	CEO and Founder	CSO and Founder	CBO and Founder	P. Researcher and Founder	Director and Founder	CSO and Founder
Additional roles	Research Fellow	None	None	Honorary Lecturer	Consultant	Senior Lecturer	Lecturer	Professor
Original department / research institute	Electronic and Electrical Engineering Dep.	Electronic and Electrical Engineering Dep.	Research institute on applied photonics	Institute of Pharmacy and Biomedical Sc.	Department of applied chemistry	Electronic Engineering Dep.	Mechanical engineering dep.	Pharmacy and Biomedical Sciences dep.
Business description	Provides industry-leading automated solutions to structural inspection problems.	Develops and designs consumer electronics for energy efficiency in the home and office.	Specialises in microLED technology to create high brightness micro-display platform solutions.	Develops antimicrobial products for treatment and prevention of bacterial contamination.	Develops a new class of anti-infective medicine, with antibacterial effects against resistant bacteria.	Makes monitoring equipment for the agricultural sector. Collar mounted in cow, measuring cow's changes in behaviour.	Development, production, and exploitation of technical solutions to generate electricity from tides.	Specialises in the rapid detection of food pathogens using innovative diagnostic products.
Critical resource for opportunity development	Financial capital	Financial capital	Financial capital	CEO knows science & investors	Financial capital	Financial capital	Knowledge and financial capital	Technical and market knowledge
Source of basic technology and competence	University research	University research	University research	Patent and the university research expertise	The university research	Research and industry experience	Research group at the university	Research and industry experience
Context of the initial idea	Doing Phd in the field, he identified interest in the technology from industry, and saw an opportunity to capitalise on the research.	Identified a problem (appliances getting left on in rooms when there was nobody there) and then thought of a solution.	Founder looked at new technologies and market areas, and contacted the institute. Decided to form a spin-off to commercialize the technology.	Emerged from research carried out since 1993. After trying licensing with limited success, the leading scientist decided to spin-off.	Idea emerged in a local pub. Encouraged by past experience, they decided to start a company, and looked for technologies and partners.	Opportunity emerged from market research undertaken by a government agency, who then funded the EE department to develop a solution.	Research for tidal technology, followed by development. When testing, got very good results, and identified an opportunity.	Research done in the dep. Two founders formed a company. They identified an opportunity, due to their knowledge of the technology and markets.

Table 4.26 Founding Team Properties

Case	A	B	C	D	E	F	G	H
Number of founders	2	1	1	3	3	3	2	2
Roles of the founders (spin-off)	CEO; Consultant	CEO	CEO	CSO; 2 Managers (n.a.)	CBO (n.a.); CEO (n.a.); CFO (n.a.)	Researcher (a.); CTO (a.); Chief Eng (a.)	CEO (a.); Director (n.a.)	CSO (a.); CEO (n.a.)
Other roles (founders)	Researcher; Lecturer	None	None	Researcher; Director; Manager	Consultant; Consultant; Manager	Reader; Professor; none	Lecturer; Director of companies	Professor; Management consultant
Year of birth (founders)	1982; (?)	1974	1969	1942; 1960; 1943	1957; 1949; 1955	1961; 1957; 1981	1966; 1958	1943; 1961
Nr of other individuals involved	3	0	1	0	1	0	0	0
Role of the other individuals	1 market researcher; 2 PhD students	n/a	Senior process engineer	n/a	Senior project manager	n/a	n/a	n/a
Market knowledge (0-10)	7	7	6	10	9	9	10	9
Market knowledge, years (y)	4 y; 10 y	2 y	2 y	10 y; 20 y; 20 y	20 y; 20 y; 20 y	6 y; 6 y; 6 y	20 y; 20 y	25 y; 4 y
Managerial knowledge (0-10)	3	7	6	9	9	8	10	9
Managerial knowledge, years (y)	2 y; 14 y	5 y	13 y	10 y; 10 y	20 y; 20 y; 20 y	12 y; 12 y; 8 y	3 y; 30 y	12 y; 15 y
Entrepreneurial knowledge (0-10)	2	7	6	9	9	8	9	10
Entrepreneurial knowledge, years (y)	1.5 y; 1.5 y	3 y	13 y	10 y; 10 y	12 y; 12 y; 12 y	12 y; 12 y; 8 y	3 y; 20 y	15 y; 15 y
Entrepreneurial knowledge (nr of firms created)	0	2	3	9	4; 4; 6 (tot.=14)	2	6	5; 5 (tot.=10)
Commitment of the founding team (%)	50%; 5%	100%	100%	100%; 100%; 25%	100% (P.M.); 80%; 60%; 20%	100% (CEO); 100%; 30%; 30%	100%; 60%	100% (CEO); 60%

not involve additional individuals in the firm during the founding period. The other cases involved 1 market researcher and 2 PhD students (Case A), a senior process engineer (Case C), and a senior project manager (Case E).

The following section of Table 4.26 synthesizes data gathered on market, managerial, and entrepreneurial knowledge, and commitment of the founders to the firm. Market, managerial and entrepreneurial knowledge were both self-evaluated by the individual (scale 0 to 10), and measured in years (y), whenever possible, for each individual in the founding team. In addition, to strengthen the measurement of entrepreneurial knowledge, an additional indicator was collected: the number of firms created in the past by each founder. Market knowledge (self-evaluated) ranged from a minimum of 6 (Firm C) to a maximum of 10 (Firms D and G). In number of years, it ranged from 2 years (e.g., Founder and CEO of firm B) to a maximum of 25 years (one of the founders of Firm H). Managerial knowledge (self-assessment) ranged from a minimum of 3 (Firm A) to a maximum of 10 (Firm G). In terms of years, it ranged from 2 years (younger founder of Firm A) to 30 years (older founder and Director of firm G). Entrepreneurial knowledge (self-assessed) ranged from a minimum of 2 (Firm A) to a maximum of 10 (Firm H). In terms of years working in startups/entrepreneurial firms, it ranges from a minimum of 1.5 years (founders of Firm A) to a maximum of 20 years (Director of Firm G). The number of companies previously created by the founding teams ranges from 0 (Firm A) to a maximum of 14 (Firm E). In terms of commitment of the founding team to the spin-off, Firm A is the one exhibiting less commitment from the founding team (the CEO is only half of the his time dedicated to the spin-off), followed by Firm H's CEO, who is almost exclusively committed to the spin-off (80% of his working time). All the other firms have at least one person exclusively dedicated to the spin-off (100% commitment).

Table 4.27 summarizes relevant properties of the cases concerning technology development, market development, funding, time-to-market, orders, and sales. For almost all cases, technology is mainly developed within the firm, though in cases C, G, and H, the firm receives considerable contribution from the academic consultants, the research unit (20%), and the university's research team, respectively. All cases, except for firm F, have other performers carrying out a more secondary

Table 4.27 Technology Development, Market Development, Funding, Time-to-Market, Orders, and Sales (March 2011)

Case	A	B	C	D	E	F	G	H
Major performer of technology development	CEO	Firm B	CEO; Academic consultants	CSO	Founders; Project manager	Firm F	Firm G (80%), Res. Unit (20%)	CSO and team
Other performers of technology development	National lab; 1 MNC, and 1 medium-sized company	Universities; Industrial partners	Major customers	Senior scientist and contract researchers	Advisory board and external contractors	None	Supply chain partners	Other founder
Major roles in market development	CEO; External market researcher	CEO	CEO; Academic consultants	CEO	CBO	CEO and key partners	CEO (40%); Director (60%)	Acquired distributor
Initial funding	Research fellowship	Self-funding	Sweat equity plus sum from CEO Designate	Research fund and government fund.	Angel investment	No external funding (prior to spinout, R&D fund)	Industrial investor in oil & gas (£ 5M)	Venture Capital
Self-funding	No	Yes	Sweat equity	No	Yes (founders)	Yes	Yes	Yes
Major source of funding	Research Fellowship	Public grants (enterprise fellowship)	Business angel, and government match fund	VC (50%), government match fund (50%)	Angel (50%), government match fund (50%)	Sales	Industrial investor	Venture Capital
Additional funding sources	£ 69K from a national laboratory	Private investment (business angels)	Early sales of bespoke systems (since month 3)	No	The founders	None	None (looking for government grants)	Government award
Estimated time-to-market	2 years	Already in market (3 yrs)	Month 25 (for volume sales)	2 years (March 2013)	2016	Already in market	Spring 2012	6 months (Sep 2011)
Date of first sales	n/a	23rd Mar 2011	Oct 2010	n/a	Not selling directly (license)	June 2010	n/a	October 2011
Date of first customer order	n/a	23rd Mar 2011	Sep 2010	n/a	Idem	June 2010	Autumn 2012	March 2011
Estimated date of first customer order	2 years (Mar 2013)	Already in market	n/a	2 years (March 2013)	Idem	Already in market	Autumn 2012	Already in market

role in technology development. These "other performers" of technology development are varied, though they are usually institutions, except for case H (it is an individual, one of the former founders), case D (partly performed by a senior scientist) and case F, which has no other performers. The institutions are (and this categorization is by no means mutually exclusive): multinational companies, medium-sized companies, industrial partners, major customers, external contract researchers, supply chain partners, national laboratory, and universities. Almost all cases have the CEO as an important figure in market development, except for Case E (this role is performed mainly by the CBO) and Case H, which delegated this role to the acquired distributor. Nevertheless, half of the cases use the support of other individuals to help with market development: external market researcher (Case A), academic consultants (Case C), key partners (Case F), and Director (Case G).

The initial funding came from various sources: research fellowship, self-funding, CEO designate scheme, R&D funds, government grant, industrial investor, venture capital, and angel investment. Five of the cases were also self-funded (Cases B, E, F, G, and H). In terms of the major source of funding, 5 of the cases are totally or partly financed by the government/public sector : government match funding (Cases C, D, and E) or fellowships (Cases A and B). However, 5 of the cases are also totally or partly financed by the private sector: angel investment (Cases C and E), venture capital (Cases D and H), industrial investor (Case G), and exclusively by sales (Case F). The cases whose major source of funding is exclusively the private sector are cases F, G, and H. The cases whose major source of funding comes exclusively from the public sector are cases A and B. Five of the cases have additional funding sources, namely: consultancy or early sales of bespoke systems (Cases A and C), angel investment (Case B), the founders (Case E), and a government award (Firm H).

The remaining of the Table 4.27 displays properties of the cases concerning the estimated time-to-market, customer orders, and sales. These values reflect the state of the cases in March 2011, when the initial interview to collect generic case data was conducted. At that time, only Cases B and F were already in the market, i.e., effectively getting revenue streams from sales to customers. Both Case B and

Case F took approximately 3 years to go to market. All the other cases advanced estimations to go into market: Case A (2 years); Case C (25 months); Case D (2 years); Case E (5 years, special case); Case G (Spring 2012); Case H (6 months). Case E is an exceptional case, since this firm does not intend to sell directly to the end customer: it will either license the technology, or sell the whole firm.

4.11 MEASUREMENT OF CONSTRUCTS

4.11.1 Market, Managerial, and Entrepreneurial Knowledge

This subsection explains how market, managerial, and entrepreneurial knowledge were measured. The indicators defined in Section 3.6 of the Methodology Chapter were used to collect the appropriate data. The data collected for each case regarding market, managerial, and entrepreneurial knowledge were shown on Table 4.26 ("Founding team properties"). The data was transformed in order to classify it according to an ordinal scale comprising three values: low, medium, and high. The intermediate steps and results of such computation are displayed in Table 4.28, and are described below.

Market and managerial knowledge were assessed by a combination of three indicators: self-assessment (0-10), number of years (SUM, i.e., the sum of number of years for all the individuals in the founding team), and number of years (AVG, i.e., averaged by the number of individuals in the founding team). These three indicators were all normalized to a scale from 0 to 10, and then added together (*Normalized* SUM: 0-30). This final sum was then converted to a scale from 0 to 10 (*Normalized* SUM: 0-10). Using the scale displayed on the bottom of Table 4.28, this final indicator was converted into a qualitative scale that classifies market and managerial knowledge according to three values: low (L), medium (M), and high (H).

Entrepreneurial knowledge was assessed by a combination of the same indicators used for market and managerial knowledge, and by a combination of two additional indicators: number of firms created (SUM, i.e., total number of firms

created by all the individuals in the founding team), and number of firms created (AVG, i.e., averaged by the number of individuals in the founding team).

Table 4.28 Measuring Market, Managerial, and Entrepreneurial Knowledge

(see text below for explanation)

Case	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Founding team (number of individuals)	2	1	1	3	3	3	2	2
Market knowledge								
1. Self-assessment (0-10)	7	7	6	10	9	9	10	9
2. Nr. of years (SUM)	14	2	2	50	60	18	40	29
3. Nr. of years (AVG)	7.0	2.0	2.0	16.7	20.0	6.0	20.0	14.5
Normalized SUM (0-30)	*12.8*	*8.3*	*7.3*	*26.7*	*29.0*	*15.0*	*26.7*	*21.1*
Normalized SUM (0-10)	*4.4*	*2.9*	*2.5*	*9.2*	*10.0*	*5.2*	*9.2*	*7.3*
Managerial knowledge								
1. Self-assessment (0-10)	3	7	6	9	9	8	10	9
2. Nr. of years (SUM)	17	5	13	20	60	32	33	27
3. Nr. of years (AVG)	8.5	5.0	13.0	6.7	20.0	10.7	16.5	13.5
Normalized SUM (0-30)	*10.1*	*10.3*	*14.7*	*15.7*	*29.0*	*18.7*	*23.8*	*20.3*
Normalized SUM (0-10)	*3.5*	*3.6*	*5.1*	*5.4*	*10.0*	*6.4*	*8.2*	*7.0*
Entrepreneurial knowledge								
1. Self-assessment (0-10)	2	7	6	9	9	8	9	10
2. Nr. of years (SUM)	1.5	3	13	20	36	32	23	30
3. Nr. of years (AVG)	1.5	3.0	13.0	6.7	12.0	10.7	11.5	15.0
4. Nr. of firms created (SUM)	0	2	3	9	14	2	6	10
5. Nr. of firms created (AVG)	0.0	2.0	3.0	3.0	4.7	0.7	3.0	5.0
Normalized SUM (0-50)	*3.4*	*11.7*	*21.0*	*26.0*	*37.9*	*25.6*	*27.9*	*36.5*
Normalized SUM (0-10)	0.9	3.1	5.5	6.8	10.0	6.7	7.4	9.6
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Market knowledge	M	L	L	H	H	M	H	H
Managerial knowledge	L	L	M	M	H	M	H	H
Entrepreneurial knowledge	L	L	M	M	H	M	H	H

Scale:

0 <= x < 4: Low (L)

4 <= x < 7: Medium (M)

7 <= x <= 10: High (H)

These five indicators were all normalized to a scale from 0 to 10, and then added together (*Normalized* SUM: 0-50). As with market and managerial knowledge, this final sum was then converted to a scale from 0 to 10 (*Normalized* SUM: 0-10). Again, using the scale displayed on the bottom of Table 4.28, this final indicator was converted into an ordinal scale that classifies entrepreneurial knowledge according to three values: low (L), medium (M), and high (H).

The qualitative assessment of the levels of market, managerial, and entrepreneurial knowledge is displayed in the bottom of Table 4.28, with grey shading. As can be easily observed, case B is the case showing the lowest levels of market (L), managerial (L), and entrepreneurial knowledge (L), whereas cases E, G, and H have the highest levels of market (H), managerial (H), and entrepreneurial knowledge (H).

4.11.2 Commitment

This subsection explains how commitment was assessed. The indicator comprising the measure of commitment defined in Section 3.6 of the Methodology Chapter was used to collect the appropriate data. The data collected for each case concerning commitment is also shown on Table 4.26 ("Founding team properties") in Section 4.10 ("Cross-case Displays").

Commitment was collected and assessed by asking the percentage of working week hours dedicated to the spin-off in relation to the total working week hours, for each member of the founding and/or management team. The final measure of commitment refers to the commitment of the most *active* of the members of the executive management/founding team, i.e., to the executive member who dedicates more time to the spin-off. Table 4.29 summarizes the measurements of the commitment of the founding team, and the role of the most committed member, for each case. The final value of commitment (in percentage) is shown on the bottom of the table, in grey shading.

Table 4.29 Measuring Commitment

Case	A	B	C	D	E	F	G	H
Commitment of the founding team (%)	50%; 5%	100%	100%	100%; 100%; 25%	100%; 80%; 60%; 20%	100%; 100%; 30%; 30%	100%; 60%	80%; 60%
Role of the most committed member	CEO	CEO	CEO	CEO	Project Manag. (P.M.)	CEO	CEO	CEO
***Commitment* (%)**	50%	100%	100%	100%	100%	100%	100%	80%

4.11.3 Performance

This subsection explains how university spin-off performance was assessed. The indicators comprising the measure defined in Section 3.6 of the Methodology chapter were used to collect the appropriate data. To respect confidentiality, the raw data collected for each case concerning spin-off performance are not displayed. The different indicators were organized in a spread sheet, and their values ranked using the RANK.EQ function in Microsoft Excel for Mac OS. Table 4.30 displays the ranks for each of the different performance indicators, by case.

A compound measure for spin-off performance, that aggregates all the different indicators into one single measure, was developed. This aggregate measure of spin-off performance corresponds to the linear sum of all the rankings. Using the scale shown on the bottom of Table 4.30, the sum of the rankings was converted into an ordinal measure of performance with four different values: Low (L), Medium (M), High (H), and Very High (VH). The eight cases were then grouped into these quartiles by score: the bottom two cases (A and B) were classified as Low; the next two cases as Medium (C and D); the following two cases (E and F) as High; and finally, the top two cases (G and H) as Very High. The resulting qualitative evaluation of performance is presented in the bottom of the table, in grey shading.

Firm performance is widely known to be a sensitive issue. In the present multiple case study, different companies – depending on the sector, size, and/or other

Table 4.30 Measuring Spin-Off Performance

Performance indicators	A	B	C	D	E	F	G	H
Market value (May 11)	1	2	3	4	7	5	8	6
Market value (May 12)	1	2	4	3	7	6	8	5
Market value (relative growth)	1	3	5	4	7	5	8	2
Patents (accepted)	1	1	4	5	8	1	7	5
Patents (filed)	2	3	6	8	6	1	3	3
Self-financing	1	3	5	4	8	2	6	7
Private equity	1	3	5	4	7	1	8	6
Grants	5	1	3	2	6	4	8	7
Manifestation of interest in:								
- Buying the business	1	1	1	1	8	1	6	6
- Licensing	1	1	6	7	8	1	5	1
- Partnering	4	1	1	5	8	5	5	1
Sales (May 11)	1	1	1	1	1	8	1	1
Sales (May 12)	5	3	4	5	1	7	1	8
Sales (relative growth)	1	1	1	1	1	8	1	7
Nr of employees (FTE, May 11)	1	1	4	5	6	7	3	8
Nr of employees (FTE, May 12)	1	3	6	5	4	7	2	8
Nr of employees (relative growth)	1	8	5	4	1	3	6	7
Stage of Product Dev. (May 11)	2	7	2	6	1	7	2	2
Stage of Product Dev. (May 12)	1	7	1	1	1	7	1	1
Self-perception of overall performance	1	2	4	6	6	2	4	6
Satisfaction with the spin-off progress	1	3	5	7	7	1	3	5
Customer orders (May 12)	1	4	4	1	1	7	8	4
Estimated sales for the next 12 months	1	5	4	3	1	6	8	7
Anticipated annual sales (Year 5)	2	3	8	1	5	4	7	6
Anticipated nr of employees (Year 5)	6	1	8	3	1	5	4	7
Start-up organizing activities (May 11)	1	4	4	2	7	7	2	4
Start-up organizing activities (May 12)	1	7	8	5	3	2	5	3
Start-up progress (May 11-12)	1	5	6	6	3	2	6	4
Overall performance rank (SUM)	47	86	118	109	130	122	136	137
Classification of ***performance***	L	L	M	M	H	H	VH	VH

* Scale (overall performance rank):

relevant dimensions – will attribute different importance to different indicators when evaluating their performance (e.g., more IP-based spin-offs will attribute higher importance to the number of accepted and filed patents). Thus, some sensitivity tests were performed to evaluate the consistency and the robustness of this compound measure of spin-off performance.

First, a ranking table similar to Table 4.30 was computed, but using the RANK.AVG function also provided in Microsoft Excel for Mac OS. The resulting absolute values for the compound measure (sum of all ranked indicators) were slightly different, but the overall relative performance was exactly the same, and so was the ordinal rank of the performance.

Second, the computation reported in Table 4.30 treated all the individual indicators as equally important. That criterion was relaxed by attributing different weights to different indicators, and then by analysing the resulting overall performance value and the subsequent qualitative classification of performance (low, medium, high, very high). For instance, case F attributes higher emphasis to sales, since they are mostly self-financed and do not own intellectual property. However, Firm G gives more importance to their company's market value (the highest in the cohort), since they are not selling yet. Therefore, slightly higher weights were attributed to market value, number of patents, sales, and number of employees (not simultaneously, but one by one), and the resulting overall relative performance was always similar. Such outcome is related with the relatively high number of indicators considered (28 individual indicators), which *stabilize* the overall performance measure.

Therefore, the stability of the aggregate measure of performance under the scrutiny of the described sensitivity analysis indicates its relative consistency and reasonable degree of robustness. As one can now easily observe, according to the qualitative measure of performance developed, cases E, F, G, and H are the highest performing cases, whereas cases A and B are the lowest performing cases.

Table 4.31 below displays a summary of the measures for market knowledge, managerial knowledge, entrepreneurial knowledge, commitment, and university spin-off performance, to facilitate cross-case comparison.

Table 4.31 All Measures: Knowledge, Commitment, and Performance

Case	A	B	C	D	E	F	G	H
Market knowledge	M	L	L	H	H	M	H	H
Managerial knowledge	L	L	M	M	H	M	H	H
Entrepreneurial knowledge	L	L	M	M	H	M	H	H
Commitment (%)	50%	100%	100%	100%	100%	100%	100%	80%
Spin-off performance	L	L	M	M	H	H	VH	VH

4.12 CONCLUSION

This chapter presented the individual cases of the eight university spin-offs. Each case was explored and described in detail by using tables with the characteristics and properties of each case and event listing matrices (Lewis, 2003; Yin, 2009). Those tables and matrices provided a chronological synthesis of the key events related to business models during the 12-month interviewing period. The initial within-case displays were the basis for developing a detailed and structured account of the cases, focused on dimensions and constructs of relevance to study business model change and performance. The subsequent cross-case displays (see Section 4.10) provided a holistic and integrated view of the eight cases, allowing a more straightforward comparison of relevant characteristics and dimensions for this study. The text supported the displays presented, and attempts to reveal pertinent commonalities between the cases, as well as their idiosyncratic characteristics. Section 4.11 explained how operationalized constructs were measured, namely market knowledge, managerial knowledge, entrepreneurial knowledge, commitment, and spin-off performance. The next chapter will present a detailed analysis of the cases described above.

5 ANALYSIS

5.1 INTRODUCTION

In the previous chapter, each case was explored and described in detail by using tables with their attributes and chronological business model maps. Those tables and maps provided a synthesis of key events related to the business models during the 12-month interviewing period. The initial within-case displays were the basis for developing a detailed account of the cases, focused on dimensions of relevance to study business model change and performance. The subsequent cross-case displays (see Section 4.10) provided an integrated view of the eight cases, allowing a straightforward comparison of relevant dimensions for this study. Finally, the measurement of previously identified and operationalized constructs (see Section 3.6) was performed.

This thesis started with the intention of unfolding the process of business model change in early-stage university spin-offs, namely by investigating closer how each business model element changes, and by examining subsequent impact on spin-off performance. Having performed within-case and cross-case presentations of the collected data (see Chapter 4), the attention of this chapter turns to the structured analysis of these data. By contrasting the cases across relevant attributes and constructs, several propositions are induced throughout this chapter.

This chapter starts by identifying the main drivers causing changes to the business models of this cohort of eight university spin-offs. These drivers were identified through open coding of the longitudinal interviews focused on business model change. In addition, several 'themes' related to business model change were also identified throughout the process of open coding, such as 'realized and intended business models' (Section 5.3), 'technology and business scope' (Section 5.5), 'causation and effectuation' (Section 5.6), and 'resource constraints' (Section 5.7). The remaining sections of this chapter (Section 5.3 to Section 5.7) will explore some of the identified themes that were more recurrent in the interviews. In particular, Section 5.3 introduces and explains the notions of realized and intended business models, one of the themes that promptly emerged from the data. To provide a clearer

picture of the number of changes underwent by the firms' business models throughout the longitudinal period, Section 5.4 examines business model change from a more quantitative perspective. It performs frequency analyses to changes in business model elements, and establishes relationships between previously identified constructs, such as commitment, market knowledge, managerial knowledge, entrepreneurial knowledge, and spin-off performance. This section also identifies patterns of change in business model elements (e.g., how changes in customer segments seem to lead to changes in realized and intended key resources) to generate a 'roadmap' for a more in-depth qualitative investigation of these patterns. Section 5.5 investigates how technology scope and business scope relate to business model change and how they subsequently impact early-stage performance. Section 5.6 uses the causation/effectuation theoretical framework to explore the relationships between the predominance of causal or effectual behaviors, business model change, and spin-off performance. Adopting a resource-based lens, Section 5.7 examines how resource constraints condition business model change and early-stage performance in university spin-offs. Finally, Section 5.8 concludes this chapter with a summary of main findings.

5.2 DRIVERS OF BUSINESS MODEL CHANGE

This section explores the main drivers causing changes to each business model element. This is relevant to understand how and why business model elements change and to identify themes related to this process of change. For this purpose, I performed open coding (Neergaard & Ulhoi, 2007; Strauss & Corbin, 1998) to all the interview transcripts, looking for drivers of business model change. Open coding corresponds to "the analytic process through which concepts are identified and their properties and dimensions are discovered in data" (Strauss & Corbin, 1998: 101). As a result of the open coding, various different *drivers* of business model change were identified. Those drivers were grouped in 2nd order, broader *categories*. In addition to drivers, different *themes*, related to the process of business model change, also emerged. This extensive list of categories and respective drivers is displayed in Table 5.1; the list of themes worthwhile exploring is displayed in Table 5.2. In all the

Table 5.1 Categories and Drivers of Business Model Change

Category	Driver	Freq.	Frequency by Company							
			A	B	C	D	E	F	G	H
Need **"extra resources"** (due to "resource constraints" of being a startup)	**Need "extra resources"**	**128**								
	[Financial capital] Funding (any type)	32		1		5		14	3	9
	[Financial capital] Private investment	14		1	13					
	[Financial capital] Grant funding	19	5		7		1	2	2	2
	[Human capital] Labor (due to increasing workload)	12	2	2	1		1		6	
	[Human capital] Scientific/technical expertise	14		2	2	3	1	3	2	1
	[Human capital] Management/financial expertise	10			2		1	3	1	3
	[Outsourced] Partnerships for product development, production, and/or distribution	7			1			6		
	[Human capital] Discontentment with existing resources	3							1	2
	[Human capital] Investment expertise	5			5					
	[Physical] New premises	4		2		2				
	[Intellectual capital] Filling patents to build IP	8			5	2		1		
Technology /prototype / product development	**Technology/prototype/product development**	**44**								
	Technology and product development	13	2				1	7	3	
	Background research, R&D, IP development, patenting	7	1		5		1			
	Product testing, trials, proof of concept	11	3					6	2	
	Normal operations	8						5	3	
	Prototype (demo) development	5	5							
	Developing supply chain	1							1	
	Outsourced production to keep core team small	1					1			
Growth (in sales)	**Growth**	**42**								
	Increase sales in additional markets (mainly geographical)	13					9			4
	Increase sales in same markets	12	1	5	1		1			4
	Large scale (high volume) production	6								6
	Seeking larger markets segments	3			3					
	Increase product range, by developing products or adopting complementary products	2		2						
	Developing distribution networks in target geographies	5		1						4
	Developing marketing strategy to increase sales	1					1			
Customers	**Customer interaction**	**42**								
	Develop technology/products for customers (got contracts to meet customer demands)	15	2	1	5	3	2			2

	Got interest / no interest from customers	6	3	1	1				1	
	Approached by large companies to partner (or to acquire spin-off)	6			1	5				
	Increasing knowledge about what customers want	7	1	2	3	1				
	Feedback from customers (taking into account what they tell)	5		1			4			
	Developing/creating own customers	3							3	
Causation vs. Effectuation	**Causation vs. Effectuation**	**29**								
	Uncontrolled external trends (e.g., social context, economic context)	6						1		5
	Networking (e.g., talking to people, random contacts triggered by websites)	6		2		3	1			
	Serendipity / unpredictability / unexpected / unplanned events	8		1		5		2		
	Following plan (as planned)	7		3			1	1	2	
	Internal revision of the business plan (planning)	2				2				
Restructu-ring	**Restructuring (e.g., Acquisition)**	**16**								16
Margin/profit growth (increase **cost-efficiency**)	**Cost-efficiency**	**16**								
	Margin/profit growth (in general)	3								3
	Looking for other manufacturer to decrease costs	5		5						
	Small margin, distributor model not working	4		4						
	Too expensive, too much resource commitment	1		1						
	Reduce costs (setup and transportation)	3		1		2				
Time-to-market	**Time-to-market** (longer/shorter)	**12**		4	1	4		1		2
Systemic nature	**Systemic nature** of business model elements	**9**	1	1	1		3	3		
Other drivers	**Other drivers**	**23**								
	Regulatory ease/requirements	6		2		2				2
	Increase visibility/exposure	6			3			3		
	Increase credibility/reliability	3		2	1					
	Competition related issues (e.g., belief that can be better and cheaper, confidentiality)	5			1			1		3
	Achieved milestones previously agreed with investors	3				3				

tables, the coding frequency, i.e., the number of times the code was applied to a portion of text, is also shown. This frequency is reported as a total ("Freq.") and by company ("Frequency by company").

For a matter of better manageability and parsimony, the number of drivers was reduced and reorganized. This process was inspired by extant literature on university spin-off development. Thus, by revisiting literature focused on the process of change or development of university spin-offs, certain drivers were merged and others eliminated. The work of Mustar et al. (2006), Rasmussen, Mosey, & Wright (2011), Shane (2004), and Wright et al. (2007) provided a solid framework on university spin-off formation and development to support the process of organizing and collapsing the identified drivers of business model change.

Table 5.2 Themes Related to Changes in Business Model Elements

Themes	Frequency
Market-pull vs. technology-push (and generic/platform vs. narrow-scope technologies)	13
Systemic nature / interdependence between business model elements	9
Customer interaction	9
Causation vs. effectuation	6
Definition of change, and different degrees of change (typology of BM changes)	4
Intended vs. realized business models	3
Resource constraints and impact in the business model	3
Co-development (or "piggy-back" development) and leveraging partners' resources	2
Time-to-market (low vs. high): choices based on this variable	2
Industry/market attributes (e.g. pace of change of industry, higher uncertainty in some markets)	2
Adequacy of BMC for early-stage research-based firms (difficulty of fit)	2

Drivers with a coding frequency lower than 3 were either merged or eliminated. Some categories were also relabelled and merged, and some drivers were included in other categories. For instance, "increase margin/profit" was relocated to the category "growth" as "margin/profit growth by reducing costs". In the category "customers", the driver "increasing knowledge about what customers want" was merged with "feedback from customers (taking into account what they tell)", and the

driver was relabelled to “increasing customer knowledge (from customer feedback)”. The need for “investment expertise” was merged with the need for “management/financial expertise”, and the driver renamed to “management/investment expertise”. “Discontentment with existing resources” and “new premises” were discarded, since they had few occurrences in the category labelled “extra resources”. Several other changes were performed. At the end of this reorganizing process, the initial 49 drivers were reorganized into a total of 27 drivers (see Table 5.3).

The three categories with higher coding frequency were “Need for extra resources” (count = 106), “Growth” (count = 54), and “Technology/product development” (count = 41). The drivers with higher coding frequency were “Need for [Financial capital] Funding (any type)” (count = 32), “Product development, including testing and trials” (count = 26), and “Need for [Financial capital] Grant funding” (count = 19). This result emphasizes the resource constraints and needs of early-stage university spin-offs, namely financial capital. It is important to stress that these categories and drivers are not mutually exclusive, i.e., firms may “need extra resources” for “growth” and/or for “technology/product development”. Therefore, each business model change may be triggered by a complex mixture of more than one driver. Moreover, there may be a sequence between these drivers, in which one driver may be *driving* the other drivers. For instance, in some cases, the intention to “Increase sales in additional geographical markets” (count = 18) may be leading to the establishment of “Partnerships for product development, licensing production, and/or distribution (or even acquisition)” (count = 13).

Table 5.3 Categories and Drivers of Business Model Change (Reorganized)

Category	Driver	Freq.	Frequency by company							
			A	B	C	D	E	F	G	H
Resources	**Need "extra resources"**	**106**								
	[Financial capital] Funding (any type)	32		1		5		14	3	9
	[Financial capital] Private investment	14		1	13					
	[Financial capital] Grant funding	19	5		7		1	2	2	2
	[Human capital] Management/investment expertise	15			7		1	3	1	3
	[Human capital] Scientific/technical expertise	14		2	2	3	1	3	2	1

	[Human capital] Labor force (increasing workload)	12	2	2	1		1		6
Growth	**Growth**	**54**							
	Increase sales in additional geographical markets	18		1			9		8
	Margin/profit growth by reducing costs	15		10		2			3
	Increase sales in same markets	12	1	5	1		1		4
	Large scale production and seeking larger markets	9			3				6
Technology / product develop-ment	**Technology/product development**	**41**							
	Product development, including testing and trials	26	5	2			1	13	5
	Background research, technology and IP development	10	1		5	2	1	1	
	Proof of concept and prototype (demo) development	5	5						
Customers	**Customer interaction**	**33**							
	Develop technology/products to meet customer demand (established contracts)	15	2	1	5	3	2		2
	Increasing customer knowledge (from customer feedback)	12	1	3	3	1	4		
	Got interest / no interest from customers	6	3	1	1			1	
Partners	Partnerships for product development, licensing production, and/or distribution (or even acquisition)	**13**			2	5		6	
Causation vs. Effectua-tion	**Causation vs. Effectuation**	**29**							
	Unexpected endogenous events (influenced by the firm, e.g. fortuitous discoveries or contacts)	14		3		8	1	2	
	Business planning and following plan	9		3		2	1	1	2
	Unexpected exogenous changes (out of firm's influence, e.g. epidemic)	6						1	5
Restructu-ring	Restructuring (e.g. acquisition)	**16**							16
Timing	Time-to-market (shorter/longer)	**12**		4	1	4		1	2
Interdepen-dence	Systemic nature of business model elements	**9**	1	1	1		3	3	
Other drivers	**Other drivers**	**19**							
	Increase visibility and/or credibility	9		2	4			3	
	Firm's normal operations	8						5	3
	Regulatory ease/requirements	6		2		2			2
	Competition related issues	5			1			1	3

Notes:

Drivers with frequency below 3 were either aggregated with other drivers or removed

Some of the identified themes will be explored in depth throughout the remaining of this chapter (e.g., "Intended vs. realized business models", "Market-pull vs. technology-push, and generic/platform vs. narrow-scope technologies", "Causation vs. effectuation", "Resource constraints and impact in the business model"). Due to resource constraints of the author (such as time!), not all themes will be explored in this thesis. However, as the data collected contains rich information on these topics, they may be explored during a post-doctoral phase. The next section examines one of the mentioned themes: "Intended vs. realized business models".

5.3 INTENDED AND REALIZED BUSINESS MODELS

While conducting the first interviews and subsequently analyzing the data, I recognized that entrepreneurs were often talking about their actual business models, as evidenced by the comments below:

> *"We've got one customer who is now asking about investing in our company."* (CEO firm C)

> *"We have four key suppliers [key partners] for the device. (...) Key activities right now are engineering and development."* (Director firm G)

However, the same entrepreneurs would abruptly interchange the previous comments on present issues with references to future intentions. The quotations shown below illustrate how these founders express their intentions towards their business models.

> *"It's possible to discuss the business model in the sense of what the company intends to do, and it will be much more difficult to discuss what it is actually doing, because it has only just started in that sense."* (CSO firm D)

> *"We narrowed the scope of our intended business. You would want to know why, I guess. ... We do not intend to grow the company, to employ hundreds of people. ... I'm very confident that if we do what we intend to do, we will have a partner, at least one."* (CBO firm E)

"So, that's what we intend to do, if that makes sense. ... It was always intended that we would bring out possibly other partners." (CSO of firm F)

In fact, sometimes the entrepreneurs would address almost simultaneously reality (present) and intentions (future):

"They [key partner] have been with us since day one [reality]. And they will be certainly in the UK for a long time. (...) Now, what may change is if we go overseas, because they are a UK based facility [intentions]." (CSO firm F)

Going back to the existing literature in business models, I found also evidence of this confusing mix between actuality/reality and intentions already in the definition of a business model. Such confusion clearly complicates the design of a research methodology aiming to study change over time, since the object of study – realizations or intentions – is not clear. For example, Osterwalder et al. (2010: 14) define business model as follows: "A business model describes the rationale of how an organization creates, delivers, and captures value". Such a definition implies a focus on the *present model* of how an organization operates (today). In the following page, Osterwalder et al. (2010: 15) write: "We believe a business model can best be described through nine basic building blocks that show the logic of how a company *intends* to make money". Such a definition, using the word "*intends"*, clearly invokes the future business model rather than the present, which is inconsistent with the previous definition. This inconsistency motivated me to dig into the problem, hoping to bring added clarity to the business model terminology.

In the realm of strategic management, this discussion has already taken place, addressing very similar concerns. More than three decades ago, Mintzberg (1978: 934) studied "both strategies that were *intended* and those that were *realized* despite intentions". The interplay between *"intended strategies"* and *"realized strategies"* has since been scrutinized (e.g., Koh & Venkatraman, 1991; Venkatraman, 1989). Snow & Hambrick (1980) address the major theoretical and methodological problems encountered when measuring organizational strategy. They discuss the challenges researchers face when studying strategy, due to the interplay between

intended and realized strategies, and also to the tenuous distinction between strategic *adjustment* or *change*. This thesis on business models faces analogous challenges.

This thesis collected data on these two levels of business models: the *realized business model(s)* and the *intended business model(s)*. I captured and mapped over time both realized business models (which are already implemented) and intended business models (residing in the entrepreneur's mind, and reflecting his intentions for the future of the firm). The data suggests that the entrepreneurs can have several intended business models, though they usually focus only on one, which they classify as their intended business model, i.e., the one they intend to pursue. Entrepreneurs then initiate their businesses with this intended business model in their minds. As they progress, parts of the intended business model become realized, and the realized business model starts forming itself. So, as changes occur, they gradually convert the intended business model into a fully realized business model. These changes are planned, since they are part of the entrepreneur's roadmap to arrive to the intended business model. Therefore, with time, the realized business model starts incrementally approaching the intended business model, and the overlap between them is increasing. What the entrepreneur seeks is to realize all of his intentions, and so he works towards making the realized business model equal to the intended business model.

While this previously planned process is in place, *external perturbations/shocks* to this process trigger unplanned changes in their intended business model (e.g., new ideas/solutions arising). These new ideas will result in a new, modified intended business model, which the entrepreneur will try to convert into a realized one. Thus, the entrepreneur will try to equalize the realized business model to this new intended business model. In some situations this process might be lengthy; in other situations this *"conversion"* is almost instantaneous. For example, when a new customer segment contacts the entrepreneur to buy his product/service, it suddenly might become part of the new intended business model. Once the transaction occurs, it will then become part of the realized business model as well.

These findings complement the dynamic view of business models proposed by Demil and Lecocq (2010: 227) based on the concept of "*business model evolution*

as a fine tuning process involving voluntary and emergent changes". This thesis proposes an additional perspective of business model change built on the notions of intentions and realizations applied to business models. It suggests that intended and realized business models co-exist and interact over time. The intended business model corresponds to the voluntary mental configuration of the business model that entrepreneurs project in the future; the realized business model is a result of the combination of the previous intended business model (voluntary) with unexpected changes that emerge throughout the process (emergent).

The following sections will draw on these new notions of realized and intended business models and treat these two types of business models as distinct entities, though highly interconnected. The next section examines the frequency of change of each individual element (or component) of both the realized and intended business models, and establishes relationships with selected constructs such as commitment, market knowledge, managerial knowledge, entrepreneurial knowledge, and spin-off performance.

5.4 FREQUENCY OF BUSINESS MODEL CHANGE

5.4.1 Introduction

Understanding the frequency of change in each business model element over time is a major research challenge. This process of counting changes is inherently complex, due to the uncertainty regarding what might be considered a change or an adjustment in this context. Since the issue of counting changes was vital for this study, additional researchers were involved in the process of evaluating changes in the business model elements, to enhance the research quality of such measure.

Hence, an email was sent to 5 other research experts, with tables containing the sequence of key events that occurred to the firms' business models. These tables correspond to the ones presented in the Results chapter (e.g., see Table 4.24). These experts were selected because they conduct research in the field of business models, are familiar with Osterwalder et al. (2010) Business Model Canvas, and apply it in different contexts, such as training, teaching and consultancy.

A first thought pointed towards defining a set of rules to assess business model element change. For instance, a set of rules could consider that an increase in something, e.g., a type of resource, is not a change; but if something new appears for the first time, or is recorded as being dumped (but not replaced with something similar), then it is a change. After thinking thoroughly on this issue of "rule setting" to assess business model changes, and after discussing it with some research colleagues, I concluded that this would bias the experts' sensitivity to what they consider to be "a change". Since they are experts in the field, I decided to present them the data, and allow them the freedom to define their own set of rules on assessing business model change.

This strategy was beneficial mainly for four reasons: 1) it avoided an *a priori* bias on what is a change, 2) it allowed for the set of rules to emerge naturally, 3) it allowed for the set of rules to be regarded as a research output itself, and 4) it allowed to check whether the set of rules defined by each expert converged. Hence, no *a priori* rules of what was a business model change were pre-defined – such decision was left to the subjective judgement of each researcher, in order not to bias the researcher with my individual, subjective view of what is a business model change. The majority of the researchers ended up using a similar set of rules:

- *Items* (e.g., customer segments, key activities) mentioned in the first meeting were not considered changes
- An increase in an existing *type of item* (e.g., a same type of resource, or a same type of customer segment) was not considered to be a change
- The introduction (+) of a new type of item (e.g., a new customer segment, a new key activity) was considered a change
- The deletion (-) of an existing type of item (and not replaced with a similar item) was considered a change
- Changes in priorities of items were not considered as changes (e.g., changes in the priorities of some key activities, or customer segments)

Table 5.4 below displays the evaluations of business model changes by the 6 different researchers, for each case, and each business model (realized and intended).

The total number of changes is also shown in the column "Total". Since these assessments were performed independently by each researcher (i.e., with no discussion or interaction between them), and no rules were pre-established, I consider the results fairly consistent.

Table 5.4 Evaluations of Business Model Changes from 6 Different Researchers

		Case																
		A		**B**		**C**		**D**		**E**		**F**		**G**		**H**		
		re	*in*	*re*	*in*	*re*	*in*	*re*	*in*	*re*	*in*	*re*	*in*	*re*	*in*	*re*	*in*	***Total***
Researcher	**R1**	1	2	21	12	12	9	6	6	2	5	7	2	10	2	13	8	***118***
	R2	3	1	13	4	5	7	4	7	2	3	5	1	6	1	11	2	***75***
	R3	0	2	18	7	12	5	5	4	2	3	9	0	8	1	11	1	***88***
	R4	3	2	23	9	4	5	3	6	2	3	8	2	3	2	7	5	***87***
	R5	0	2	20	10	10	9	6	7	2	5	6	2	8	1	12	5	***105***
	R6	0	1	24	8	12	9	6	7	2	5	10	2	9	2	19	7	***123***

The researchers' evaluations were then averaged and displayed in Table 5.5 below. The table shows the number of business model changes for all cases and for all elements of the Osterwalder et al. (2010) Business Model Canvas (BMC). For each case, two columns are presented: the left column displays the number of changes in the realized business model (*re*), and the right, shaded column displays the number of changes in the intended business model (*in*). A SUM of all the changes in the whole BMC is also shown, as well as changes in *Funding* and *Goals*. The table is complemented, at the bottom, with the previously computed measures of market knowledge, managerial knowledge, entrepreneurial knowledge, commitment, and spin-off performance.

The following subsections will attempt to establish relationships between the number of changes in the realized and/or intended business models, with commitment, market knowledge, managerial knowledge, entrepreneurial knowledge, spin-off performance, and other emerging constructs.

5.4.2 Commitment

The number of changes in the realized and intended business models for each case firm, detailed by its individual elements, is summarized in Table 5.5. These changes occurred between May 2011 and May 2012. There was high variation in the number of business model changes: the number of changes in the realized business models ranged from 1.4 (Case A) to 19 (Case B), whereas the number of changes in the intended business models ranged from 1.4 (Cases F and G) to 8.4 (Case B). Adding the number of changes of the intended and the realized business models provides a rough measure of the business model *activity* (either realized or intended) for each case. The combined number of changes of the realized and intended business models ranges from 3.2 (Case A) to 27.4 (Case B), which shows a relatively high variation in the number of changes for this cohort.

'Commitment' was assessed from interviews with the main informants, and refers to the ratio between the number of hours dedicated to the spin-off and the total number of working hours (weekly). This measure was collected for all founding/management team members, and the resulting measure of commitment refers to the most committed member of the team (usually the CEO). Commitment ranges from 50% (case A) to 100% (all other cases). As noted previously, firm A was the spin-off which changed its business model the least, as indicated by the total number of changes in the realized and intended business models (= 3.2). Case A is also the case that exhibits less commitment from its founder and future CEO. The spin-off is dormant (not active) and does not have any employees yet. This evidence suggests that commitment may have an association with the number of business model changes.

> *Proposition 1. Lower (higher) commitment of the founding team is typically associated with lower (higher) number of changes in the realized and intended business models in a fixed period (ceteris paribus).*

Table 5.5 Number of Changes in Intended and Realized Business Models

	A*		B			C			D			E			F			G			H**		B to G *(SUM)*	
	re	*in*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*re*	*in*
1. Customer Segments (CS)	0	1	1.4	2.2	*3.6*	0	2.4	*2.4*	0.8	4.6	*5.4*	0	1.8	*1.8*	0	0.8	*0.8*	0	0	*0*	0.4	1.4	2.2	11.8
2. Value Proposition (VP)	0	0	1.6	0.6	*2.2*	1.8	0.4	*2.2*	0	0.8	*0.8*	0	0.8	*0.8*	2.2	0	*2.2*	0	0	*0*	2.6	0	5.6	2.6
3. Channels (CH)	0	0	2.6	0.0	*2.6*	0	1.4	*1.4*	0	0	*0*	0	0.8	*0.8*	0	0	*0*	0	0.8	*0.8*	0.2	1.4	2.6	3
4. Customer Relationships (CR)	0	0	0.6	0.0	*0.6*	0	0	*0*	0	0	*0*	0	0	*0*	0	0	*0*	0	0	*0*	0	0	0.6	0
5. Revenue Streams (R$)	0	0.8	0	1.0	*1*	0	1	*1*	0.4	0.2	*0.6*	0	0.4	*0.4*	0	0	*0*	0	0	*0*	1	0	0.4	2.6
6. Key Resources (KR)	0	0	1.4	1.2	*2.6*	2.6	0.4	*3*	2.6	0.4	*3*	0.2	0	*0.2*	0	0	*0*	1	0	*1*	2.6	0.4	7.8	2
7. Key Activities (KA)	1.4	0	8	0.0	*8*	1.2	0	*1.2*	0	0	*0*	0.8	0	*0.8*	2	0	*2*	2.8	0	*2.8*	2.8	0	14.8	0
8. Key Partners (KP)	0	0	1.6	2.4	*4*	1	1.4	*2.4*	1	0	*1*	1	0	*1*	2	0.6	*2.6*	2	0.6	*2.6*	0.2	1	8.6	5
9. Cost Structure (C$)	0	0	1.8	1.0	*2.8*	2	0	*2*	0	0	*0*	0	0	*0*	0.8	0	*0.8*	1.2	0	*1.2*	1	0	5.8	1
SUM	**1.4**	**1.8**	**19**	**8.4**	***27.4***	**8.6**	**7**	***15.6***	**4.8**	**6**	***10.8***	**2**	**3.8**	***5.8***	**7**	**1.4**	***8.4***	**7**	**1.4**	***8.4***	**10.8**	**4.2**	**48.4**	**28**
10. Funding (F$)	0.4	0	1.8	0.8	*2.6*	1.8	1.2	*3*	1.2	0	*1.2*	0.6	2	*2.6*	1	0	*1*	1	0.4	*1.4*	0.6	0	7.4	4.4
11. Goals		1.8		4.0			2.4			0.6			1.2			1.2			0			0		9.4
Market Knowledge		M		L			L			H			H			M			H			H		
Manag. Knowledge		L		L			M			M			H			M			H			H		
Entrep. Knowledge		L		L			M			M			H			M			H			H		
Commitment (%)		50%		100%			100%			100%			100%			100%			100%			100%		
Performance		L		L			M			M			H			H			H			H		

Note: re = realized; in = intended

* *Firm A's status is dormant*

** *Firm H underwent restructuring during the data collection period (acquired another company)*

This finding links the notion of 'entrepreneurial commitment' (Erikson, 2002: 282), as the "emotional, intellectual, and physical energy that is employed in" reaching the firms' objectives, with the concept of business model change. More generally, this extends previous research in the area of entrepreneurial commitment (Eriksson, 2002; McCarthy, Schoorman, & Cooper, 1993) and organizational commitment (DeTienne, Shepherd, & De Castro, 2008; Johnston et al., 1990) by establishing a bridge with business model research. This result implies that a more committed team will change the business model faster, both at the realized and intended level, therefore reaching a viable, scalable, and profitable business model (Blank & Dorf, 2012) in a shorter time. The founder of Case A was almost exclusively focused on internal product development. Thus, Case A's interaction with the external environment was distinctly lower compared to the other cases. Such idiosyncrasy may suggest an additional relationship between frequency of interaction with external environment and the speed of the business model change process.

In order to control for commitment and maintaining it constant, Case A will, when appropriate, be excluded from the subsequent analysis. During the data collection period, Case H acquired a distributor (thus the higher number of employees). Such acquisition immediately prompted changes in the value proposition, revenue streams, key resources, key activities, and cost structure. Since Case H is also an exceptional case, it will also play an intermittent, special role in the analysis, together with Case A. Therefore, the cases that will more frequently be the object of analysis are Cases B to G.

5.4.3 Market, Managerial and Entrepreneurial Knowledge

As mentioned previously, three knowledge types were measured: market knowledge, managerial knowledge, and entrepreneurial knowledge. The remaining 6 cases (B to G) display a varied mixture of values for knowledge types, ranging from low to high. One finding is that when a type of knowledge has a certain value (e.g., high), the other types of knowledge seem to have a close or equal value, which suggests some sort of positive relationship between knowledge types. For example,

when market knowledge is high, managerial and entrepreneurial knowledge is usually also high (High: Cases E, G, and H; Medium: Case F; Low: Case B). This fact suggests a positive relationship between market knowledge, managerial knowledge, and entrepreneurial knowledge.

A second finding is that the number of changes in the intended and realized business models seem to be related to the level of knowledge. In fact, the case with simultaneously lower values of market, managerial and entrepreneurial knowledge (Case B) is the one experiencing the higher sum of number of changes in the realized and intended business models (27.4 changes). The cases with simultaneously higher values of market, managerial and entrepreneurial knowledge (Cases E and G) have the lower sum of number of changes in the realized and intended business models (5.8 and 8.4, respectively). Therefore, in the context of early-stage university spin-offs, this leads to the following proposition:

> *Proposition 2. Higher (lower) market, managerial and entrepreneurial knowledge is typically associated with lower (higher) sum of the number of changes in the realized and intended business models, in a fixed period (ceteris paribus).*

Previous work has shown that founding teams that incorporate individuals with prior experience in commercial contexts, and thus with greater market knowledge, positively impacts spin-off performance (Wennberg, Wiklund, & Wright, 2011). Similarly, Knockaert et al. (2011) found that science-based entrepreneurial teams incorporating both tacit knowledge about the technology and a commercial mindset, are more likely to reach post-founding speed to first product that will lead to enhanced firm performance. Proposition 2 complements this work by establishing a link with the business model construct. In particular, it suggests that founding teams with higher market, managerial, and entrepreneurial knowledge (intimately related to greater commercial experience or mindset) need less business model iterations (or changes) both at the intentional and realized levels, to converge to a viable business model.

5.4.4 Frequency of Change in Business Model Elements

As evidenced in Table 5.5, the element that changed more often in the realized business models (Cases B to G) was Key Activities (changed 14.8 times). The elements that changed less often in the realized business models were the Customer Relationships and Revenue Streams (0.4 and 0.6, respectively). In respect to the intended business models, the element that changed more often was the Customer Segment (11.8), and the elements that changed less often were the Customer Relationships (0) and the Revenue Streams (0). Considering the sum of the number of changes in the realized and intended business models, the element with the least sum of changes was Customer Relationships (0.6), and the elements changing more often were the Customer Segments, Key Activities, and Key Partners (14, 14.8, and 13.6, respectively).

Usually, entrepreneurs start by designing the customer-facing aspects of their business models to achieve an appropriate fit with their value proposition (Osterwalder et al., 2010). Of these customer-facing elements, the customer segment is frequently the *leading* one, i.e., the definition of the customer segment usually precedes the definition of the channels, and customer relationships. Therefore, the decision process involved in defining the customer segment is the one characterized by more uncertainty. In fact, after crystalizing the customer segments, a great part of the uncertainty is removed: all the remaining decisions to define the channels, customer relationships and the other remaining elements (e.g., key activities, key resources) are usually more straightforward.

As shown in Table 5.5 above, the element undergoing more changes in intentions is indeed the customer segment, i.e., the leading business model element, and the one usually characterized by more uncertainty. On the other hand, the more internal-facing elements (key activities, key resources) undergo much less changes in intentions, and are effectively changed. Such evidence may suggest a relationship between uncertainty and number of changes in the intended business model. Since higher knowledge usually results in less uncertainty, then the previous considerations on market, managerial, and entrepreneurial knowledge are also in harmony with this proposition. Therefore, one may propose that:

Proposition 3. The higher (lower) the uncertainty associated to a certain intended business model element, the higher (lower) the number of changes it undergoes (ceteris paribus).

This result adds nuance to the discussion of Sosna et al. (2010) regarding the adoption of experiential 'trial-and-error' approaches to business model change in contexts of uncertain and changing market conditions. It suggests that business model elements that establish an interface with contexts of higher market uncertainty (e.g., customer segments) need more trial-and-error iterations (i.e., need to be changed more times) to reach a viable configuration. As evidenced by Table 5.5, in spin-offs with simultaneously high market, managerial and entrepreneurial knowledge (e.g., Cases E and G), the sum of the number of changes in the intended and realized business models is lower. The director of Firm G justified the constancy of their business model as a result of an intense initial period of strategic planning (3 months), in which the management team formulated alternative intended business models and tested them frequently with industry experts (mainly CEOs and investors). This formulation and testing followed a feedback loop fashion, until reaching an optimum business model configuration to initiate business activity.

As pointed out by Loch et al. (2008), *external* problem areas of the firm (e.g., customer needs, industry readiness, product functionality) usually have higher potential for *unknown unknowns* or *unforeseeable uncertainty*, and therefore are characterized by higher levels of uncertainty. More *internal* problem areas of the firm (e.g., key resources, key activities) are usually characterized by *foreseeable uncertainty*, and thus lower levels of uncertainty. To deal with higher initial levels of unforeseeable uncertainty, that usually characterizes more externally-faced business model elements such as customer segments, the methods of experimentation or trial-and-error learning are appropriate. These methods have proven to be effective management approaches in contexts of high unforeseeable uncertainty (Loch et al., 2008).

5.4.5 Business Model Change and Spin-Off Performance

In order to investigate the relationship between performance and number of changes in the realized and intended business models, the average number of changes of each business model element was calculated for Low and Medium performing firms (L/M), and for High (and Very High) performing firms, separately. The low/medium performing firms are Cases B, C, and D, and the high performing firms are cases E, F, and G. For the reasons already mentioned in Section 5.4.2, cases A and H were not included in this calculation. Hence, Table 5.6 below includes the number of changes in the realized and intended business models for low/medium and high performing firms, and the difference in the number of changes (Δ) for these two subsets.

Table 5.6 Number of Changes for Low/Medium and High Performing Spin-Offs

	L/M		**High**		**Δ**	
	re	*in*	*re*	*in*	*re*	*in*
1. Customer Segments (CS)	0.7	3.1	0.0	0.9	0.7	*2.2*
2. Value Proposition (VP)	1.1	0.6	0.7	0.3	0.4	0.3
3. Channels (CH)	0.9	0.5	0.0	0.5	0.9	-0.1
4. Customer Relationships (CR)	0.2	0.0	0.0	0.0	0.2	0.0
5. Revenue Streams (R$)	0.1	0.7	0.0	0.1	0.1	0.6
6. Key Resources (KR)	2.2	0.7	0.4	0.0	*1.8*	0.7
7. Key Activities (KA)	3.1	0.0	1.9	0.0	1.2	0.0
8. Key Partners (KP)	1.2	1.3	1.7	0.4	-0.5	0.9
9. Cost Structure (C$)	1.3	0.3	0.7	0.0	0.6	0.3
SUM	**10.8**	**7.1**	**5.3**	**2.2**	***5.5***	***4.9***
10. Funding (F$)	1.6	0.7	0.9	0.8	0.7	-0.1
11. Goals (GL)		2.3		0.8		1.5

Note: Does not include cases A and H

One evident finding is that in higher performing spin-offs, both the intended and realized business models change less often (less 4.9 and 5.5 times, respectively). Such result suggests that:

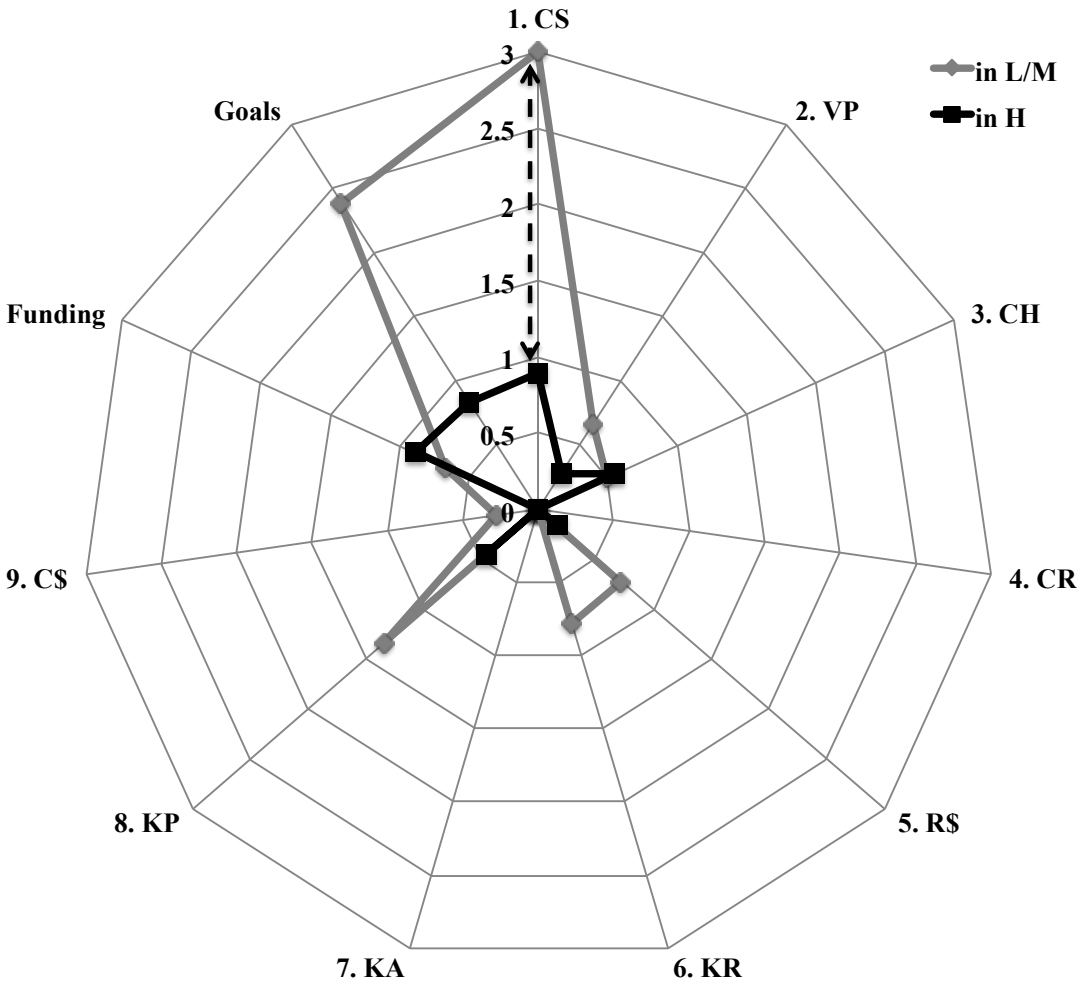
Proposition 4. In high (low) performing early-stage university spin-offs, intended and realized business models change less (more) often.

This finding extends previous work relating certain forms of knowledge present in spin-off founding teams, such as tacit knowledge or market knowledge (Knockaert et al., 2011; Wennberg et al., 2011), with spin-off performance. In particular, this finding establishes the missing bridge between business model change and 'knowledge-performance'. In particular, it suggests that higher performing university spin-off firms (which typically have teams with higher levels of knowledge) change less their intended and realized business models, since they need less iterations to reach a viable business model.Figure 5.1 below shows the difference between low/medium performing university spin-offs (grey line) and high performing university spin-offs (black line) in what concerns the number of changes in their intended business models.

One finding arising from the visual analysis of Figure 5.1 is that the intended customer segments change considerably less (minus 2.2 times) in higher performing university spin-offs (black dotted arrow shows the higher difference between low/medium and high performing firms). This difference indicates that in higher performing firms, entrepreneurs' intentions towards customer segments are more stable, i.e., they don't constantly change their minds in that sense. The reason for the enhanced stability in the business models of higher performing firms, including intended customer segments, seems to be related to the fact that these spin-offs undergo an intense period of strategic planning before firm incorporation. This was already mentioned in Section 5.4.4, and is observed by the Director of one of the highest performing firms (case G):

"We did a lot of strategy work before we started the company. So, before we really made any progress at all on the company, we spent between 3 and 6 months actually just developing the strategy in detail."

Figure 5.1 Nr. of Changes in the Intended BMs (L/M vs H Performing Spin-Offs)



Moreover, these spin-offs interacted earlier (also before firm incorporation) and more intensively with stakeholders to test their strategies and their intended business models. They performed iterative testing before starting up, by taking into account the feedback of potential customers and industry experts during this period.

> *"We talked to a lot of people. We basically took our strategy to many people who are involved in the industry, and we took their comments, and then revised the strategy to take their comments into account."* (Director Firm G)

Throughout this iterative planning and testing period, their intended business models, including the intended customer segments, changed often and very rapidly.

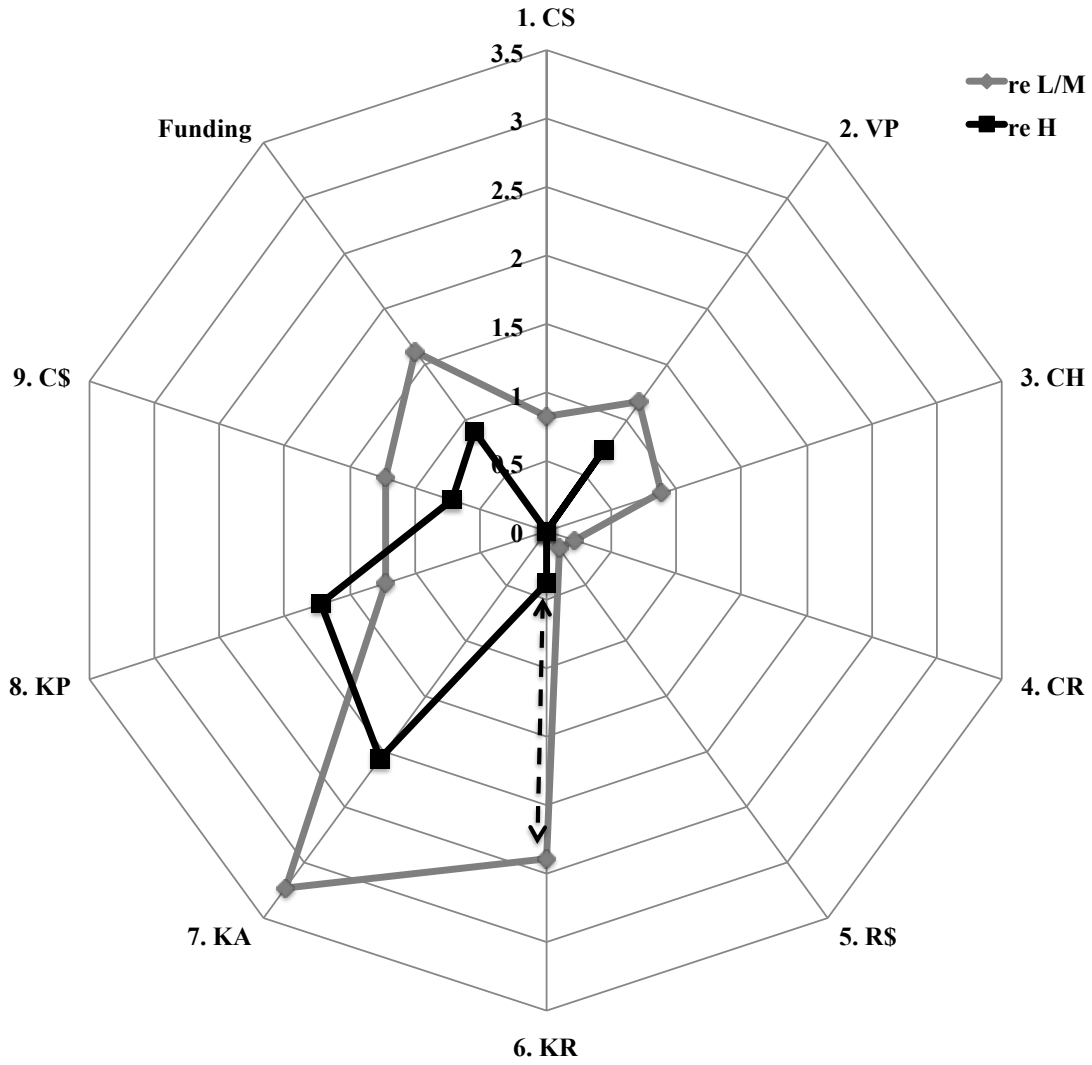
Such period of testing allowed them to make more informed decisions and to crystalize certain dimensions of their intended business models, including the customer segments, before incorporating. This iterative planning and testing practice towards their intended business models removed some of the initial uncertainty, and added robustness to their decisions in terms of intended customer segments. This reduced the need to change them so often during the post-incorporation business activity. Such an explanation suggests the following propositions:

> *Proposition 5. Higher performing early-stage university spin-offs interact earlier (before firm incorporation) and more intensively with stakeholders to perform iterative testing to their intended business models.*

This finding also adds nuance to the findings of Wennberg et al. (2011) and Knockaert et al. (2011) regarding the positive influence of commercial experience, developed through continuous and frequent interaction with different stakeholders, on spin-off performance. Proposition 5 extends this line of work by emphasizing that higher performing university spin-offs interact not only *earlier* but also more intensively with stakeholders, even before firm incorporation, to test their intended business models and collect useful feedback. These propositions also strengthen the advocated link between the adoption of lean startup principles (Ries, 2011) and the application of the customer development process "to iteratively build, test and search for a business model, turning unknowns into knowns" (Blank & Dorf, 2012: 28), and early-stage university spin-off performance.

Figure 5.2 below shows the difference between low/medium performing university spin-offs (grey line) and high performing university spin-offs (black line) on the number of changes in their realized business models. An immediate finding arising from the visual analysis of Figure 5.2 is that the realized key resources change considerably less (minus 1.8 times) in higher performing university spin-offs. Data gathered from the interviews show clear evidence that many changes that occurred in *realized* key resources were triggered partly or entirely by changes in *intended* customer segments. For instance, Firm B recruited more human resources due to their intention of exploring additional intended customer segments.

Figure 5.2 Nr. of Changes in the Realized BMs (L/M vs H Performing Spin-Offs)



"[SC: You recruited a new sales team, which is kind of a human resource. Why and how did that change?]

Previously we were focused on things like the supply chain. (...) So, we got that, we got Tesco's, and we got E-on, they both raised purchase orders [realized customer segments]. (...) And we realized that the life blood of the company is now sales and marketing. So, the focus has moved away from securing those 1 or 2 customers, and (...) it's now moved on to recruiting the

sales team, and marketing the product online [to target other intended customer segments]." (CEO Firm B, Month 0)

Firm C frequently receives specific enquires for bespoke systems, as the CEO comments:

"We've now had about 60 unique enquiries from companies (...), and we respond to every one of them, and it's not a standard reply we give them. We try to engage with them to understand what sector they're working in." (Month 0)

The activity described above is highly resource-intensive. Therefore, Firm C needed to recruit additional resources to deal with these intended customer segments (that might become realized or not). When asked why Firm C recruited more human resources, the CEO promptly answered:

"Well, that's very much to do with the fact that we are talking to a lot of different companies, we are delivering samples to companies, and we needed more capability." (Month 1)

Hence, this process of interaction and actual experimentation (after firm birth) consumes resources. The management team's hope is to successfully convert some of these intended customer segments into realized customer segments, to actually bring some revenue in.

The evidence above suggests that the higher number of changes in *intended* customer segments of the lower performing firms seems to be triggering a higher number of changes in their *realized* key resources (e.g., human resources, as in the previous examples), but also a higher number of intentions to change those key resources. In fact, the sum of the changes in *intended* and *realized* key resources in low/medium performing firms (Case B, 2.6; Case C = 3.0; Case D = 3.0) is consistently and substantially higher than in high performing firms (Case E = 0.0; Case F = 0.0; Case G = 1.0).

For instance, the CEO of Firm C explains how their intention of exploring other customer segments triggered their intention of bringing in additional human resources:

> *"[SC: And why did you raise the objective from 20 to 30 people?]*
>
> *Because we're going for a bigger market [new intended customer segment(s)]. We're going for a much bigger opportunity, and need to do more development. There's more stuff that needs to be done. So, we need to bring in more people [intend to increase/change key resources]."* (CEO Firm C, Month 9)

The intention to move to new product markets (and thus different customer segments), might also trigger changes in intangible key resources such as patents, as the CSO of Firm D details:

> *"The company is really… depends on its IP. And this IP it's capital, if you like [key resource]. And these are [market] areas with specific applications or methods. (…) So, it's essentially a product patent. And one of them is extending the first patent to different series of [market] applications: (…) Water culture, aquaculture applications, seeds, plants, etc. (…)"* (Month 10)

He then explains the importance of securing those market areas/applications with specific patents, one of the company's most valuable resources:

> *"You get hold of the technology and slap as many patents as we can think of… So, whenever we think, we slap in a patent. It's the protection you need. So, when you come to exploit the idea, you will need it [laughs]!"* (CSO Firm D, Month 10)

Therefore, the evidence above suggests that changes in intended customer segments may trigger changes in realized key resources, but also in intended key resources. Intended customer segments do not generate any revenue to the company, but realized key resources drain costs from the firm. Thus, if some of these intended customer segments are not effectively and timely converted into realized customer

segments, the company might arrive to a situation of financial risk. The discussion above then suggests the following proposition:

> *Proposition 6. Earlier intended business model testing results in higher intended customer segment stability, thus reducing unproductive changes in realized and intended key resources (and mitigating harmful resource consequences).*

This result adds nuance to Zott and Amit's (2010) generic conceptualization of a firm's business model "as a system of interdependent activities" (p. 216), therefore encouraging "holistic thinking in business model design, instead of concentrating on isolated choices" (p. 223). Proposition 6 builds on that conceptualization and specifies that customer segments and key resources are intimately related. Moreover, it suggests that 'perturbations' in the customer segments, even at the intentional level, will be followed by perturbations in key resources, both at the intentional and realized levels. If these customer segments never generate any revenue (i.e., become 'realized' customer segments), then the firm will be consuming resources unproductively, which may have a harmful impact on performance, and ultimately on survival.

5.4.6 Concluding Thoughts

It is important to emphasize that the analysis above was strongly guided by quantitative measures of the frequency of change in business model elements. These measurements contributed to reveal patterns and allowed a more focused exploration of the qualitative data. As such, this analysis was also strongly anchored in qualitative data, evidenced by the various references to interview transcripts throughout the text.

In an oversimplified way, evidence suggests that too much change in the business model seems to be related with lower performance. However, one is not saying that changing business models is 'bad', or that the business model should never be changed in order to achieve higher performance. In fact, all the spin-offs,

higher or lower performing, changed their business models. Therefore, there must be a minimum level of change to guarantee survival and/or good performance.

The following sections of this chapter will continue to explore the different *themes* related to business model change that emerged from the initial process of open coding. The next section examines the tension between technology push and market pull, and between broad vs. narrow scope technologies, and how these constructs relate to business model change and spin-off performance.

5.5 TECHNOLOGY SCOPE, BUSINESS SCOPE, AND BUSINESS MODEL CHANGE

This section investigates how constructs such as technology push, market pull, technology scope, business scope, radical technology, and incremental technology, relate to business model change and performance. It starts with an introduction to main constructs, then performs within-case analyses, and concludes with a cross-case analysis with induction of propositions.

5.5.1 Introduction

Technology push and *market pull* are terms that emerged within the early innovation models of the 1950s and 1960s. Technology push focused on technology with no concern for market forces, whereas market pull considered the market as the primary source of ideas, assigning R&D a reactive role (Khilji, Mroczkowski, & Bernstein, 2006). Spedale (2003) similarly states that the literature on innovation distinguishes between:

> *"Market-pull" (where the primary starting point for firms' decisions is the market and its customers' needs) and "technology-push" strategies (where innovation and development are mainly driven by existing scientific knowledge and original research and invention, independently from the existence of a market)*.

Brem & Voigt (2009) provide a comprehensive review on the topic of market pull and technology push, which they define as follows:

> Market pull / demand pull / need pull*: The innovations' source is a currently inadequate satisfaction of customer needs, which results in new demands for problem-solving ('invent-to-order' a product for a certain need). (...)*
>
> Technology push*: The stimulus for new products and processes comes from (internal or external) research; the goal is to make commercial use of new know-how. (...) Therefore, it does not matter if a certain demand already exists or not*. (Brem & Voigt, 2009: 355)

Other authors (e.g., Bernstein & Singh, 2006; Caetano & Amaral, 2011) also provide similar definitions of market pull and technology push, though the definitions above seem more thorough.

According to Shane (2004) *generic*, *general-purpose*, or *platform technologies* (term often used by practitioners), are technologies with broad applications in multiple fields. Maine & Garnsey (2006: 375) employ the definition of Keenan (2003) of generic or general purpose technology as "a technology the exploitation of which will yield benefits for a wide range of sectors of the economy and/or society". Thus, "a generic technology has a wide breath of applications across [multiple] industry sectors" (Maine & Garnsey, 2006: 376). Examples of generic technologies are the piezoelectric device (Shane, 2004) and steam power (Maine & Garnsey, 2006). More generally, Clarysse et al. (2011: 1423) define *scope of technology* as "the degree to which it is possible to use the same core (...) technology in different applications". According to them, "a platform technology (...) can serve as a base for several products and market applications" (2011: 1424).

Maine & Garnsey (2006: 375) employ Utterback's (1996: 158) definition of *radical technology* as a technology that has "the potential for delivering dramatically better product performance or lower production costs, or both". On the other hand, "*incremental technological* improvements enhance and extend the underlying technology" (Tushman & Anderson, 1986: 441), but do not introduce a technological discontinuity.

Each case of the cohort was analysed and classified according to the following constructs, drawing on the definitions provided above: 1) market pull, 2) technology push, 3) generic technology, 4) narrow technology, 5) radical technology, and 6) incremental technology.

5.5.2 Within-Case Analysis

5.5.2.1 Case A

The interviewee of Firm A stated that "there's been research going into this area for 8 eight years, and we're now trying to commercialise it". This statement reveals a strong focus on research and technology, and suggests less prior concern with market forces or customers' needs. Hence, Firm A seems to be an example of *technology push*. In fact, the interviewee added in a subsequent interview that Firm A is still in search of markets to commercialize its products:

> *"Initially we were looking at nuclear, petrochemical, aviation, and power generation as well. And then in February 2011, we dropped aviation because there wasn't very good fit technically. (...) We would be best trying the easier segments technically, and then coming back to that later. (...) And then power generation, I suppose we weren't making a lot of traction with that. (...)*
>
> *Then we got some interest, in the market research, for a particular application to look at green stores, and problems with corrosion on the roofs of green silos. So, we thought that was quite an interesting market, actually. But then that really didn't come to anything. (...)*
>
> *We're trying to sell our technology and our company to as many people as possible. And the people that are most interested in, we focus on. And the people who we keep selling and they don't seem to be that interested, we don't spend as much time on."* (CEO Firm A, Month 0)

On Month 3, the interviewee revealed that they were re-focusing again their energy in the research side: "I suppose we pulled back a bit from the

commercialization side, because our product wasn't really ready to generate early revenue. (...) So, we're focusing more on R&D now". Such chronology of statements corroborates the initial perspective that technology-push was the dominant commercialization strategy for Firm A.

As the comments shown above illustrate, this firm was exploring a wide array of markets, which points to a *generic or platform technology*. A subsequent comment from the interviewee strengthens this assumption.

> *"Because our technology is quite generic, and we're trying to look for a sort of a… really just want to find one killer application, where we could make lots of money from applying this technology. I mean, we're probably still at the stage where we have technology and we don't have a product. So, as we do more and more like talking to our customers, or potential customers, we get a better idea of where the technology could be used."*

According to Firm A's founder, their technology offers "reduced costs, improved quality, and improved safety" over other existing value propositions in the market. Though it delivers better performance than competing proposals, such delivery is not "dramatically better" (Utterback, 1996: 158). In that sense, their innovation or technological change may be described as being *incremental*.

5.5.2.2 Case B

The founder and CEO of Firm B decided to start up a company soon after he identified a problem – lack of energy efficiency: "Appliances [were] getting left on in rooms when there was nobody in the room." He then thought of a solution, which then became the foundation of his enterprise. This historical account and the lack of demand mentioned by the founder points suggests *technology push*:

> *"There is no demand. Or it's very little demand for the product, because [the problem] is more awareness of the product. (...) We've got to try and create the demand for it just now. Hopefully, it will transform into a situation where there is demand."* (CEO Firm B, Month 0)

Such statement is somehow more inharmonious with market pull than with a technology push, which strengthens the initial technology push assumption.

The founder of Firm B firmly believes its technology is applicable to a wide range of sectors and contexts. Such belief is clearly reflected in his effort to sell its product to many different customer segments, both industrial markets (B2B) and consumer markets (B2C), and experimenting with multiple channels to reach them. Therefore, Firm B's technology can be said to be *generic*.

> *"I've got retailers, energy, utilities, distributors, web distributors, products made to order. I've got a different thing in here, for B2B."* (Month 0)

> *"The direct sales and shopping centres is off. (...) Too much time commitment, resource intensive. (...) We are now looking at public sector."* (Month 8)

> *"Licensing is something that has always been considered. So, we're constantly on the lookout for a licensing opportunity. (...) [Interviewer: What changed was you added consultancy to the revenue streams...] Yes, one of our sales guys decided to offer consultancy to [shopping mall]. (...) Just consultancy about how they should manage their ranging of energy efficient products."* (Month 9)

> *"Right, so, what I've said in here is TV shopping [selling products through TV shopping]."* (Month 11)

Firm B's core business is to develop and design consumer electronics to improve energy efficiency, both to the home and office. Their value proposition to customers is a (1) reduction in the utility bill, (2) improved convenience, (3) reduction in the risk of electrical fire, and (4) improved green credentials. This offering is translated into cost and performance improvements, though these improvements are not dramatic. Hence, Firm B's degree of technological change can be classified as *incremental*.

5.5.2.3 Case C

Firm C's technology has its origins in scientific research performed at a research institute from a university in the UK. This research project was initiated in 2001. The founder of firm C, an external entrepreneur, was looking for new technologies and growing market areas, and became aware of the institute's activity in 2009. He contacted the institute in August 2009, and at that time he started to understand better how he could differentiate and commercialize that research capability. This description suggests that the development of this company was been predominantly driven by *technology push*.

> *"So, as I say, there is almost 10 years of research, 10 years of continued research into this technology within the institute. (...) The people at the university (...) had IP, they had know-how, they had a core patent. So, there was a belief that there was a company there to be formed. Now, one of the issues I faced when I came in to the university, was trying to think about how you can take the technology and form a business through it."* (First interview)

> *"We had more enquiries in different sectors than we first anticipated. (...) We have now four or five sectors with different customers in those sectors, who are very interested in what we're doing."* (Month 0)

The CEO and founder clearly states, at various points in time, that they have a *platform technology* (or generic technology), with a wide range of applications, and therefore is suitable for many different sectors.

> *"They [read: products] are suitable for a number of evolving market applications. (...) Although we have product strategy, we also have a platform technology. (...) So, I have got a product focus, but I've also got the strategy of looking at specific applications, thinking yeah, this platform could work with new applications."* (First interview)

> *"We are starting to see our value proposition across different sectors."* (Month 0)

"We're branding ourselves under the technology, rather than the markets. So that, when it comes to our investment proposition, our investors will see a consistent platform technology." (Month 9)

"So, what we have is an evolution. And, as we go through that, the complexity, the capabilities have to be increased. And as they increase, it opens up new applications." (Month 10)

Firm C claims to have a truly differentiated family of products and a unique technology suitable for a wide range of applications. Firms C "specializes in X technology to create a range of industry leading (…) platform solutions" (Founder). Its novel technology is based on many years of development (since 2001 onwards) at a university's research institute. Though the referred technology presents a significant degree of novelty, which would classify it as *radical*, the author's description doesn't seem to fit the concept of technological discontinuity. Hence, it appears prudent to classify it as somewhere in between the *incremental*/*radical* continuum.

5.5.2.4 Case D

Firm D develops products based on its patented technology. This technology is applicable to the treatment of infections and contaminations in medicine, food safety, sanitation and many other areas. The actual concept came in 1993 from a research project.

"This was a major project, it went on the university for about 10 years. (...) The idea was about 1993, the idea of the technology. (...) The idea of forming a company would be in about 2009. But this wasn't the company which is actually formed. This was going to be a veterinary science company, veterinary medicine, therapeutics, but that didn't get funded – it was the right idea at the wrong time [laughs]." (First interview)

The narrative above suggests the presence of a *technology push* situation. The starting point was a research project that resulted in a broad technology in search of

specific market applications. A subsequent comment from one of the founders reflects the technology push strategy and his perspective on how to bring technologies to market.

> *"I think the technology is one of these things were you tell people about it, and they all think: oh yes… could you use it here, could you use it there?"* (First interview)

In a later interview, the founder describes again the difficulties in pushing a new technology to the market:

> *"It's just the difficulty of introducing novel technology into the market place. (…) There's a lot more of a learning curve for the interested parties, when the technology is novel. (…) It's a new sector, so they don't have any experience, there are no models they can consult, there's nobody else they can ask. And this prolongs the stage of giving comfort to your clients [laughs]."* (Month 8)

In a subsequent interview, the founder describes how Firm D distills its *generic technology* into more specific segments by taking into account arising opportunities and occasional interaction with potential customers or partners.

> *"Because the model will change given opportunities that may or may not arise. (…) You apply the generic technology, let's say, in dressings, and you might apply in web dressings, you might try wound closures… So, how many segments you can create will depend on what the customers want. (…) Obviously, the broader, and more exclusive, the more money we want for it. But essentially, the model is we have a generic technology, and if your business is in the sector X, then you can license that."* (Month 0)

The CSO and co-founder of Firm D mentioned frequently the many different potential applications of its *generic technology*, at various points in time. The excerpts below validate this statement.

> *"This technology has very wide applications, so there was the idea of forming a spin-off."* (First interview)

"This is generic technology we've got, and it applies to a vast number of segments." (Month 0)

"We have identified 45 fields, each of which has a number of sectors, each of which could be licensed independently." (Month 9)

Though Firm D developed a new technology, its primary purpose is to enhance, though not dramatically, existing customer products. Therefore, it can be said to be an *incremental technology*, rather than a radical technology.

"We're offering a technology, (...) which will enhance the value of the existing products that these manufacturers have." (Month 0)

"We would license (...) looking at enhancing an existing product, rather than [providing] a totally novel product." (Month 8)

5.5.2.5 Case E

Firm E is a biopharmaceutical company established in 2009. The first sketch of the business emerged in a bar in the Netherlands in June 2007, with the two founders brainstorming ideas over a couple of beers. After that initial discussion, and agreeing that they wanted to start up a company together, the two founders went "*hunting*" for technologies. Thus, the technology appears to be the crucial point of departure, which suits the *technology push* concept.

"We started by turning on the radar and we said: "Right, we got to find something that's exciting, let's look." And I think we must have looked to something like 100 different potential partners and technologies. We went hunting. And we did that on our own money." (First interview)

The founders started the venture with three different product development projects, but over time they narrowed them down to a single project.

We narrowed the scope of our intended business. Originally we had quite an ambitious plan to go after two cancer projects and an infectious diseases

project, where we were going to handle effectively three different programs. We ended up with one." (Month 0)

As the CBO explained, the management team *narrowed* the *scope* of their *business*, due to resource constraints, mostly financial and/or human. However, over time, they discovered a certain plurality or multiplicity of applications, though they tried to keep their focus in only one development project. As they got more funding, they expanded their focus to two product development projects.

"We were sufficiently broad in the tests we applied to the drug. (...) So, we literally wanted to find out more about what we had, because as I said earlier, if we can prove that we have more than one compound, that would put us into a M&A discussion, than simply a single product licensing. And we proved it." (Month 0)

"So, the plurality aspect has already been demonstrated by drug X, and that means that there's more of a chance of an acquisition or multiple license than before, which of course is great news." (Month 3)

"And that was because we discovered there were more applications coming out from the technology, for example Malaria, tropical diseases, antifungal applications, and so on." (Month 7)

"We are looking at expanding the scope of what we're doing, but we don't have resources to do that right now. So, we're kind of investigating how we might go about resourcing that through grants and financing." (Month 11)

This evidence suggests that the *technology* has a *broad scope* (i.e., generic or platform technology), though the management team deliberately *narrowed* the *scope* of their *business*, due to resource constraints (mostly financial and human). Hence, these findings suggest a distinction between "technology scope", and "business scope". Bercovitz & Mitchell (2007: 65) define *business scope* as "the firm's variety of offerings (i.e., product lines, product sub-sectors)". However, this definition is too narrowly focused on the product, and is similar to Thirumalai & Shinga's (2011: 380) definition of *product scope* as the "breadth and depth of the product portfolio of

a firm". Song, Podoynitsyna, Van der Bij, & Halman (2008: 12) include also the product dimension in their definition of *market scope:* the "variety in customers and customer segments, their geographic range, and the number of products". I will introduce channels (as an interface between products and markets), and define *business scope* more generally as *"the firm's variety in products, channels, and markets"*. Since Firm E is currently focused in few products (i.e., one project initially) and few markets, its *business scope* is narrow.

As written above, Firm E's CBO claimed his company was established "to develop a completely new class of drugs" (First interview). In a following interview, he reiterates a similar claim, which intensifies the complete novelty of the technology, and therefore its classification as a *radical technology*.

> *"The value proposition is a completely novel class of drug. And where resistance is an issue you need to have something novel, otherwise it will not work! (...) Pharma considers novelty to be essential."* (Month 0)

5.5.2.6 Case F

The initial business idea for Firm F emerged from a specific market research performed by a government agency. The founder and current CSO describes how it happened, emphasizing that the main source of financial capital comes from actual sales to customers.

> *"We got Research and Development funding from X [Government Agency]. It was part of a large program. There was 5 Million pounds worth of R&D. That allowed us to demonstrate Proof of Principle. After that, the most significant piece of funding came from our first customer. (...) Capital generated through sales."* (First interview)

In a later interview, the entrepreneur explains in more detail how they knew so clearly what the market wanted. The narrative suggests that this company was prominently driven by *market pull*.

"We had a very clear understanding of our target market, route to market, and what we needed to deliver to the end customer. (...)

[Interviewer: And why did you have this clear knowledge of the target market and of the customer needs? Where did that come from?]

The research was in response to a piece of market analysis that had been done by [Government Agency]. So they had identified there was a market sector and a market need. And they put in place the research program to deliver a technical solution to match that market need." (Month 10)

Firm F's technology, developed to address a specific market need, is rather focused, i.e., *narrow technology scope*. Also, Firm F maintains its focus on a single product and a very specific target market through time, as its CSO firmly comments in two different interviews, separated by a period of six months. Such evidence suggests a *narrow business scope*, reflected on the deliberate choice of keeping its exploitation narrow since company formation and throughout the longitudinal interviewing period.

"[Interviewer: What are your customer segments?] Dairy farming industry: milk production. [Interviewer: And they never changed?] No. It's not going to. I mean, that's the target market (...), it's not going to move." (Month 0)

"The customer segments are not going to change. I really don't think so." (Month 6)

The technology developed by Firm F improves specific monitoring for dairy farming, compared to existing solutions in the market. It is also priced more competitively, and has the ability to be applied to other important management functions, thus enabling a more integrated monitoring of dairy farms. The description of such technology suits the concept of *incremental technology*.

5.5.2.7 Case G

Firm G's technology had its origins in a project undertaken by an energy research group within the energy systems department at the university, focused on renewable energy sources.

> *"By the year 2000, wind was a mature technology. So, the R&D challenges are less, and it was more of an optimization challenge. We recognized that in the renewable sector there need to be additional technologies coming on board. (...) We identified that the tidal power was a research challenge that if harnessed could provide reliable power. (...) We looked at the types of technologies that were being developed. And we recognized that these were basically wind turbines that were being modified to run in the water. From an engineering knowledge that's not an optimum solution."* (First interview)

The co-founder and current CEO of Firm G describes how they started their research:

> *"I was the head of that research group, so I led the team in this area. (...) The initial research that we undertook had an end objective in producing a technology that could do something better, easier and cheaper. It wasn't as if we were undertaking fundamental research and then by accident, we produced the technology. (...) We had a clear objective of what it was that we wanted to achieve. Which is probably different from a number of technology developments."* (First interview)

The narrative above describing the origin of the business idea may suggest a *technology push* mechanics. However, subsequent comments from both founders reveal an evolution of their concern towards the market side.

> *"[It started] very much from the R&D side. And it has evolved from there towards the business side."* (Co-founder and CEO, First interview)

> *"We spent a lot of time (...) looking at the markets, understanding what the forces were in the market that we would have to deal with. And developing a*

business model that would respond to that." (Co-founder and Director, Month 4)

Furthermore, the Director of Firm G explains the process of creating their own customers – in other words, how they influenced market forces and created market pull for their venture. In that sense, it seems reasonable to assume a hybrid model of *technology push* and *market pull*.

"Generally we go and say we want to build the tidal farm now. We're going to setup a company to do it, put together a business plan for that tidal farm, and then we'll raise money into it, and then we'll sell out devices. So, we create our own customers." (Month 0)

"Some of the SPVs are becoming a little bit more concrete. (...) And now they're registered as companies, and we will start putting some money into them, so they will effectively become our customers quite soon (...). So, we're building our own customers." (Month 2)

As stated above, even before Firm G's formation, the research that led to it started with a very clear and focused aim in mind. As such, the value proposition is very specific, and so are the customer segments. Therefore, the *technology* can be classified as *narrow-scope*. It may have other applications, but the founders never revealed any other potential uses or mentioned any intention of broadening its scope of application. Hence, *business scope* can also be classified as *narrow*.

As explained previously by the co-founder and CEO, there was a strong concern, since the early days of the research project, to build a completely new way of harnessing tidal power, rather than optimizing existing solutions based on wind turbines. Such approach led to a disruptive technological change, as the Director clearly states below, and therefore to the emergence of a *radical technology*.

"I think customers are dissatisfied with the alternatives that are available to them. So, they're quite actively looking for solutions. And we offer a different type of product. We offer a disruptive technology that perhaps meets their needs a lot better than the competitors." (Co-founder and Director, Month 0)

5.5.2.8 Case H

Firm H specializes in the rapid detection of pathogens using innovative assays and diagnostic instrumentation. This firm's intellectual property combines chemistry, immunology and microbiology, as well as novel detection methods. The research that developed this technology started much before firm incorporation.

> *"The original idea extends from work done in the department in 1995. (...) It took us from 1995 to 2007 to get a company, because the university was not interested at all. So, 'co-founder X' and I formed a company, outside the university, in the incubator center, in 2007. (...) I already have been working on Company Z, so I could make the connection that we have something that is far better than what they have got. (...) So, I knew what the markets would actually want."* (Founder and CSO, First interview)

Such historical account suggests a *technology push* mechanism, though it also reveals the founder's concern and knowledge of the market, coming from past industrial experience in the same field. In fact, following interviews provide further evidence that developments in the value proposition were also led through market demand. Hence, this company followed a hybrid mechanism intertwining *technology push* and *market pull*.

> *"We've initiated the so-called Y assays, [because] two customers have already come back to us saying: "can you make these for us?" (...) So, we have been asked to look in these areas and we have already started working on two of these toxins at this present time. But if anything, it was customer-led. That's why it started."* (Month 11)

The interviewee used the expression "platform technology" when describing the value proposition, suggesting a *generic technology*. Furthermore, both customer segments and value proposition suffered many additions throughout the interviewing period (see Table 4.23), confirming the multiplicity of applications of Firm H's technology, and the *broadening scope* of their *business*.

"Has to be, platform technology. (...) We have our R&D still going on. The first kit is the X, the second is the Y, the third, fourth, fifth, sixth, all already lined up. So, that is still going on. The X is going through trial." (Month 2)

The co-founder and CSO of firm H describes its technology as innovative, and refers to its products as "completely automatic testing systems" (Month 6). The main advantages of Firm H's products over existing competitors are speed of test significantly reduced and cost substantially less expensive. However, the evidence available does not provide full clarity on whether or not the technology offers a dramatic improvement over competing systems. Therefore, for a matter of prudence, it will be classified as "in between" the *incremental – radical technology* continuum.

5.5.3 Cross-Case Analysis

Table 5.7 provides a summary of the typologies of innovation, technology scope, business scope, and technological change (last four lines of the mentioned table) for all the cases in this study, along with the number of changes of their realized and intended business model elements throughout the 12-month tracking period.

An observation of this table suggests that a *technology-push* driven innovation, exploring a *generic technology* with a *broad business scope*, in which the *technological change is incremental*, appears to be related to low or medium performance, and more intended business model changes (see cases B, C, and D – case A is exceptional, since it is dormant). A thorough analysis of these four typologies (driver of innovation, technology scope, business scope, and technological change) and their impact on the number of business model changes and performance seems to suggest some relationships. Apparently, there is no visible relationship between the degree of technological change (incremental or radical) and the number of changes in the business models, or performance. On the other hand, the cases that evolved to a narrower business scope (see cases E, F, and G) tend to be associated with fewer changes in the intended business models (number of changes = 3.8, 1.4, 1.4, respectively), and higher performance. This leads to the following propositions:

Proposition 7. In early-stage university spin-offs, a narrower (broader) business scope is typically associated with lower (higher) number of changes in their intended business models, and thus higher (lower) performance.

Cases F and G are characterized simultaneously by a narrow technology scope and a narrow business scope. These are also the cases with fewer changes in their intended business models (number of changes = 1.4, for both cases). Therefore, it seems that the technology scope also affects the number of changes in the intended business models, suggestion the following proposition:

Proposition 8. In early-stage university spin-offs, a narrower (broader) technology scope is typically associated with lower (higher) number of changes in their intended business models, and thus higher (lower) performance.

A positive relationship appears also to exist between the technology scope and the driver of innovation, i.e., the cases where the technology scope is narrow (see cases F and G) were market-pull driven. Additionally, it seems that firms with a narrower technology scope tend to have a narrower business scope, since they have fewer technological options. However, firms with a narrow business scope may not have necessarily emerged from a narrow-scope technology. These might be firms with a broad (or generic) technology scope that prioritized their technology applications and decided to (temporarily) narrow down their business scope, due to resource constraints (e.g., financial and human). In sum, data suggests a relationship between the driver of innovation and the technology scope (i.e., technology-push seems related to broader technology scope; market-pull seems related to narrower technology scope). Moreover, a narrow technology scope is more likely to lead to a narrow business scope.

A deeper observation at the level of the business model element reveals also relationships between the scope of the technology (or business) and the number of changes in the intended customer segments and value proposition. In fact, cases F and G (in the reduced cohort of 6 cases) were the ones experiencing fewer changes in

Table 5.7 Typologies of Technologies and Business Model Change

	A*		B			C			D			E			F			G			H**		B to G (SUM)	
	re	*in*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*sum*	*re*	*in*	*re*	*in*
1. Customer Segments (CS)	0	1	1.4	2.2	*3.6*	0	2.4	*2.4*	0.8	4.6	*5.4*	0	1.8	*1.8*	0	0.8	*0.8*	0	0	*0*	0.4	1.4	2.2	11.8
2. Value Proposition (VP)	0	0	1.6	0.6	*2.2*	1.8	0.4	*2.2*	0	0.8	*0.8*	0	0.8	*0.8*	2.2	0	*2.2*	0	0	*0*	2.6	0	5.6	2.6
3. Channels (CH)	0	0	2.6	0.0	*2.6*	0	1.4	*1.4*	0	0	*0*	0	0.8	*0.8*	0	0	*0*	0	0.8	*0.8*	0.2	1.4	2.6	3
4. Customer Relationships (CR)	0	0	0.6	0.0	*0.6*	0	0	*0*	0	0	*0*	0	0	*0*	0	0	*0*	0	0	*0*	0	0	0.6	0
5. Revenue Streams (R$)	0	0.8	0	1.0	*1*	0	1	*1*	0.4	0.2	*0.6*	0	0.4	*0.4*	0	0	*0*	0	0	*0*	1	0	0.4	2.6
6. Key Resources (KR)	0	0	1.4	1.2	*2.6*	2.6	0.4	*3*	2.6	0.4	*3*	0.2	0	*0.2*	0	0	*0*	1	0	*1*	2.6	0.4	7.8	2
7. Key Activities (KA)	1.4	0	8	0.0	*8*	1.2	0	*1.2*	0	0	*0*	0.8	0	*0.8*	2	0	*2*	2.8	0	*2.8*	2.8	0	14.8	0
8. Key Partners (KP)	0	0	1.6	2.4	*4*	1	1.4	*2.4*	1	0	*1*	1	0	*1*	2	0.6	*2.6*	2	0.6	*2.6*	0.2	1	8.6	5
9. Cost Structure (C$)	0	0	1.8	1.0	*2.8*	2	0	*2*	0	0	*0*	0	0	*0*	0.8	0	*0.8*	1.2	0	*1.2*	1	0	5.8	1
SUM	**1.4**	**1.8**	**19**	**8.4**	***27.4***	**8.6**	**7**	***15.6***	**4.8**	**6**	***10.8***	**2**	**3.8**	***5.8***	**7**	**1.4**	***8.4***	**7**	**1.4**	***8.4***	**10.8**	**4.2**	**48.4**	**28**
10. Funding (F$)	0.4	0	1.8	0.8	*2.6*	1.8	1.2	*3*	1.2	0	*1.2*	0.6	2	*2.6*	1	0	*1*	1	0.4	*1.4*	0.6	0	7.4	4.4
11. Goals		1.8		4.0			2.4			0.6			1.2			1.2			0			0		9.4
Market Knowledge	M		L			L			H			H			M			H			H			
Managerial Knowledge	L		L			M			M			H			M			H			H			
Entrepreneurial Knowledge	L		L			M			M			H			M			H			H			
Commitment (%)	50%		100%			100%			100%			100%			100%			100%			100%			
Performance	L		L			M			M			H			H			H			H			
Driver of innovation	T-push		T-push			T-push			T-push			T-push			M-pull			T-p / M-p			T-p / M-p			
Technology scope	Broad		Broad			Broad			Broad			Broad			Narrow			Narrow			Broad			
Business scope	Broad		Broad			Broad			Broad			Narrow			Narrow			Narrow			Broad			
Technological change	Increm.		Increm.			Inc. / Rad.			Increm.			Radical			Increm.			Radical			Inc. / Rad.			

Note: re = realized; in = intended

** Firm A's status is dormant; ** Firm H underwent restructuring during the data collection period (acquired another company)*

their intended value propositions (Case F = 0; Case G = 0) and fewer changes in their intended customer segments (Case F = 0.8; Case G = 0).

Existing studies dealing with generic, general-purpose or platform technologies, state that these technologies have broad applications in multiple fields (Shane, 2004) or in a wide range of sectors (Maine & Garnsey, 2006). Thus, narrower or lower scope technologies will have applications in less fields or sectors. The lower number of applications and sectors suggests a relationship with the lower number of changes in intended value proposition and customer segments. Therefore, this leads to the following propositions, in the context of early-stage university spin-offs, and at the business model element level:

> *Proposition 9. A narrower (broader) technology or business scope is typically associated with lower (higher) number of changes in the intended customer segments and value proposition.*

These findings extend existing studies on business models in the strategy field that investigate the relationship between business models and firm performance (Zott et al., 2011). Zott and Amit (2007) examined how business model design affected entrepreneurial firm performance, and found that the more novelty-centred the entrepreneurial firm's business model design (as opposed to efficiency-centred), the higher the firm's performance. This thesis extends the novelty- versus efficiency-centred perspective, and examines technology and business scope, generating alternative relationships with business model change and entrepreneurial firm performance (Propositions 7 and 8). In particular, it is suggested that a narrow business and/or technology scope is typically associated with a lower number of changes in intended business models, which appears to translate in higher performance. Proposition 9 adds more detail to the previous propositions by showing how technology or business scope impacts business model development at the element level. In particular, it suggests that business models with narrower technology or business scopes typically undergo fewer changes in their intended customer segments and value proposition.

5.6 CAUSATION, EFFECTUATION, AND BUSINESS MODEL CHANGE

5.6.1 Introduction

The purpose of Section 5.6 is to investigate how causation and effectuation relate to business model change and performance of early-stage university spin-offs. The relevance of these theoretical frameworks emerged as I reviewed the literature, interacted with the data, engaged with other scholars in the field, and presented the research at entrepreneurship and strategic management conferences. This iterative process between theory, data and colleagues revealed that for entrepreneurs changing business models under conditions of uncertainty and turbulence, some scholars emphasize experimental approaches (McGrath, 2010; Murray & Tripsas, 2004), such as effectuation (Sarasvathy, 2001), while others emphasize causation (e.g., Kotler, 1991). A third stream of authors blends the structure and discipline of the scientific method with effectual behavior (Ries, 2011; Sull, 2004). Therefore, there is ambiguity on whether causation or effectuation (or both) is desirable, how this configuration changes over time, how it differs across business model elements (Osterwalder, Pigneur, & Clark, 2010), and its effect on performance (Teece, 2010; Zott, Amit, & Massa, 2011). Hence, part of this study will focus on the tension between causation and effectuation in the process of business model change in early-stage university spin-offs.

This introductory Subsection 5.6.1 now briefly reviews the causation and effectuation (Sarasvathy, 2001) frameworks. It starts with a concise review of the marketing management literature (Kotler, 1991) and strategic management literature (Ansoff, 1979; Mintzberg, 1978; Porter, 1980). These two approaches are also referred to as "causal" approaches or just "causation" (Sarasvathy, 2001). Finally, it finishes with a concise review on the construct of effectuation.

5.6.1.1 Causation

Sarasvathy (2001) describes the process employed by marketing managers to introduce a new product/service in the marketplace. This set of procedures is detailed by Kotler (1991) in his book *Marketing Management*, which is a widely used textbook in management programs around the world. He presents the following

definition of market: “A market consists of all the potential customers sharing a particular need or want who might be willing and able to engage in exchange to satisfy that need or want” (Kotler, 1991: 63). Therefore, he assumes that markets exist *a priori*, and proposes the following procedure to bring products/services to market: 1) Analyse long-run opportunities in the market; 2) Research and select target markets (STP approach: Segmentation, Targeting, and Positioning); 3) Design marketing strategies; 4) Plan marketing programs; and 5) Organize, implement, and control marketing effort. This process requires a reasonable amount of resources for market research and to implement devised marketing strategies. It also involves considerable amounts of time and analytical effort in trying to develop several predictions, such as developing demand forecasts for the products/services. This sort of process emphasizes prediction over control.

Strategic management, often called “policy” or simply “strategy”, is concerned with the direction of business firms (Rumelt, Schendel, & Teece, 1991). One of the fundamental missions of strategic management research is to investigate and explain differences in performance between firms (Wiggins & Ruefli, 2002). In order to survive, firms have *strategic* choices such as: a) selection of goals, b) choice of products and services to offer, c) its positioning to compete in product-markets, d) level of scope and diversity, and e) design of organization structure (Rumelt et al., 1991). This set of strategic choices lies at the core of the firm’s strategy, and is the result of an almost purely analytical process. In fact, the 1970s were marked by the rapid expansion of strategy consulting firms and the establishment of professional societies. Consulting firms such as McKinsey and Boston Consulting Group pioneered in developing new analytical tools for strategy, frequently in the form of matrices. This analytical logic emphasizes prediction rather than control.

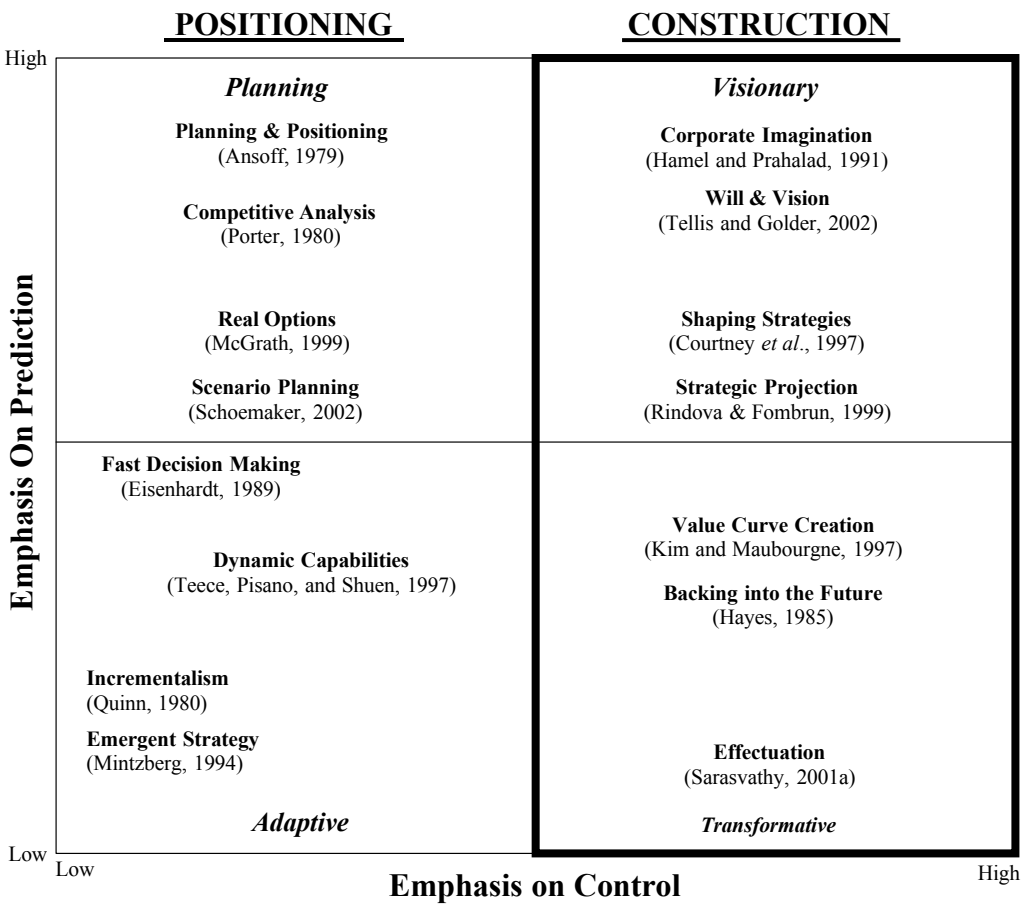
The ‘strategic planning’ school is probably the oldest in strategic management (Wiltbank et al., 2006) and is based on work from several authors such as Ansoff (1979) and Porter (1980). This school emphasizes the importance of systematic analysis and planning. It pays special attention to detail, frequent analysis, environmental scanning, and rational evaluation of alternatives for strategy formation. According to Wiltbank et al. (2006), the planning school claims that, as

uncertainty increases, those who work more diligently to analyze and predict more accurately will perform better. Advocates of the strategic planning school argue that though the predictive approach may not be perfect because it is difficult, it represents the best technique to maintain strategic alignment with the environment (Hough & White, 2003).

Conversely to the planning school, the 'strategic learning' school suggests reducing the use of predictive rationality, and proposes a faster reacting and more experimental behavior, in order to stay flexible and adaptive to situations as they develop (Wiltbank et al., 2006). Proponents of the learning school advocate that organizations who follow this prescription, successfully overcome competitors that also struggle to cope with the challenge of an uncertain future. Adaptive approaches avoid predicting future events; instead, the emphasis is in positioning the firm for agile responses to unpredictable events as they emerge (Wiltbank et al., 2006). According to Mintzberg (1978), strategy formation is an incremental learning process, whereby the environment feeds back, and subsequent strategy incorporates this learning. The learning school argues that in more turbulent and dynamic contexts, systematic planning may slow adaptation and locks organizations into rigid trajectories (Mintzberg, 1978). This rigidness also hinders the exploitation of potential environmental contingencies.

The subsequently developed 'planned emergence' school combines the strategic planning and adaptive/learning approaches (Wiltbank et al., 2006). Studies on strategic decision making in high-velocity environments have proliferated (e.g., Bourgeois & Eisenhardt, 1988; Eisenhardt, 1989a; Eisenhardt & Bourgeois, 1988). These studies acknowledge the complexity of decision making and emphasize the role of rational planning, by collecting and using real-time information to generate multiple alternatives. But they also highlight emotion as integral to high-velocity strategic decision making. Other approaches, such as dynamic capabilities (Teece et al., 1997), scenario planning (Shoemaker, 2002), and real options (McGrath, 1999), in different ways combine rational planning/predictive strategies with flexible adaptation to deal with contexts of high uncertainty.

Figure 5.3 Literature on Approaches to Situational Control



Source: Wiltbank et al. (2006)

The core role of prediction is intrinsic to the previously reviewed approaches to strategy making, advocated by the planning, learning and planned emergence schools. They all suggest positioning within an environment that is exogenous to the firms, i.e., organizations do not exert any influence in this environment. Therefore, under this assumption of exogeneity, predicting and subsequently positioning are the obvious ways to deal with an environment that is conceptualized as independent from the organizations (Wiltbank et al., 2006). These deterministic approaches in strategic management believe that predicting future events will allow the organizations to control the consequences of those events. Sarasvathy (2001) refers to these approaches, described by the marketing management and strategic management literature, as *"causation"* approaches.

Emerging theories in entrepreneurship such as effectuation (Sarasvathy, 2001), also described as "non-predictive control" or "transformative" approaches (Wiltbank et al., 2006: 983) relax the exogeneity assumption and view the environment as endogenous to the influence of organizations. Therefore, the environment is dependent on the organizations, since organizations can shape it. These approaches emphasize the role of control over prediction, i.e., instead of trying to predict the evolution of the environment, firms can actively participate in transforming the environment (see Figure 5.3). The next section presents a brief review on the theoretical framework of effectuation.

5.6.1.2 Effectuation

In the 1990s and early 2000s, three central concepts were introduced in management and entrepreneurship research: effectuation (Sarasvathy, 2001, 2008), bricolage (Baker & Nelson, 2005), and improvisation (Weick, 1993). These emerging theoretical constructs have increased in prominence due to their relevance in times of environmental turbulence and high uncertainty. For reasons stated previously, this study uses the effectuation framework. Hence, a short review of the concept follows.

In her most popular work on *effectuation*, Sarasvathy (2001: 245) puts forward the following definition: "Causation processes take a particular effect as given and focus on selecting between means to create that effect." Inverting the previous definition of causation processes, "Effectuation processes take a set of means as given and focus on selecting between possible effects that can be created with that set of means." (Sarasvathy, 2001: 345). This concept, introduced by Sarasvathy (2001), was later expanded by Sarasvathy & Dew (2005) and Sarasvathy (2008). Sarasvathy (2008: 16) defines effectuation as a *logic of action*:

> *"Effectuation is the inverse of causation. Causal models begin with an effect to be created. They seek either to select between means to achieve those effects or to create new means to achieve preselected ends. Effectual models, in contrast, begin with given means and seek to create new ends using non-predictive strategies."*

According to Sarasvathy (2008: 17), a *causal* logic is based on the premise "to the extent we can predict the future, we can control it", whereas an *effectual* logic is based on the premise "to the extent we can control the future, we do not need to predict it". Sarasvathy (2008: 149) provides yet another definition of effectuation: "Effectuation is a design logic for making things in a human-made universe". According to the author, effectuation does not begin with a specific goal:

> *"It begins with a given set of means and allows goals to emerge contingently over time from the varied imaginations and diverse aspirations of the founders and the people with whom they interact."* (Sarasvathy, 2008: 73)

At the individual level, the "means" of the entrepreneurs include "who they are, what they know, and whom they know" (Sarasvathy, 2001: 250), i.e., their own a) traits, tastes, and abilities, b) knowledge, and c) social networks. At the firm level, these means are the physical resources, human resources, and organizational resources (Barney, 1991). According to Sarasvathy (2001), causation processes are excellent at exploiting knowledge, whereas effectuation processes are excellent at exploiting contingencies. Moreover, effectuation is an especially appealing logic "in dynamic, nonlinear, and ecological environments (Sarasvathy, 2001) where the future is unknowable and, therefore, not measurable" (Fisher, 2012: 1026). In opposition to causal logic, which assumes that entrepreneurial opportunities are identified (Shane, 2000), effectual logic assumes that entrepreneurial opportunities are created (Sarasvathy, 2008) through a process of enactment (Fisher, 2012; Weick, 1979).

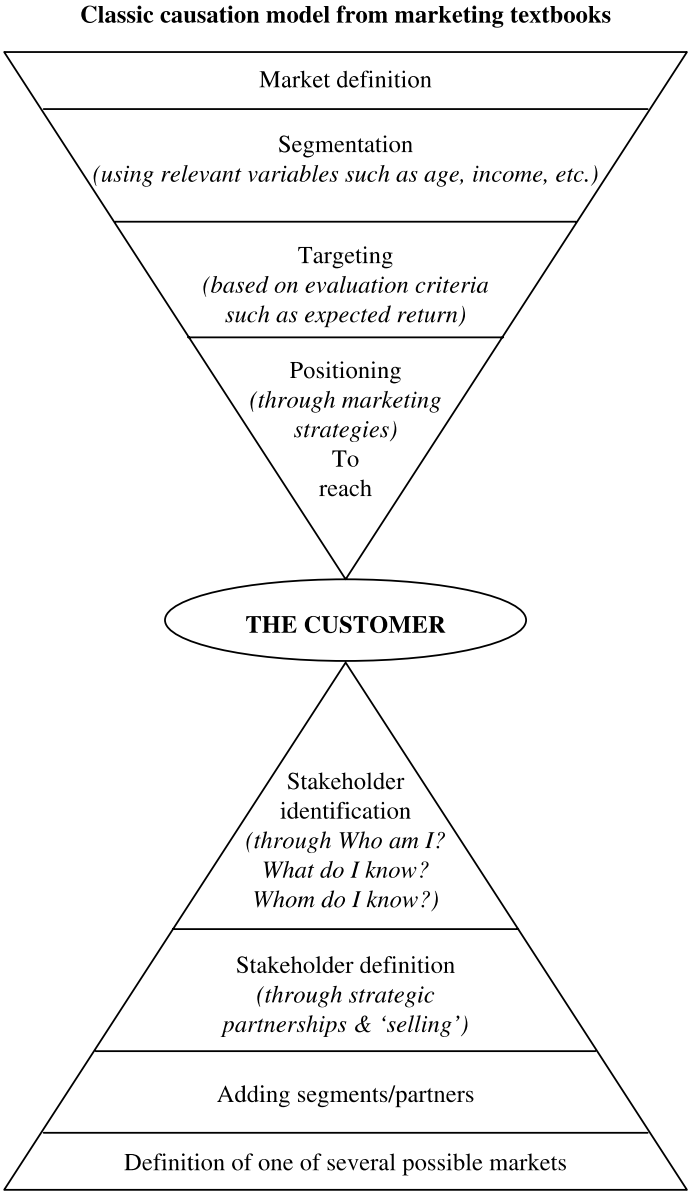
Though effectuation and causation are usually presented as a dichotomy, Sarasvathy (2001: 245) notifies that "both causation and effectuation are integral parts of human reasoning that can occur simultaneously, overlapping and intertwining over different contexts of decisions and actions". She also clarifies that effectuation processes are not "better" or "more efficient" than causation processes – the interesting issue is to understand "under what circumstances which types of processes provide particular advantages and disadvantages" (Sarasvathy, 2001: 249).

In her book, Sarasvathy (2008) induced six elements to describe the effectual logic, which emerged directly from coding the data. Sarasvathy (2008) claims that expert entrepreneurs start their decision-making processes with a given set of means, rather than a predetermined goal (element 1). Also, they opt for "affordable loss rather than expected return" (element 2) (Sarasvathy, 2008: 34). Instead of gathering information about potential returns or predicting ideal levels of investment, "effectuators" attempt to take the product directly to market, spending only what they can afford to lose. These entrepreneurs seek to convert initial customers into partners, and/or try to sell to customers/partners at a very early stage (element 3). Extreme "effectuators" suggest selling even before the product is developed or produced. Expert entrepreneurs also tend to ignore competition and stress partnerships (element 4). They are also more likely to create a market, by progressively adding customer segments, than finding a market (element 5). And finally, they allow unanticipated ends to emerge, as opposed to narrowly striving to achieve the preselected goal (element 6).

Figure 5.4 extends the reasoning above and contrasts the effectuation process used by expert entrepreneurs with the traditional causation model described in marketing textbooks (Sarasvathy, 2008). *Causation* starts with a predefined market (Kotler, 1991), and the market is then divided into customer segments. Based on an evaluation of market revenue potential, some segments are selected and targeted. From the competitive analyses, an optimal positioning is subsequently defined to reach the customer. On the other hand, *effectuation* begins by identifying a set of possible means as given, and then proceeds by progressively creating situations in a contingent manner, and taking advantage of new opportunities. The evidence shows that effectuation is intrinsically stakeholder-dependent, rather than goal-driven or resource-dependent.

The following section explains how the collected data was analyzed.

Figure 5.4 Causal Model of Marketing versus Effectuation (Sarasvathy, 2008)



5.6.2 Data Analysis Procedure

Drawing on the data collected from the eight university spin-offs, I created a list of key business model events. Business model events were defined as changes that occurred to the business model elements throughout the 12-month longitudinal period. This list was created and saved as a Microsoft Excel (2011) file, and the data

was retrieved from the QSR Nvivo (10) main file containing all the data sources and previously coded text. This software package was utilized to maintain a chain of evidence between the raw data and the key business model events (Yin, 2009). The following variables were registered for each key business model event: 1) Event number, 2) Firm, 3) Date (Month and Year), 4) Month (0 to 12, relative to 1st interview), 5) Business model (intended or realized), 6) Business model element (e.g., customer segment), and 7) Short description (of the event). The final key business model event list contained 166 events in total.

Effectual behavior relates to effectuation principles; causal behavior relates to planning or "causation" (Sarasvathy, 2001) principles. Drawing on the detailed descriptions of the key business models events, which include their drivers (contained on the Nvivo file), these events were classified according to following coding scheme: 1) *effectual* (event predominantly driven by effectual behaviour), 2) *causal* (event predominantly driven by causal behaviour), 3) *causal-effectual* (event driven by a mix of causal and effectual behaviours), 4) *not clear* (lack of clarity on the nature of the behaviours). This enabled the investigation of the tension between effectuation and causation across the different cases and across time.

As explained in the previous section, Sarasvathy (2001) contrasts effectuation and causation within four dimensions, and later adds that effectuation can be regarded as "the inverse of causation" (Sarasvathy, 2008: 22). Other recent literature compares effectuation and causation using additional and slightly different dimensions (e.g., Bretell, 2012). Table 5.8 shown below was developed to distinguish between effectual and causal behaviour. This table was inspired on the work of several researchers on the topic of effectuation (Brettel, Mauer, Engelen, & Kupper, 2012; Chandler, DeTienne, McKelvie, & Mumford, 2011; Fisher, 2012; Sarasvathy, 2001, 2008; Wiltbank et al., 2006). Coding decisions for effectuation and causation were made on the basis of this table.

After coding for "causal vs. effectual", I then conducted an in-depth analysis by performing cross-case comparisons using pivot tables and by creating several graphs to better visualize the data (in Microsoft Excel 2011 for Mac). This analytic process helped to identify patterns of effectual and/or causal logic over time, and

relationships between causal vs. effectual behaviour, business model change, and performance in the context of early-stage university spin-offs.

Table 5.8 Effectuation vs Causation

Dimension	Effectuation characteristics	Causation characteristics
Dimension 1: Means vs. Goals	Experimenting with given means to identify business opportunities	Approach driven by pre-establishing goals and striving to achieve them
Dimension 2: Affordable loss vs. expected returns	Focus on projects where the loss in a worst-case scenario is affordable	Selection of projects based on maximization of expected returns
Dimension 3: Partnerships vs. competitive analysis	Emphasis on partnerships and pre-commitments with stakeholders	Business planning and competitive market analysis
Dimension 4: Leveraging vs. avoiding the unexpected	Contingencies are seen as a source of opportunities	Contingencies are avoided or quickly overcome to reach pre-established goals
Dimension 5: Non-predictive control vs. Planning	Focus on controlling an unpredictable future	Focus on predicting an uncertain future

Based on Bretell et al. (2012), Chandler et al. (2011), Fisher (2012), Sarasvathy (2001), Sarasvathy (2008), and Wiltbank et al. (2006).

5.6.3 Behaviour Types and Performance: Static Analysis

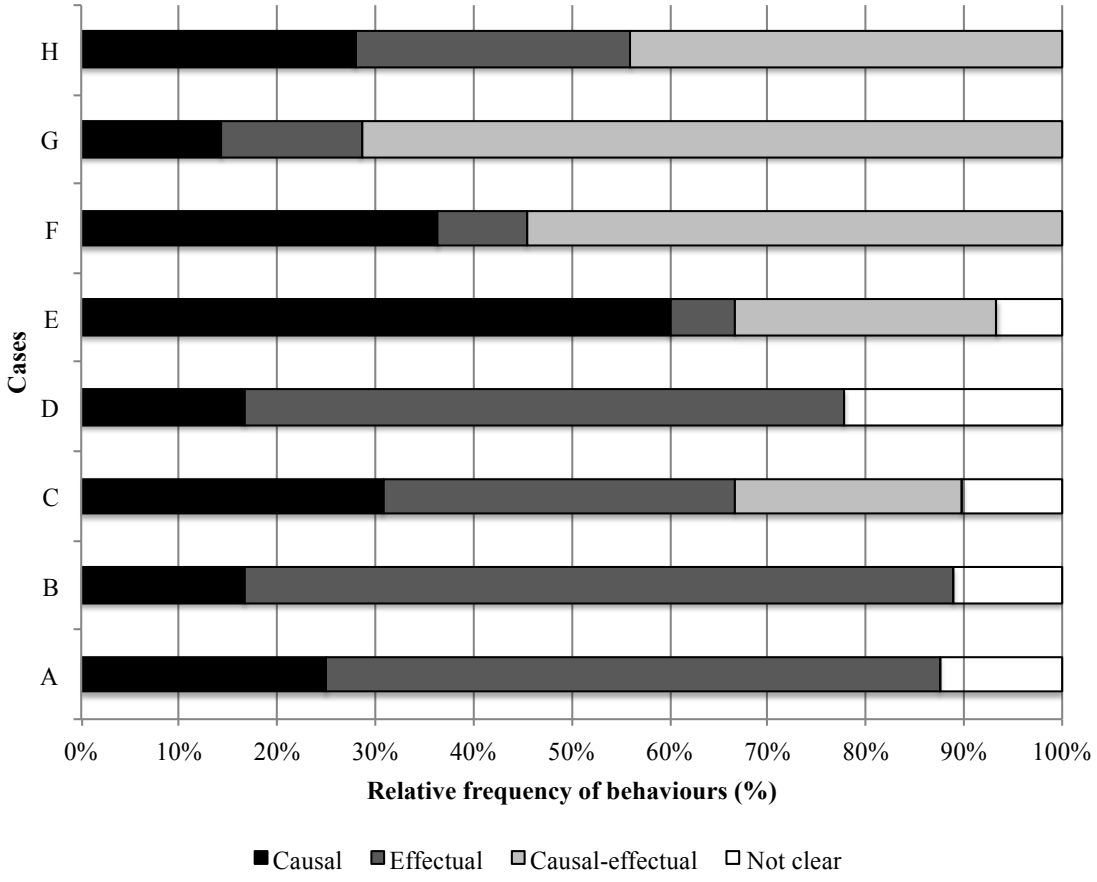
This section examines the behavior types (causal, effectual, or combined causal-effectual) that drove each of the 166 business model changes identified, and patterns in the relative frequency of these behavior types. It also establishes a relationship between these patterns and firm performance. Figure 5.5 shows the relative frequency of behavior types that drove business model changes for each case. Changes were classified as causal, effectual, combined causal-effectual driven or 'not clear'. All firms exhibited causal and effectual behaviors during the period of study (12 months). Five firms also exhibited combined causal-effectual behaviors.

The low or medium performing firms are cases A, B, C, and D. These cases exhibit mainly causal and effectual behaviors. Only case C, a medium performing firm, had some business model changes driven by combined causal-effectual behavior, though this behavior was not predominant over causal or effectual

behaviors. Therefore, business model changes for the 4 lower or medium performing firms were mainly driven by either *purely* causal or effectual behaviors. In other words, there were no business model changes (with the exception of 23% of the changes of case C) driven by a combined causal-effectual behavior. Furthermore, low and medium performing firms clearly exhibited a predominance of effectual behavior over causal behavior. This suggests the following propositions:

> *Proposition 10a. Lower performing early-stage firms are more likely to exhibit only purely causal behavior and effectual behavior (i.e., absence of combined causal-effectual behavior).*
>
> *Proposition 10b. Lower performing early-stage firms are more likely to exhibit a predominance of effectual behavior over causal behavior.*

Figure 5.5 Relative Frequency of Different Behaviour Types (Months 0 to 12)



The high performing firms are cases E, F, G, and H. These cases manifest all three types of behaviors: causal, effectual, and combined causal-effectual. With the exception of case E, which had a predominance of causal behavior, all the high performing cases exhibited a predominance of combined causal-effectual behaviors. This suggests that high performing firms tend to blend causal and effectual reasoning simultaneously in their business model decisions, leading to the following propositions:

> *Proposition 11a. Higher performing early-stage firms are more likely to exhibit all the three types of behaviors: causal, effectual, and combined causal-effectual.*

> *Proposition 11b. Higher performing early-stage firms are more likely to exhibit a predominance of combined causal-effectual behavior over purely causal or effectual behaviors.*

Previous work by Andries et al. (2013) revealed two approaches to business model development: 'focused commitment' and 'simultaneous experimentation'. According to the authors, focused commitment positively affects initial growth but jeopardizes long-term survival. On the other hand, simultaneous experimentation implies lower initial growth, but facilitates long-term survival. The authors advocate that simultaneous experimentation "implies both *effectual experimentation* building on the venture's own means and strengths and the *conscious planning* and selection of specific business model experiments" (Andries et al., 2013: 307). This set of propositions (10a-11b) confirms this duality (i.e., experimentation-planning) and add nuance to the discussion of Andries et al. (2013) on effectuation, by providing more insight on the relative frequencies of effectual and causal behaviors and their relationship with firm performance. In particular, findings suggest that high performing firms change their business models by simultaneously combining causation and effectuation. They also suggest that lower performing early-stage firms may have lower strategic planning abilities, or exercise them less, and that they have difficulty in combining behaviors for each business model decision. This appears to result in a less solid trajectory and possibly a more erratic evolution of their business models.

Figure 5.6 Behaviour Types driving Realized and Intended BMs of High Performing Firms

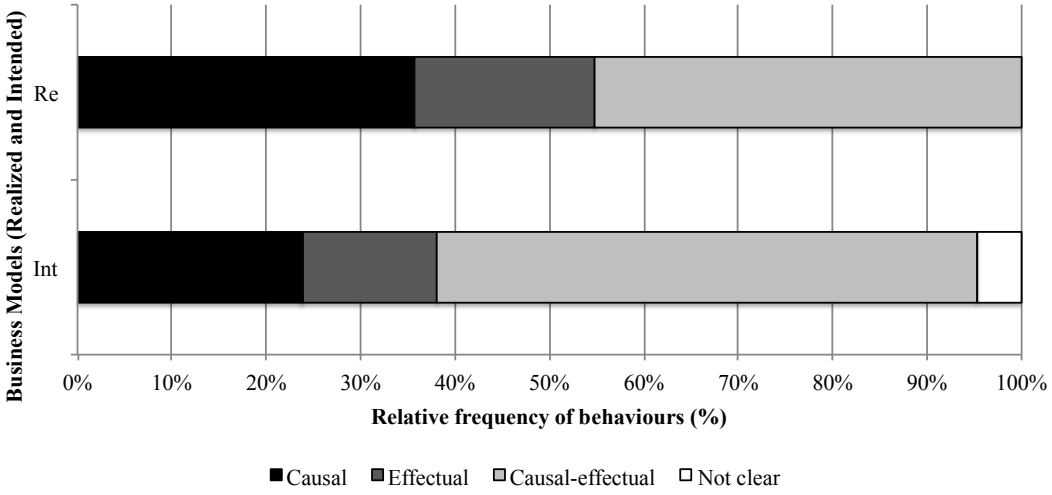


Figure 5.7 Behaviour Types driving Realized and Intended BMs of Low/Medium Performing Firms

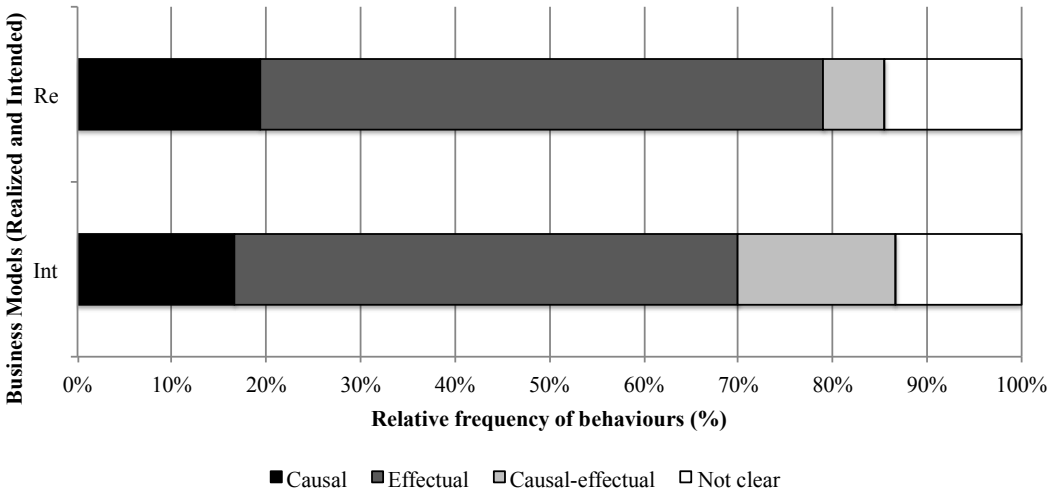


Figure 5.6 and Figure 5.7 display charts representing the relative frequency of behaviour types driving changes in the realized and intended business models, for higher and lower/medium performing firms, respectively. These figures indicate that the relative frequency of behaviour types is very similar for the realized and intended

business models; however, the frequency of causal behaviour is slightly higher for realized business models, especially in higher performing firms. This suggests that high performing firms do plan a bit more before performing real changes (as compared to changes in their intentions). As discussed before, the relative frequencies of behaviour types are substantially different for higher performing and low/medium performing firms. A visual comparison between Figure 5.6 and Figure 5.7 show that higher performing firms exhibit a predominance of combined causal-effectual behaviour, whereas lower performing firms exhibit a predominance of effectual behaviour driving business model changes. These results corroborate the argument advanced earlier in Propositions 10b and 11b.

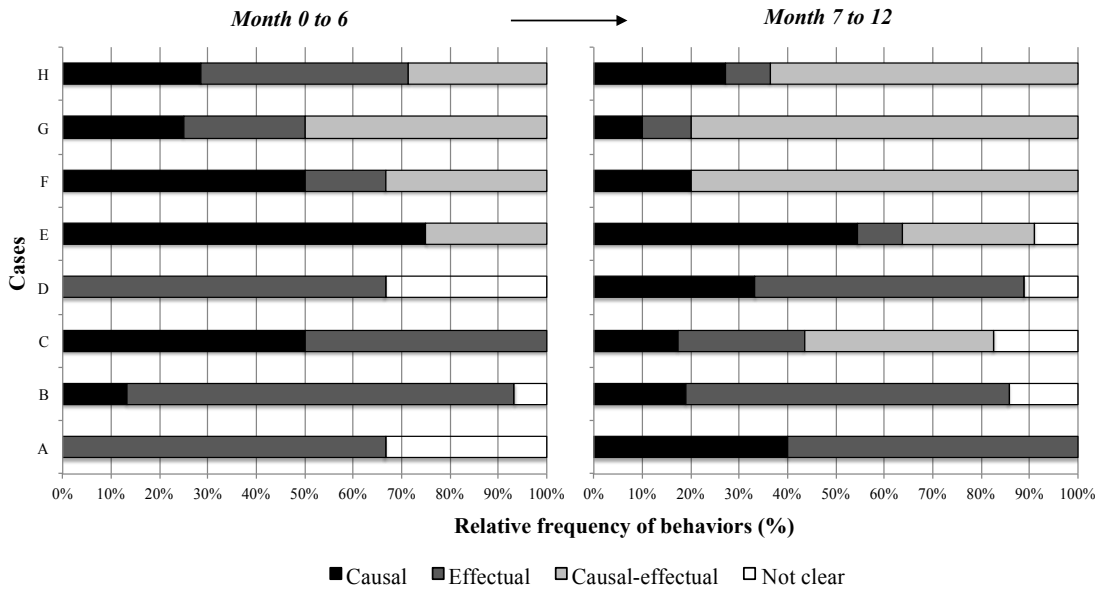
5.6.4 Behaviour Types and Performance: Dynamic Analysis

This section investigates the evolution of the relative frequency of different behavior types, for each case, over time. The study period is evenly split in two: period 1 (months 1 to 6), and period 2 (months 7 to 12). Figure 5.8 below displays the relative frequency of behavior types for the two periods for each firm, indicating how the relative frequency of behavior types evolved.

The patterns of behavior type evolution differ between low and high performing firms. In the first period, half of the low performing firms (cases A and D) exhibited only effectual behavior. Cases B and C exhibited both effectual and causal behaviors. In the second period, all of the firms exhibit causal and effectual behaviors. Case C manifests also a combined causal-effectual behavior. All low performing cases evolved to a more balanced proportion of behaviors, though in most, effectuation continued to dominate. Therefore, it can be proposed that:

> *Proposition 12a. Lower performing early-stage firms tend to adopt over time the behaviors that were initially absent (e.g., causal or combined causal-effectual).*
>
> *Proposition 12b. Lower performing early-stage firms tend to evolve to a full range of behavior types with effectuation dominating.*

Figure 5.8 Evolution of the Relative Frequency of Different Behaviour Types Over Time



The patterns of behavior evolution in high performing early-stage firms were quite different. In the first period, almost all of the high performing firms exhibited the three behaviors: causal, effectual, and causal-effectual. The only exception was case E, which did not manifest a pure effectual behavior, although effectual behavior was present as combined causal-effectual behavior. Hence, high performing firms tend to exhibit all the three types of behaviors in the first period. In the second period, the causal and the effectual behaviors decreased considerably, and the combined causal-effectual behavior increased in proportion. In three of the high performing firms (F, G, and H), 60% of behaviors were combined causal-effectual. This suggests the following propositions:

> *Proposition 13a. High performing early-stage firms develop a range of behaviors early on, including causal, effectual, and combined causal-effectual.*

> *Proposition 13b. In high performing early-stage firms, causal-effectual behavior becomes dominant over time.*

These findings suggest that over time all firms (i.e., both low and high performing firms) learn and exhibit all three types of behaviors (causal, effectual, and causal-effectual). More successful firms learn how to integrate causal and effectual behavior into combined causal-effectual behavior more quickly, and with higher relative frequency.

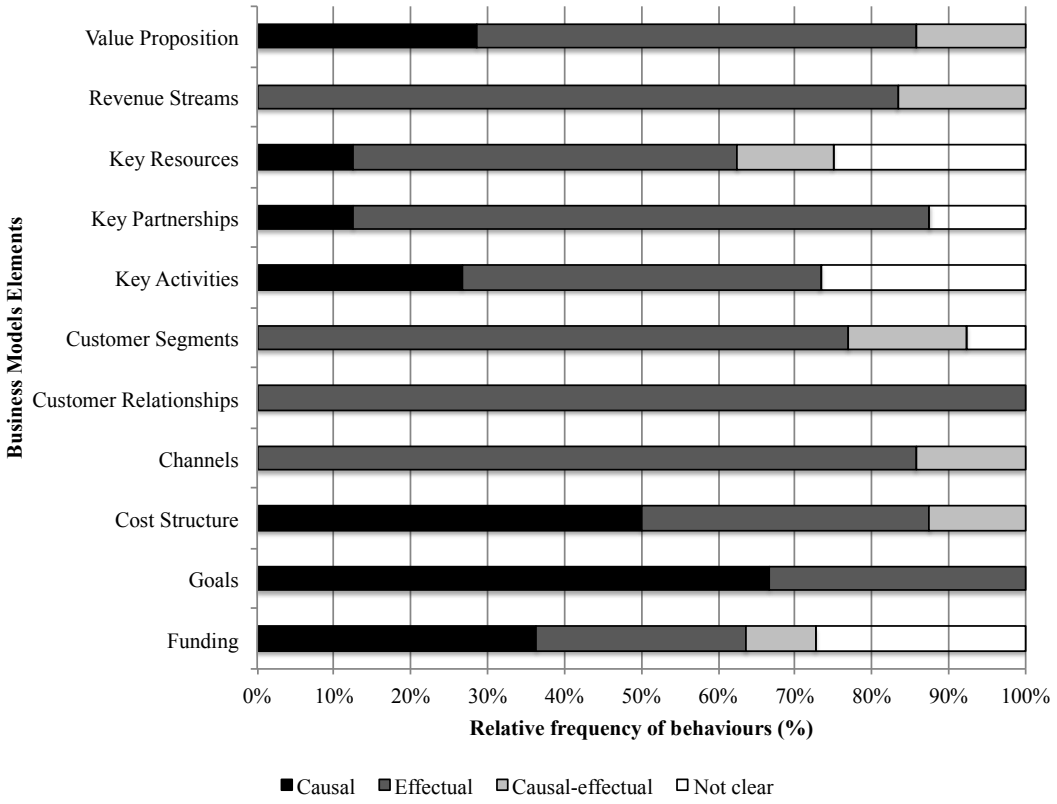
This set of propositions (12a-13b) relating the predominance of causal or effectual behaviors in the process of business model change and their impact on spin-off performance extend the work of Van Burg et al. (2008) regarding how to effectively create university spin-offs by adopting a science-based design approach. The authors argue that the design approach promotes the interplay between emergent and deliberate design processes (Sarasvathy, 2004), and develop a set of design principles that are practice based but grounded in existing research on university spin-offs. This thesis extends such design principles by complementing them with behaviors that conduce to a more effective creation and development of university spin-offs. Propositions 10a-13b shed more light on the types of behaviors, including their proportions and circumstances, that are desirable if one wants to design a high performing university spin-off. This set of propositions relating spin-off team behavior with firm performance complements other studies focused at the university or department levels (Rasmussen et al., 2014). These findings add more detail on the factors influencing spin-off performance at the team level, in particular by adopting an effectuation theoretical lens.

5.6.5 Behaviour Types in Business Model Elements

This section examines patterns in the relative frequency of behavior types (causal, effectual, or combined causal-effectual) that drove business model changes for each business model element across all firms. Figure 5.9 shows that customer facing elements (customer segments, customer relationships, channels, and revenue streams), that are located in the right half of the Business Model Canvas (Osterwalder et al., 2010) were changed as consequence of a predominantly effectual behavior. A more balanced mix of effectual, causal and combined causal-effectual

behaviors drove changes in the other elements of the business model (value proposition, key resources, key partners, key activities, and cost structure).

Figure 5.9 Relative Frequency of Different Behaviour Types in BM Elements



The nature of change in goals is quite distinct from the other elements, since changes in goals are driven by a predominantly causal behaviour. This result was expected and validates the robustness of the analysis process, since goals are usually defined as the result of a planning, and thus causal, activity.

Customer-facing business model elements are more "outward" facing, i.e., they are part of, or interface with, the external environment. Therefore, the uncertainty – mostly market uncertainty, since these are customer-facing elements – is very high, especially in the case of early-stage ventures (Van de Vrande & Vanhaverbeke, 2012). In the face of high uncertainty, entrepreneurs tend to employ a more "experimenting", trial-end-error mindset (Loch, Solt, & Bailey, 2008), which is

in line with the effectual behavior (Sarasvathy, 2008). Since uncertainty is lower in "inward"-facing business model elements, planning appears to be an appropriate management approach (Loch et al., 2008), which justifies the lower proportion of effectual behavior and, consequently, higher proportion of causal behavior. This leads to the following propositions:

> *Proposition 14a. The more inward-facing the business model element, the more likely it is to be changed, entirely or partly, by causal drivers.*
>
> *Proposition 14b. Conversely, the more outward-facing the business model element, the more likely it is to be changed, entirely or partly, by effectual drivers.*

This finding extends Sosna's et al. (2010) dynamic perspective on business model innovation that emphasized the importance of trial-and-error experiential learning, especially for conditions of market uncertainty. The more outward-facing business model elements (e.g., customer segments, customer relationships, channels) are the ones that establish a deeper and wider interface with the market, and therefore are more prone to market uncertainty. Propositions 14a and 14b add detail to Sosna's et al. (2010) argument by suggesting that for these business model elements a more effectual approach, which is in many ways consonant with experiential trial-and-error learning (Sarasvathy, 2008), should be adopted.

5.6.6 Behaviour Types, Business Model Stability, and Performance

This section explores the relationship between behaviour types, business model stability, and early-stage spin-off performance. The interviewees of higher performing firms were asked to justify the more stable behaviour of their business models over time. The CSO of Firm F explains why their business model did not change so often during the interviewing period:

> *"That's because I think we had a very clear understanding of our target market, route to market, and what we needed to deliver to the end customer.*

(...) We may add additional features, but the core service, the core product is still going to be the same."

As the interviewee explained, Firm F had a clear understanding of the target market (i.e., customer segments), route to market (i.e., channels), and of what they needed to deliver to the end customer (i.e., value proposition). Therefore, they had less market uncertainty – or more market knowledge – than low/medium performing firms. The CSO then explained how the firm developed this higher level of knowledge:

"We had spent a number of years analysing what we wanted to do. (...) The research was in response to a piece of market analysis that had been done [a parastatal enterprise agency]. So, they had identified there was a market sector and a market need. And they put in place the research programme to deliver a technical solution to match that market need, and during the course of executing that technical solution, we refined our understanding of what the market opportunity was. So, it's just understanding what you've got to do. It doesn't make it easy, but it removes some of the uncertainty." (CSO Firm F, Month 10)

The higher knowledge came from analysing the market, and from interacting with it while developing their technical solution. And that analytic but also interactive process, though not necessarily easy, removes some of the uncertainty. The process of analyzing the market seems more related to a causal behavior. On the other hand, the process of interacting with the market is more effectual. This suggests that higher performing firms exhibit a combination of causal (e.g., planning, analyzing) and effectual behavior (e.g., creating opportunities, establishing partnerships, interacting with the market), i.e., what we earlier defined as combined causal-effectual behavior. Such reasoning corroborates the findings presented above, and propositions 11b and 13b in particular.

The Director of Firm G also explained why their business model showed a considerable stability over time:

"I think our strategy is relatively well thought out for the market that we face. And our business model is setup to deal with the market we face. So, the thing that would make our business model unstable is if we got our strategy wrong. And so far [knocked wood] our strategy seems to be right. (...) We spent a lot of time, almost 9 months, developing our business model. Looking at the markets, understanding what the forces were in the market that we would have to deal with. And developing a business model that would respond to that. So, I think we got some stability because of that." (Director Firm G, Month 4)

The narrative of Firm G's Director reveals that they invested significant effort and time in planning their strategy, analysing the market, and in developing their business model. These planning, analysis and design activities reflect a predominantly causal behaviour. The Director of firm G, in month 8, justified further why the firm was moving ahead with few deviations to what was previously expected:

"My view is that we did a lot of strategy work before we started the company. So, before we really made any progress at all on the company, we spent between 3 and 6 months actually just developing the strategy in detail. So, you know, I think we have expectations of exactly how this will develop, but maybe other people haven't thought that far through for their own businesses".

The comments above emphasize again the careful planning activity, a clear evidence of causal behavior. The Director then explained how they developed their strategy even before incorporating:

"So, we talked to a lot of people. We basically took our strategy, and then disclosed it to many people who are involved in the industry and you know, we took their comments and then revised the strategy to take their comments into account." (Month 8)

This explanation shows clearly that Firm G also interacted with stakeholders to test their assumptions and reflected that feedback on the firm's strategy and business model. This behavior is effectual. The Director then detailed who were the actors with whom they interacted:

> *"Many. People who have been in the wind industry, which we use as an analogue for how our industry will develop. People who work for utility companies, people who work for banks. So, you know, a pretty wide range of people. (...) Senior managers, senior professionals."* (Month 8)

These example comments suggest that higher performing firms engage intensively in both causal and effectual behavior, right from the earlier stages of development (even before firm incorporation). This practice provides a higher inflow of knowledge, and a consequent reduction of uncertainty. As a consequence, their business models undergo fewer changes after incorporation. These firms progress more or less according to plan, but do not avoid leveraging contingencies. If an opportunity arises, they evaluate its potential interest for the firm, and consider revisiting their plan. Such behaviour reveals an open and embracing attitude towards contingency.

In sum, higher performing early-stage university spin-offs tend to engage in a combined causal behaviour (e.g., strategic planning) and effectual behaviour (e.g., establishing partnerships, leveraging contingencies). Lower performing early-stage firms tend to engage in a highly experimental attitude, performing several changes to their business models without the guidance of a solid, consistent plan. Higher performing firms develop very early a central backbone (their strategic plan), and they are committed to experiment and interact around this central backbone, maintaining a mindful attitude towards contingency.

5.7 RESOURCE CONSTRAINTS AND BUSINESS MODEL CHANGE

5.7.1 Introduction

The purpose of this section is to examine how resource constraints affect business model change and performance of early-stage university spin-offs. From conducting open coding to the interviews and to the archival data looking at drivers of business model change, and also from reviewing the literature on university spin-offs, the issue of "resources" promptly emerged as a theme of relevance (see Table 5.10). In particular, when explaining changes in their business models, the topic of "resource constraints" was recurrent on the entrepreneurs' narratives (see Table 5.9). Hence, this study also uses a resource-based view (Barney, 1991) to examine the process of business model change in early-stage university spin-offs. This introductory Subsection 5.7.1 will briefly review the resource-based view framework (Barney, 1991; Rumelt, 1984; Wernerfelt, 1984).

5.7.1.1 Resource-Based Theory

The development of the resource-based theory was fuelled by the desire to understand and explain sustained superior firm performance. The first and older explanation, fundamentally focused on industry structure and market power, was articulated in the work of Porter (e.g., Porter, 1979; Porter, 1980; Porter, 1981) and draws on industrial economics. The second explanation of sustained superior performance is more "internal-facing" and focuses on the differential ability of some firms to be more efficient and effective. The work of Penrose (1959) is considered crucial in the development of the resource-based view. This work is followed by notable contributions from Barney (1986), Barney (1991), Dierickx & Cool (1989), Lippman & Rumelt (1982), Nelson & Winter (1982), Rumelt (1984), Rumelt (1987), Teece (1980), Teece (1982), and Wernerfelt (1984).

Barney & Clark (2007) claim that resource-based theory is rooted in four main sources of prior theoretical work: a) the traditional study of distinctive competencies (Hitt & Ireland, 1985), b) Ricardo's (1817) analysis of land rents, c) Penrose (1959), and d) the study of the antitrust implications of economics. However, some of the basic principles of resource-based theory are laid in Barney

(1986), Dierickx & Cool (1989), Rumelt (1984), and Wernerfelt (1984). They suggest that it is possible to develop a theory of persistent superior firm performance using a firm's resources as a unit of analysis, and describe some of the attributes that resources must possess to enable a firm to gain and sustain superior performance (Barney & Clark, 2007).

According to Barney & Clark (2007), not all firm resources hold the potential of sustained competitive advantages. The authors argue that to have this potential, a firm resource must have four attributes:

> *"a) it must be valuable, in the sense that it exploits opportunities and/or neutralizes threats in a firm's environment,*
>
> *b) it must be rare among a firm's current and potential competition,*
>
> *c) it must be imperfectly imitable, and*
>
> *d) it must be able to be exploited by a firm's organizational processes."* (Barney & Clark, 2007: 57)

These attributes are indicators of how heterogeneous and immobile a firm's resources are, and show their usefulness in generating sustained competitive advantages. Such attributes have been structured into a framework to analyze the potential of a broad range of firm resources to be sources of sustained competitive advantage. The VRIO framework, depicted in Figure 5.10, expresses the four key parameters as a series of questions about the business activities of the firm:

> *"The question of Value: Do a firm's resources and capabilities enable the firm to respond to environmental threats or opportunities?*
>
> *The question of Rarity: Is a resource currently controlled by only a small number of competing firms?*
>
> *The question of Imitability: Do firms without a resource face a cost disadvantage in obtaining or developing it?*

The question of Organization: Are a firm's other policies and procedures organized to support the exploitation of its valuable, rare, and costly to imitate resources?" (Barney & Clark, 2007: 70)

Most of the empirical research on resource-based theory is performed in the domain of strategic management. However, the field of entrepreneurship borrows frequently this theoretical lens from strategic management, and therefore some research has also been conducted in this discipline. Barney & Clark (2007) mention some studies performing resource-based research in the context of entrepreneurship (e.g., Borch, Huse, & Senneseth, 1999; Brush & Chaganti, 1999; Choi & Shepherd, 2004; Deeds, DeCarolis, & Coombs, 2000), though there are several more focusing on various different aspects of the resource-based theory.

Figure 5.10 The VRIO Framework and Sustained Competitive Advantage

Is a resource or capability . . .					
Valuable?	Rare?	Costly to imitate?	Exploited by organization?	Competitive implications	Economic performance
No	—	—	No	Competitive disadvantage	Below normal
Yes	No	—	↑	Competitive parity	Normal
Yes	Yes	No	↓	Temporary competitive advantage	Above normal
Yes	Yes	Yes	Yes	Sustained competitive advantage	Above normal

Source: Barney & Clark (2007)

Currently available typologies of firm resources are usually very broad in scope (Barney & Clark, 2007). Barney (2002) provides a generic typology, distinguishing between financial, physical, human, and organizational resources. An alternative first division is between tangible and intangible resources (Helfat et al.,

2009). Such division is similar to the one adopted within the accounting practice. Fernandez, Montes, & Vazquez (2000) classify intangible resources as people dependent (human capital) or people independent (organisational capital, technological capital, and relational capital). Other authors (e.g., Barney & Clark, 2007) use the expression "invisible resources" instead of "intangible resources". According to these authors, invisible resources might be information-based resources such as technology, customer trust, brand image, and control of distribution, corporate culture, and management skills. And people (read: human resources) are both accumulators and producers of invisible assets. Other authors also refer to "relational resources" or "social capital" (Nahapiet & Ghoshal, 1998: 243) such as partnerships and social networks that somehow extend the firm's "resource base".

Some scholars from the marketing discipline conceptualize market-based assets (or resources) as "assets that arise from the commingling of the firm with entities in its external environment" (Srivastava, Shervani, & Fahey, 1998: 2). They recognize that "a significant proportion of the market value of firms today lies in intangible (...) assets", and that "performance is increasingly tied to [such] assets" (1998: 4). These assets are divided in two types – relational and intellectual – and are largely intangible.

> *"'Relational' market-based assets are outcomes of the relationship between a firm and key external stakeholders, including distributors, retailers, end customers, other strategic partners. (...) 'Intellectual' market-based assets are the types of knowledge a firm possesses about the environment, such as the emerging and potential state of market conditions and the entities in it, including competitors, customers, channels, suppliers."* (Srivastava et al., 1998: 5*)*

Subsequently, Srivastava, Fahey, & Christensen (2001) propose the integration of marketing theorists and RBV proponents, and explore how market-based assets may lead to superior competitive advantage.

Kraaijenbrink & Groen (2008) provide a collection of current definitions of resources and typologies of resources. The diversity of definitions and typologies

reflects the several attempts to reach a consensual definition and typology. Rather, with each additional paper, a new definition or typology is put forward, and the diversity of classifications accumulates progressively. Therefore, converging into an agreed typology of resources has been a difficult task, possibly because different contexts or research purposes may require different typologies.

5.7.2 Data Analysis Procedure

The data analysis focused on: 1) identifying resource constraints, 1) identifying coping strategies to overcome those resource constraints, and 3) identifying business model elements affected by the resource constraints and coping strategies.

Drawing on the works of several authors (Barney, 2002; Barney & Clark, 2007; Helfat et al., 2009; Utterback, 1996), a typology of resources was developed and is displayed in Table 5.9. This typology served as a basis for the initial coding list, which was subsequently modified throughout the coding process, as new codes emerged.

Table 5.9 Typology of Resources

Category	Subcategory	Examples of Components
Tangible	Physical	Facilities Equipment
	Financial	Private investment, grants 'Money'
Intangible	Human	Technical (inc. scientific) knowledge Managerial knowledge Entrepreneurial knowledge Market knowledge
	Technological	Intellectual property (e.g. patents)
	Relational	Partners (e.g. suppliers, distributors)

	Social network
	Reputation
	Customer trust
Organizational	Firm strategy
	Brand image
	Financial (equity/shareholding)
	Databases
	Norms, routines, and culture

New nodes that emerged throughout the coding process were added to Table 5.9; the nodes that were not used to code were deleted from Table 5.9. The modified list of codes is presented below in Table 5.10, in the form of a coding matrix. This coding matrix represents the coding frequency of a certain node for each firm. Therefore, the lines display the nodes/codes, the columns display the cases, and the cells reflect the number of times a certain node was coded for a certain company ("count").

Table 5.10 Coding Matrix for the Resource Constraints

	A	B	C	D	E	F	G	H
Financial resources	27	12	15	18	26	2	8	7
Human resources (in general)	4	4	5	2	5	2	3	3
Reputation	2	3	3	3	0	0	0	2
Size	0	0	3	0	1	1	0	0
Market knowledge	1	1	2	2	0	1	0	0
Time	2	6	2	1	1	0	0	0
Entrepreneurial knowledge	2	0	1	1	0	0	0	0
Managerial Knowledge	2	0	1	1	0	0	0	0
Brand image	0	3	0	1	0	0	0	0
Partners	4	1	0	0	0	0	0	0
Physical resources	3	1	0	0	2	0	0	1
Total =	47	31	32	29	35	6	11	13

The coding matrix represented on Table 5.10 reveals that *"Financial resources"* is by far and large the most significant resource constraint for early-stage

university spin-offs. The following resource constraints, in terms of relevance, are *"Human resources"* and *"Reputation"*. Some companies also mentioned, directly or indirectly, *"Time"* as a constraint in their activity:

> *"Getting the supply chain right occupies a lot of time. (...) It's quite time consuming for us to phone up every [potential customer]..."* (Founder Firm B, month 0)

> *"Too much time commitment, resource intensive."* (Founder Firm B, month 8)

> *"That's just through lack of resource, lack of time really."* (Founder Firm C, month 0)

> *"We had to spend longer doing this, which was burning more budget, burning more time..."* (Founder Firm E, month 3)

Whether time can be considered a resource will not be a topic of discussion for this study. Since each firm "has" exactly the same "amount of time" to perform its activities, i.e., 24 hours per day, these comments on *"lack of time"* will not be considered.

An observation of Table 5.10 suggests that lower/medium performing firms (Cases A, B, C, and D) have more resource constraints in general. The narrative of lower/medium performing firms reveals a more frequent reference to resource constraints than higher performing firms (see Totals), which suggests the perception of having higher resource constraints. That perception may be factual, in which case it can be concluded that lower/medium performing firms have higher resource constraints than higher performing firms.

An additional finding is that lower/medium performing firms not only have higher levels of resource constraints, but also a wider array of different types of resource constraints. For example, Firm G only refers 2 types of resource constraints (financial resources and human resources), whereas Firm A mentions 9 types of resource constraints (financial resources, human resources, reputation, market

knowledge, time, entrepreneurial knowledge, managerial knowledge, partners, and physical resources). Therefore, lower/medium performing firms have or perceive that they have more types of resource constraints than higher performing firms.

5.7.3 Within-Case and Cross-Case Analysis

A summary of the empirical data from each case (within-case analysis) relating to each resource constraint, coping strategy, and business model elements affected, including quotes from the interviews, is provided in Table 5.11 (Cases A and B), Table 5.12 (Cases C and D), Table 5.13 (Cases E and F) and Table 5.14 (Cases G and H). The resource constraints, coping strategies, and quotes from the interviews are displayed in a chronological order, as they emerged throughout the longitudinal interviewing process. Table 5.15 provides a cross-case synthesis of the resource constraints, coping strategies, and business model elements affected.

The most cited type of resource constraint was the financial. Seven of the cases (with the exception of case F) mentioned financial issues as one of their resource constraints. Following financial resources, human resources and reputation/brand image were the second most mentioned constraints – both were referred by four of the eight university spin-offs. Physical resources were mentioned by three cases, followed by managerial knowledge (2 cases), market knowledge (1 case), and entrepreneurial knowledge (1 case).

To cope with financial issues, "applying for grants" was the most popular measure, employed by six of the eight firms. Four of the companies also chose to narrow their value proposition and/or prioritizing customer segments, due to lack of financial muscle and human resources. Similarly, in order to increase reputation and knowledge (market, managerial and entrepreneurial), four firms decided to bring in an external CEO or surrogate entrepreneur. Also, to alleviate the financial bottleneck, and simultaneously to acquire experience and knowledge about the markets, four firms sold consultancy, collaborative research contracts, bespoke systems or demo units. Other popular coping strategies included engaging with customer and/or potential customers, partnering with big companies for *"piggybacking"*, partnering

Table 5.11 Resource Constraints in Cases A and B

Case	*Resource constraints*	*Coping strategies*	*BM elements affected*
A	Financial. *"[Innovation agency] might sort of pull the plug when they start to look at our accounts, and realize that we have no money." (FA, 1st interview)* Physical. *"We don't have offices, I'm not up and running…" (FA, 1st interview)* Human. *"There's one lecturer, say 0.25 lecturers (25%), (…) and I come under an employee (50%)." (FA, 1st interview)* Reputation and size. *"There was a feeling that we weren't really 'big' enough." (FA, 1st interview)* Managerial knowledge. *"I would probably rate it as quite low. For that we need someone." (FA, 1st interview)* Entrepreneurial knowledge. *"Pretty low. (…) I have not really worked as an entrepreneur, other than the fellowship." (FA, 1st interview)*	Consultancy or bespoke systems to bring in some revenue. *"It was more like a sort of consultancy. (…) They [customers] asked us to build them a bespoke system." (FA, 1st interview)* Create a good website to increase reputation. *"We thought we'd better have a good website that made us look like a proper company." (FA, 1st interview)* Applying for grants to bring money in. *"We went in for a big grant" (FA, 1st interview); "We've got a grant starting in the 1st of October [2011]" (FA, month 5)* Bringing in a surrogate entrepreneur to increase managerial and entrepreneurial knowledge. *"We have been thinking about maybe bringing in a CEO, through the university program." (FA, month 0)* Interact with potential customers to increase market knowledge and refine the product. *"As we talk to our customers, or potential customers, we get a better idea of where the technology could be used." (FA, month 0)* Establish partnerships to access additional resources. *"As we bring in more key partners, then they have resources that we can perhaps use." (FA, month 0)*	Customer Segments, Value Proposition, Revenue Streams, Key Resources, Key Activities, Key Partners, Cost Structure, Funding
B	Human. *"It comes back to being a startup company, not having the financial or human resources..." (FB, month 0)* Financial. *"Not having accounts that show that we could have the financial muscle to supply a large order." (FB, month 2)* Brand image/reputation. *"We still don't have a strong brand, but we want to build a strong brand." (FB, month 8).* Physical. *"We're taking on three employees. Therefore, we need new premises." (FB, month 9)*	Implement marketing campaign to increase brand awareness, and thus sales. *"Without any online marketing the sales are very very low. So, we decided that we needed to implement a structured online marketing campaign." (FB, month 0)* Using distributors to increase market reach. *"To make contact with the right buyers (…) can be quite time consuming. Whereas these companies [specialized distributors] actually do that for you, (…) they already know the buyers." (FB, month 0)* Prioritizing customers with shorter lead times in the buying decision process, to accelerate sales. *"The decision making process with the retailers is much shorter than with the utilities companies." (FB, month 0)* Engaging with customers to refine and articulate better their value proposition. *(FB, month 0)* Fulfilling accreditations and marketing green credentials to increase reputation. *"We're also been explicit about our credentials, because we've got a credibility challenge with being a startup company." (FB, month 2)* Establishing partnerships to develop alternative sales channels (e.g. TV shopping) *"We will be bringing partners to develop other sales channels." (FB, month 2)* Applying for grants to bring money in. *"We will always be applying for grant funding." (FB, month 11)* Sourcing alternative manufacturer to reduce costs. *"We can't get our cost down to a sufficient level with our existing manufacturer. So, we're now looking for a new manufacturer." (FB, month 11)*	Customer Segments, Value Proposition, Channels, Key Activities, Key Partners, Cost Structure, Funding

Table 5.12 Resource Constraints in Cases C and D

Case	*Resource constraints*	*Coping strategies*	*BM elements affected*
C	Human. *"They'll [potential customers] give us phone calls, lots of emails, and I'm not out in about as much as I should be. And that's just lack of resource, lack of time really." (FC, month 0)*	Maintaining partnership with original research institute. *"They [research institute] do the research, and it's up to us to look at the development and new product introduction. (…) So, the company itself is not sinking a lot of resource into research." (FC, 1st interview)*	Customer Segments, Value Proposition, Revenue Streams, Key Resources, Key Partners, Funding
		Selling demo units and bespoke systems. *"We get the customers to pay for systems, devices, etc., so that at least there is a commitment from their side." (Month 0)*	
		'Piggybacking' to access resources and increase credibility. *"We're talking to number 2 player in the world in this area. They've got a huge amount of resources behind them, which we're trying to piggyback on." (Month 0).*	
	Financial. "*We are looking to generate more internal IP, but that's constrained by our funding at the moment." (Month 1)*	Using customers' resources to increase market knowledge. *"They [customers] also provide information on the market sector. (…) For instance, in the semiconductor market, one of our customers told us a lot about that market." (Month 0)*	
		Using customers to test products and provide feedback. *"Customers test the devices, (…) and they feedback." (Month 2)*	
	Reputation. *"To grow the business, we need to be raising our profile [read: reputation, credibility]." (Month 2)*	Involving investors and potential directors to increase reputation. *"What we're doing is talking to potential investors, talking to potential non-executive directors who can come on board and provide (…) credibility to the company." (Month 2)*	
		Raising funds to scale the business. *"We need to be scaling the business, we need to be raising fund." (Month 8)*	
		Applying to grant funding. *"What we're always trying to do is leverage grant funding." (Month 12)*	
D	Financial. *"We need the cash flow. (…) We don't have enough [financial] capital" (FD, month 1); "We need to be financially more secure" (Month 7)*	Bringing in a specialized management team to increase market and managerial knowledge. *"And the reason we brought in the managerial team is because they have extensive market experience in the sector. (…) And they have general business experience of managing small companies in this market sector. (1st interview)*	Customer Segments, Value Proposition, Revenue Streams, Key Resources, Funding
		Bringing in an external CEO. *"That's when we started looking for CEOs. In about 2009, we managed to get some credible ones." (1st interview)*	
	Reputation / Brand image / Novelty. *"It's just the difficulty of introducing novel technology into the marketplace. There's a lot more, how should I say… resistance." (Month 8)*	Selecting the value proposition that has lower implementation costs. *"The cost of setting up veterinary pharma company, as I said, is substantially more than setting up a wound care company" (Month 0).*	
		Prioritizing customers or value proposition with lower time-to-market. *"Then wound care… yeah, you can do it in 18 months, veterinary care you're talking 3 to 5 years" (Month 0)*	
		Getting research contracts to bring in some revenue. *"Get a signed contract of some sort [R&D], and bring some money in [goals]" (Month 0)*	
	Market knowledge and managerial knowledge. *"I'm not a business person. And, although I know quite a bit about it, I have limited market experience." (1st interview)*	Raising funds from investors to carry out their plans. *"So, there's this business plan they [investors] agreed, and it needs finance to carry it out." (Month 10)*	
		Focusing in segments with less regulatory hurdles. *"It may well be one of the last segments to be developed, because it's got more regulatory hurdles, it's further to market." (Month 12)*	
		Creating and launching a good website to increase visibility and reputation. *"A big driver was the website, once that went live, within days. We had phone calls saying, we're interested in this technology." (Month 12)*	

Table 5.13 Resource Constraints in Cases E and F

Case	*Resource constraints*	*Coping strategies*	*BM elements affected*
E	Physical. *"We can't do that internally. We do not have a lab." (Month 0)* Financial. *"We cannot do two [projects]. We just don't have enough finance." (Month 7)*	Focusing, narrowing the scope of the business. *"We had an ambitious plan to go after (...) 3 different programs. (...) We ended up with one. (...) We had to make some choices. The economic climate interrupted our fine plans. (FE, Month 0)* Having a semi-virtual structure. *"We have a semi-virtual structure, (...) it doesn't cost as much. It depends on the experience of the people in the organization, together with the quality of consultants, advisors, etc. (Month 0)* Using a Strategic Advisory Board. *"Because of the semi-virtual structure, we use a strategic advisory board. These are experts. About half of them are professors, which we wouldn't be able to afford if they were full time. (Month 0)* Founders/managers taking low salaries during startup. *"We're not paying ourselves fulltime. (...) We have taken low salaries, because we do other things. (...) Some people call it 'sweat equity'. Until you get external money, that's what you got to do." (Month 0)* Low cost, virtual offices, available in multiple geographies. *"We have a Regus office. (...) We're allowed to use our privileges almost anywhere, it's amazing." (Month 0)* Developing a network of external contractors. *"The other thing we need, which is essential, is a network of external contractors." (Month 0)* Trying to establish funded research collaborations in parallel. *"Funded research collaboration in parallel, because the key there is the resources would come from the partner. You wouldn't have to go and raise money." (Month 6)* Applying for grant funding. *"We're trying to obviously increase our activity but through grant sources." (Month 7)* Establishing partnerships/'piggybacking' to access resources. *"Getting a regional partner, who will drive the necessary clinical trials with us in a support role, rather than a resource role. So, we don't come out of our R&D budget. I call this piggyback development." (Month 10).* Maintaining strong alliance with the university, for fundraising and research. *"(...) A grant that could have us working with the university." (Month 9);"There are other grants that I'm looking at with the university, together we are more powerful." (Month 11)*	Value Proposition, Key Resources, Key Partners, Cost Structure, Funding
F	Human. *"We may have to bring in some more [people]. (...) There's just too much work to do." (Month 6)*	Focusing on key activities. *"We're a small team and we need to concentrate on our key activities, which is really engineering, research and development. With a little bit of operational management to ensure everything works well." (Month 0)* Partnering to deliver product to the customers, maintaining a supervisory role. *"Initially we did the first 20 farm installations ourselves, to make sure we understood how it operated. After that, we tended for an installation company to do that." (Month 0)* Recruiting people with different skills. *"He's got a slightly different skill set. (...) He will allow us to do a complete revision of our product for next year." (Month 6)* Recruiting additional people to support volume increase. *"We may need to bring on more people to support the volume increase." (Month 10)* Performing initial strategic planning to reduce market and technological uncertainty. *"We had spent a number of years analyzing what we wanted to do. (...) It doesn't make it easy, but it removes some of the uncertainty." (Month 10)* Developing a solution that meets a specific market need. *"This company was setup from some research. (...) The research was in response to a piece of market analysis (...). They [government agency] had identified a market sector and a market need. And they put in place a research program to deliver a technical solution to match that market need [performed by Firm F]." (Month 10).* Applying for grant funding. *"It's a competition. (...) So, you make a case and you apply, and we got it. (...) It's to develop illness detection features." (Month 10)* Establishing partnerships to increase market penetration and expand geographically. *"These guys were our first partner and we worked with them to establish the product and get it to market. (...) And we'll continue to look for other partners in different geographies." (Month 12)*	Value Proposition, Channels, Key Resources, Key Activities, Key Partners, Funding

Table 5.14 Resource Constraints in Cases G and H

Case	*Resource constraints*	*Coping strategies*	*BM elements affected*
G	Financial. *"Therefore, there is a big challenge in financing the company to that level of investment." (1st interview)*	Partnering with the supply chain for product development. *"The development work has been undertaken with the company and the supply chain. (...) If you devolve the development work into the supply chain, you can typically do it a lot cheaper." (1st interview)* Keeping the core team small. *"There's only 3 employees in [Firm G]." (1st interview)* Maintaining the core knowledge inside the company, and managing the 'outsourced' product development. *"We've got the knowledge base in the company, we then subcontract the development of that knowledge to the supply chain. (...) So, they [external contractors] have been led by us, they're being managed by us." (1st interview)* Going after grant support. *"We will look for grant support from [government agency], or local enterprise companies." (1st interview)* Partnering with investment experts to help with fundraising. *"An additional key partner is [investment group], who are helping us with the fundraising." (Month 1)* Creating a distinct company (Single Purpose Vehicle) for each energy farm, and attracting local investors to finance it. *"We're now registering SPVs and these SPVs are starting to develop their own business plans. So, now we need to figure out how we're going to finance those." (Month 1)*	Value Proposition, Key Resources, Key Activities, Key Partners, Cost Structure, Funding
H	Financial. *"It seems very difficult to get money" (Month 0); "We need a lot of money" (Month 2);*	Hiring an external CEO / surrogate entrepreneur. *"I went back to the university and said: do you know any people who would like to be a managing director of an almost non-existing company, and we could offer him 10% of the shareholding?" (Month 0)* Acquiring a sales and distribution company, to get their products to market. *"We absorbed their whole company [sales and distribution organization]. Their company turned over more than 4 Million pounds, they were in profit." (Month 2)* Getting additional funding rounds. *"The equipment up here costs a lot of money. So, that's why there's got to be additional investment round." (Month 2)* Partnering with a manufacturer to extend production capacity. *"We just don't have the capacity. (...) We will make some raw materials for them, and pass them. They will assemble the whole thing into a kit, they will sell in China, but then we would import these things back into Europe, and sell them in Europe." (Month 6)* Partnering with additional distributors to expand to different geographies. *"The cost of trying to break into the U.S. yourself is just ludicrous. And they tend to be quite restrictive in allowing people to do that. So, you're far better finding a distributor that will get you started, and will distribute the products, that's all." (Month 12)* Getting new facilities to increase production. *"We're going into production, we're gonna have to have a 10 thousand square foot facility." (Month 0)*	Channels, Revenue Streams, Key Resources, Key Partners, Cost Structure, Funding

Table 5.15 Resource Constraints: Case Summaries and Cross-Case Synthesis

Case	*Resource constraints*	*Coping strategies*	*BM elements affected*
A	Financial, Physical, Human, Reputation/size, Managerial and Entrepreneurial knowledge	Consultancy or bespoke systems to bring some revenue; Create good website to increase reputation; Applying for grants; Bringing in a surrogate entrepreneur/CEO; Interact with potential customers to increase market knowledge and refine product; Establish partnerships to access additional resources.	CS, VP, R$, KR, KA, KP, C$, F$
B	Human, Financial, Brand image/reputation, Physical	Implement marketing campaign; Distributors to increase market reach; Prioritizing customers with shorter decision times; Engaging with customers to refine VP; Fulfilling accreditations and green credentials; Establishing partnerships to develop alternative sales channels; Applying for grants; Sourcing alternative manufacturer to reduce costs.	CS, VP, CH, KA, KP, C$, F$
C	Human, Financial, Reputation	Partnership with original research institute; Selling demo units and bespoke systems; 'Piggybacking' to access resources; Using customers resources; Using customers to test VP; Involving investors and potential directors; Raising funds to scale business; Applying for grants.	CS, VP, R$, KR, KP, F$
D	Financial, Reputation / Brand image / Novelty, Market and Managerial knowledge	Bringing in specialized management team; Bringing in external CEO; Selecting VP that has lower implementation costs; Prioritizing customers and VP with shorter time-to-market; Getting research contracts to bring in some revenue; Raising funds from investors; Customer segments/VP with less regulatory hurdles; Creating and launching good website.	CS, VP, R$, KR, F$
E	Physical, Financial	Narrowing scope of the business; Semi-virtual structure; Using a Strategic Advisory Board; Founders/managers taking low salaries during startup; Low cost, virtual offices; Network of external contractors; Establish funded research collaborations; Applying for grant funding; Partnerships/'Piggybacking' to access resources; Maintaining partnership with the university.	VP, KR, KP, C$, F$
F	Human	Focusing on key activities; Partnering to deliver product; Recruiting people with different skills; Recruiting additional people to support volume increase; Initial strategic planning to reduce uncertainty; Developing solution that meets specific market need; Applying for grant funding; Partnerships to increase market penetration and expand geographically.	VP, CH, KR, KA, KP, F$
G	Financial	Partnering with supply chain for product development (PD); Small core team; Core knowledge inside company, managing outsourced PD; Applying for grants; Partnering with investment experts; Creating distinct company for each energy farm.	VP, KR, KA, KP, C$, F$
H	Financial	Hiring external CEO/surrogate entrepreneur; Acquiring sales and distribution company to get products to market; Getting additional funding rounds; Partnering with manufacturer to extend production capacity; Partnering with additional distributors to expand to different geographies; Getting new facilities to increase production.	CH, R$, KR, KP, C$, F$
ALL	Financial (7), Human (4), Reputation / Brand image (4), Physical (3), Managerial knowledge (2), Market knowledge (1), Entrepreneurial knowledge (1)	Applying for grants (6); Bringing in external CEO / surrogate entrepreneur (4); Focusing, i.e. narrowing VP and/or prioritizing CS (4); Selling consultancy, collaborative research contracts, bespoke systems or demo units to bring in revenue (4); Engaging with customers and/or potential customers to increase market knowledge and/or refine VP (3); Partnering with big companies to access additional resources /'piggybacking' (3); Partnering with distributors to get product to market, increase market penetration and/or expand geographically (3); Partnering with supply chain / manufacturers to develop product, reduce costs, or increase production capacity (3); Raising additional funding from investors (3).	F$ (8), VP (7), KR (7), KP (7), C$ (5), CS (4), R$ (4), KA (4), CH (3)

with distributors to get the product to market and expand, partnering with the supply chain and manufacturers, and raising additional funding from investors.

Since the most cited type of resource constraint is financial, and the most popular coping strategy is applying for grants, it is not surprising that the business model element being most affected is the funding (F$, mentioned by all firms). Following funding, the business model elements undergoing more changes as a consequence of resource constraints and subsequent execution of coping strategies are the value proposition, key resources, and key partners, each of them mentioned by seven firms.

5.7.4 Resource Constraints, Business Model Change, and Performance

This subsection aims to investigate the relationship between the topic of resource constraints, business model change, and early-stage spin-off performance. Table 5.16 summarizes the resource constraints, coping strategies and business model elements affected for low/medium performing firms and high performing firms, separately.

The data suggests that low/medium performing firms address much more frequently the topic of resource constrains and project a wider spectrum of resource constraints. In fact, low/medium performing firms mentioned the following types of resource constraints: reputation/brand (3 cases), financial (3 cases), human (2 cases), physical (1 case), market knowledge (1 case), and managerial knowledge (1 case). On the other hand, higher performing firms only mentioned three types of resource constraints: financial (2 cases), human (1 case), and physical (1 case).

In terms of coping strategies, one common measure between low/medium and high performing firms was to apply for grant funding. One slight difference is that all of the high performing firms applied for grant funding (3 cases), whereas only two of the low/medium performing firms mentioned to apply for grant funding. Low/medium performing firms also referred the following coping strategies: a) engaging with customers to test products and provide feedback, thus refining VP (2

cases), and b) raising funds from investors to carry out business plan and/or scale the business (2 cases).

One coping strategy that was mentioned by two high performing firms, but not mentioned by any of the low/medium performing firms, was "focusing on key activities and/or narrowing the scope of the business". Previous discussions throughout the analysis chapter (see Propositions 7 and 8 in Section 5.5.3) pointed already in this direction: that higher performing early-stage university spin-offs tend to have a narrower technology scope and/or maintain a narrower business scope than lower performing ones. Hence, this suggests that higher performing early-stage university spin-offs are more likely to have a narrower business model, i.e., more focused value proposition, and less customer segments.

Higher performing firms tend also to cope with existing resource constraints by keeping their core team small, opting by a "semi-virtual" structure (mentioned by 2 cases). However, they maintain a close supervision and management of the outsourced activities performed by their partners (2 cases). Another salient characteristic of higher performing firms is that they establish more partnerships than lower performing firms. Moreover, higher performing firms establish partnerships with a wider array of actors, seeking for and embracing cooperation in a broader array of activities. Specifically, concerning partnerships, higher performing firms mentioned the following coping strategies: a) partnering to deliver product to customers, and/or to increase market penetration and expand geographically (2 cases), b) establishing partnerships/"piggybacking" to access resources, c) maintaining partnership with the university, d) partnering with the supply chain for product development, and e) partnering with investment experts to help with fundraising. This evidence suggests the following proposition:

> *Proposition 15. Higher performing early-stage university spin-offs tend to establish more partnerships and with different types of actors, thus triggering more changes in the key partners (KP) element of their realized business models.*

Table 5.16 Resource Constraints: High vs Medium/Low Performing Cases

Case	*Resource constraints*	*Coping strategies*	*BM elements affected*
M/L perf. (B, C, D)	Reputation/Brand (3), Financial (3), Human (2), Physical, Market knowledge, Managerial knowledge	Engaging with customers to test products and provide feedback, thus refining VP (2); Applying for grants to bring in some revenue (2); Raising funds from investors to carry out business plan / scale the business (2). Implement marketing campaign to increase brand awareness; Partnering with distributors to increase market reach and develop alternative sales channels; Prioritizing customer segments with shorter decision times; Fulfilling accreditations and marketing green credentials to increase reputation; Sourcing alternative manufacturer to reduce costs; Maintaining partnership with original research institute; Selling demo units and bespoke systems; 'Piggybacking' to access resources and increase credibility; Using customers' resources to increase market knowledge; Involving investors and potential directors to increase reputation; Bringing in a specialized management team to increase market and managerial knowledge; Bringing in an external CEO; Selecting the VP that has lower implementation costs; Prioritizing customer segments or VP with lower time-to-market; Getting research contracts to bring in some revenue; Focusing in segments with less regulatory hurdles; Creating and launching a good website to increase visibility and reputation.	CS (3), VP (3), F$ (3), R$ (2), KR (2), KP (2), CH (1), KA (1), C$ (1)
High perf. (E, F, G)	Financial (2), Human, Physical	Applying for grant funding (3); Focusing on key activities and/or narrowing the scope of the business (2); Keeping the core team small, semi-virtual structure (2); Supervising and managing the 'outsourced' activities to partners (2); Partnering to deliver product to the customers, and/or to increase market penetration and expand geographically (2). Establishing partnerships/'piggybacking' to access resources; Maintaining partnership with the university; Partnering with the supply chain for product development; Partnering with investment experts to help with fundraising. Using a Strategic Advisory Board; Developing a network of external contractors; Trying to establish funded research collaborations in parallel; Founders/managers taking low salaries during startup; Recruiting people with different skills; Recruiting additional people to support volume increase; Performing initial strategic planning to reduce market and technological uncertainty; Developing a solution that meets a specific market need; Maintaining the core knowledge inside the company; Creating a distinct company (Single Purpose Vehicle) for each energy farm, and attracting local investors to finance it.	VP (3), CH (1), KR (3), KA (2), KP (3), C$ (2), F$ (3)

Though the total number of changes of the realized business models is higher for lower performing firms, an inverse behaviour is seen for the realized key partners (KP) element of the business model (see Table 5.7). In fact, the key partners element of the realized business model changed more often in higher performing firms (1.7 times, in average) than in lower/medium performing firms (1.2 times, in average).

In relation to the business model elements affected by the perceived resource constraints and the subsequent coping strategies, it can be seen that more business model elements are affected for lower/medium performing firms (9 elements) than for higher performing firms (7 elements). Therefore, the fact that lower/medium performing firms perceive or project more resource constraints, leads them to devise and execute more coping strategies, which in turn generates a higher number of business model changes, and also triggers changes to a wider range of business model elements.

> *Proposition 16. Low/medium performing university spin-offs tend to project more resource constraints, thus triggering a higher number of business model changes and to a wider range of different business model elements.*

These findings add nuance to recent work on contextual influences on entrepreneurial innovation (Autio et al., 2014) and on knowledge and business ecosystems (Clarysse et al., 2014) by explaining these dynamics from a business model perspective. For entrepreneurial firms it is important to be located and participate in such business ecosystems (Clarysse et al., 2014), so they interact with other firms and co-evolve their capabilities and roles. This location setting facilitates the establishment of more partnerships and with different types of actors, which triggers more changes in the key partners (KP) element of firms' realized business models. This behavior is typically associated with higher performance. Therefore, the finding formalized on Proposition 15 explains how the context may influence the performance of early-stage university spin-offs and how it may impact their business models. On the other hand, low performing university spin-offs tend to project more resource constraints, which leads them into an erratic spiral of business model iterations to try to overcome those constraints (Proposition 16). Therefore, locating firms within successful entrepreneurial innovation contexts (Autio et al., 2014) or

business ecosystems (Clarysse et al., 2014) might allow them to access more resources (e.g., through the establishment of partnerships), thus reducing resource constraints and the number of 'unproductive' changes to business model elements.

5.8 CONCLUSION

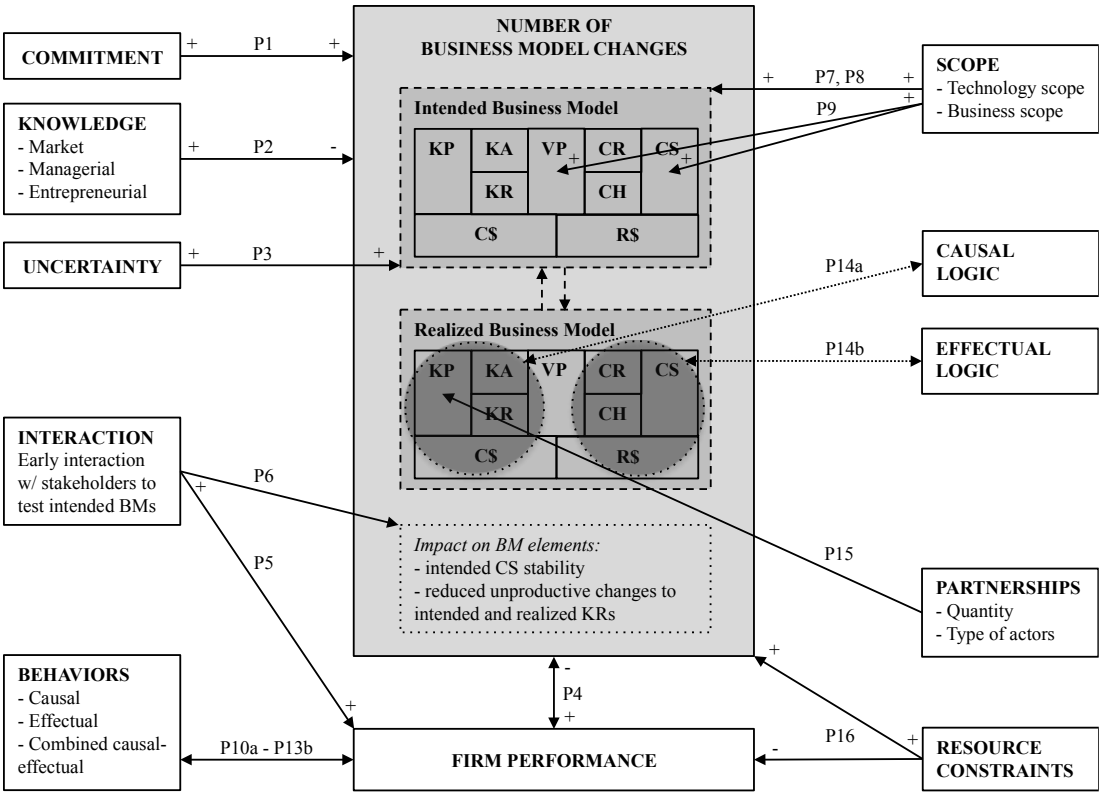
This chapter presented a structured analysis of the data gathered longitudinally on business model change, in the context of early-stage university spin-offs. Figure 5.11 provides a visual representation of the propositions induced throughout the analysis process.

Adopting an open coding technique, it started by identifying the drivers of business model change, and a list of themes worthwhile exploring in this study and in future research. The next section examined one of those themes, emphasizing the importance of distinguishing intentions from realizations, and introducing the concepts of realized and intended business models.

The following Section 5.4 analyzed the relationships between the number of business model changes and previously computed measures of commitment, market knowledge, managerial knowledge, entrepreneurial knowledge, and performance. The data suggests that higher commitment triggers a higher number of changes in the realized and intended business models. On the other hand, higher levels of market, managerial and entrepreneurial knowledge tend to be associated with fewer changes in the realized and intended business models. Evidence also indicates that the higher the uncertainty surrounding a certain intended business model element, the higher the likelihood of this intended element undergoing more changes. In terms of relationship with performance, the analysis suggests that in higher performing early-stage university spin-offs, both intended and realized business models change less often, as a whole. Furthermore, higher performing early-stage university spin-offs interact earlier (before firm incorporation) and more intensively with stakeholders to perform iterative testing to their intended business models. This early practice results

in higher intended customer segment stability, and reduces ineffective changes in realized and intended key resources, thus mitigating harmful resource consequences.

Figure 5.11 Visual Representation of the Propositions



Subsequently, Section 5.5 investigated the relationships between technology scope, business scope, business model change, and early-stage spin-off performance. The cross-case analysis suggested the narrower the technology and/or business scope of early-stage university spin-offs, the lower the number of changes in their intended business models (and thus the higher their performance). More specifically, at the business model element level, the narrower the technology or business scope of the early-stage spin-off, the lower the number of changes in the intended customer segments and value proposition.

Section 5.6 analyzed the data through the causation versus effectuation lens. Evidence suggests that higher performing early-stage firms are more likely to exhibit all the three types of behaviors (i.e., causal, effectual, and combined causal-effectual), with a predominance of combined causal-effectual behavior. On the other hand, lower performing early-stage firms are more likely to exhibit only purely causal behavior and effectual behavior (i.e., absence of combined causal-effectual behavior), with effectual behavior dominating. Furthermore, while high performing early-stage firms tend to develop a full range of behaviors early on (including causal, effectual, and combined causal-effectual), lower performing firms adopt later the behaviors initially absent. Data also indicates that more outward-facing business model elements (i.e., customer segments, value propositions, customer relationships, channels, and revenue streams) are more likely to be changed, entirely or partly, by effectual drivers, due to the higher uncertainty that characterizes them. On the other hand, more inward-facing business model elements are more likely to be changed by causal drivers.

Finally, Section 5.7 examined the theme of resource constraints and its relationship with business model change and early-stage spin-off performance. The analysis suggests that low/medium performing early-stage university spin-offs tend to perceive more resource constraints, leading them to implement more coping strategies, which in turn triggers a higher number of business model changes to a wider range of different business model elements. On the other hand, higher performing university spin-offs tend to establish more partnerships and with different types of actors, thus triggering more changes (only) in the key partners element of their realized business models.

The next chapter summarizes the findings of this study, and outlines its theoretical contribution and practical implications. The chapter then concludes by identifying limitations and future research avenues in the fields of business models and university spin-offs.

6 DISCUSSION AND CONCLUSION

6.1 INTRODUCTION

The aim of this thesis has been to explore the topic of business model change in the context of early-stage university spin-offs. In particular, it has sought to explore three research questions: 1) How does the process of business model change unfold in early-stage university spin-offs? 2) How does business model change link to performance in early-stage university spin-offs? and 3) How do business model elements change and interact over time in early-stage university spin-offs?

By employing a longitudinal design to trace business model changes in real-time, this study contributes mainly to the business model and university entrepreneurship literature with: 1) a review of business models structured according to 'static' and 'dynamic' approaches, 2) an identification of drivers and themes related to the process of business model change, and 3) the introduction of the notions of realized and intended business models. This study generated also a set of propositions relating business model change (aggregate and by element) and early-stage spin-off performance with: 1) commitment, market knowledge, managerial knowledge, and uncertainty, 2) technology scope and business scope, 3) relative frequency of causal and/or effectual behaviors (by using the effectuation theoretical framework), and 4) resource constraints (by using the resource-based view).

This chapter addresses the three research questions raised previously by synthesizing the main findings derived from the data analysis, which were thoroughly reported in Chapter 5. This study includes data collected longitudinally from 8 university spin-offs in the U.K., totalling 98 face-to-face longitudinal interviews and additional data from several other sources. This final chapter proceeds as follows. First, the main findings related to each of the three research questions are outlined. Then, the theoretical contribution is given, followed by a discussion of the practical implications to academic entrepreneurs, universities, and policy makers. Finally, the limitations of the study and suggestions for future research are presented.

6.2 OVERVIEW AND DISCUSSION OF FINDINGS

6.2.1 How Does the Process of Business Model Change Unfold?

Prior studies have suggested that business models (e.g., Chesbrough, 2007b; Kaplan et al., 2009; Magretta, 2002) and business model design (Zott & Amit, 2007) are important. Though important, business models cannot be fully anticipated in advance (Andries & Debackere, 2007; McGrath, 2010), especially in fast-moving environments characterized by high uncertainty. This high uncertainty induces business model changes (Andries & Debackere, 2007), as the entrepreneur acquires knowledge through engagement with others and involvement in entrepreneurial activities (Druilhe & Garnsey, 2004). Therefore, sustainable business models are learned through experimentation (Murray & Tripsas, 2004) or "by doing" (Vohora et al., 2004) over time.

However, most business model research presents "a static perspective" (Sosna, Trevinyo-Rodriguez, & Velamuri, 2010: 384), focused only on a single point in time. In fact, Zott & Amit (2008: 20) conclude that "little research has been conducted so far on how business models evolve". Moreover, there are few longitudinal studies on business models of new ventures, and they are either single case studies (e.g., Doganova & Eyquem-Renault, 2009), or focused on a single sector (e.g., Bohnsack, Pinkse, & Kolk, 2014). These studies do not allow cross-case comparisons, which hinders analytical generalizability. One exception is the study by Andries, Debackere, & Van Looy (2013), though the interviews are retrospective, and some of the data are relatively old, going back up to 30 years. Hence, researchers have called for business model studies examining real-time change by employing longitudinal designs (George & Bock, 2011; Morris et al., 2005; Svejenova et al., 2010; Zott & Amit, 2007, 2008). Similarly, researchers on university spin-offs (e.g., Bahelt et al., 2010) argue that most spin-off studies are static and present snapshots of their development process. Therefore, they also suggest longitudinal designs to examine the phenomena over time (Markman et al., 2008; Van Geenhuizen & Soetanto, 2009), especially during their early stages (Heirman & Clarysse, 2007). I am not aware of any published studies that undertook real time tracking of business model changes in early stages of university spin-off development.

This study employed such a longitudinal field research design to examine how business models change over time in early-stage university spin-offs. First, the *drivers* that triggered changes to the business models were identified (see Section 5.2). The need for resources, mainly financial capital (more specifically, funding) and human capital (scientific/technical expertise) are some of the drivers causing more changes in the business models. The intention to grow sales, namely by increasing sales in additional geographical markets, and to grow profit, by augmenting margins through cost reduction, were also important triggers of change. Product development activities, including testing and trials, are also strong motivators for change. Finally, many of the changes were driven by customer interaction, namely when developing technology or products to meet customer demands. These findings complement Ambos & Birkinshaw's (2010) work, which argued that archetype transitions are triggered by collective cognitive dissonance between venture leaders' understanding of the old interpretive scheme and the emerging reality. This thesis contributed with an additional layer of understanding by following the drivers that triggered changes to business model elements over time. Business model elements were changed as consequence of a combination of internal stimuli (decisions to acquire key resources to perform key activities) and external stimuli (e.g. meeting emerging customer demands) aiming at increasing firms' revenue and profit.

In addition to the drivers, different *themes* emerged when exploring the data from a process perspective on business model change. The most salient themes were: 1) market pull versus technology-push (including generic/platform- versus narrow-scope technologies), 2) systemic nature and interdependence of business model elements, 3) customer interaction, 4) causation versus effectuation, 5) definition of change and different levels of change, 6) intended versus realized business models, and 7) resource constraints and their impact in the business model. This thesis explored many of these topics; the remaining ones are suggested for future research (see Section 6.7). Knowing the drivers of business model change and related areas is relevant, since they help to direct entrepreneurs' attention to fewer aspects. Since these are the drivers that originate more substantial business model changes, focusing on them for a more targeted sensing or scanning may be beneficial from a

controlling/management point of view. It helps entrepreneurs by prioritizing the "focal points" to which they have to pay special attention, and to collect information for decision making. It also aids future researchers on business model change to identify topics that could be worthwhile exploring.

Second, this study revealed that business models evolve both at the intentional level and at the reality level (see Section 5.3). Entrepreneurs often talk about their already implemented business models, though they also refer to intentions for their business models, sometimes even in the same sentence. This blurriness between reality and intentions is also reflected in some of the most popular definitions of business models. For example, Osterwalder et al. (2010: 14) defines the business model as "the rationale of how an organization creates, delivers, and captures value", but also as "the logic of how a company *intends* to make money" (Osterwalder et al., 2010: 15). While the former definition uses the present tense and emphasizes *realizations*, the latter employs the word "intends" and is clearly focused on *intentions*. Strategic management scholars have also studied the interplay between intended and realized strategies (Koh & Venkatraman, 1991; Mintzberg, 1978; Venkatraman, 1989).

The research methodology was re-designed to collect data on these two levels of business models, i.e., realized business models (already implemented) and intended business models (residing in the entrepreneur's mind, and reflecting his intentions). The data reveals that entrepreneurs may have several intended business models, though they usually focus on one, i.e., the one they intend to pursue. Entrepreneurs start with this intended business model in their minds, and as they progress, part of the intended business model becomes realized. With time, the realized business model becomes progressively more similar to the intended business model. Ultimately, the entrepreneur seeks to equalize the realized business model and the intended business model. While this process is in place, external perturbations trigger unexpected changes in the intended business models (e.g., new ideas/solutions arising). These new ideas modify the intended business model, and the entrepreneur subsequently updates his/her realized business model. In some

situations this process is lengthy; in other situations this "conversion" from intention to realization is almost instantaneous.

These two types of business models, intended and realized, change individually but not independently, since there is a strong interaction between them. This duality is a reflection of the duality between thought and action (Bandura, 1986), or between decision making and entrepreneurial action (McMullen & Shepherd, 2006). According to McMullen & Shepherd (2006: 134),

> *"it is important to note that a decision is a necessary but insufficient condition for the occurrence of entrepreneurship. We return to the basic realization that entrepreneurship requires one not just to decide but to decide to act."*

Similarly, a change in the intended business model is a necessary but insufficient condition for the occurrence of a change in the realized business model. Changing intentions is not enough; action is necessary to produce real changes. Nevertheless, the quality of the intended business model affects the quality of the realized business model, just as the quality of thoughts shape the quality of actions. Hence, this study implies that entrepreneurs should be more aware of this distinction and dynamics between intended and realized business models; moreover, conceptual frameworks should be developed to help practitioners to think/plan and manage this business model duality. Also, from a communication point of view, introducing this clarity between "what we are" (realized business model) and "what we want to be" is useful and beneficial. This thesis contributes to Andries et al. (2013) work by adding to the 'reality level' the not less important 'intentional level' of the business model change process. The real-time data collection on business model elements over a considerable period of time, which differs from the retrospective nature of Andries et al. (2013) data collection strategy, allowed the emergence of these two levels of business models, and enabled the discussion of certain aspects regarding their nature and interaction. This rationale holds true also to Ambos and Birkinshaw (2010) discussion, which focused on the evolution of 'realized' archetypes over time.

Third, this study suggests that more committed management teams are likely to induce more changes in both realized and intended business models than less committed management teams (see Section 5.4.2). Hence, commitment acts as a catalyst for the process of business model change, shortening the time to reach a viable business model. Data also indicates that firms with higher levels of market, managerial, and entrepreneurial knowledge usually exhibit a lower sum of changes in the intended and realized business models (see Section 5.4.4). Evidence also suggests a positive relationship between market knowledge, managerial knowledge, and entrepreneurial knowledge in university spin-offs. For instance, if a spin-off has high market knowledge, then it is likely to have high managerial and entrepreneurial knowledge. Similarly, if a spin-off has low market knowledge, then it is likely to have also low managerial and entrepreneurial knowledge.

Fourth, this study distinguishes between *technology scope* and *business scope*, and relates them to the process of business model change (see Sections 5.5.1 and 5.5.2). In particular, the data suggests that early-stage university spin-off firms with narrower business and/or technology scopes are more likely to undergo fewer changes in their intended business models (see Section 5.5.3). In other words, intended business models reflecting broad business scopes and/or based on platform technologies are likely to undergo more changes. This relationship holds for intended business models, but not for realized business models. Therefore, this study suggests that even in the presence of a generic technology, entrepreneurs should strive to prioritize applications as soon as possible, and narrow down their business scope (at least temporarily, during early stages), since firms are usually resource constrained. Though apparently difficult for the entrepreneurs, this practice appears to relate to fewer business model changes and thus higher early-stage performance.

Fifth, the data reveals various degrees or intensities of change in business models (see Sections 5.2 and 5.4.1, and Table 5.2). Change is not an "on-off" concept; on the contrary, change has various shades of grey. Therefore, business models evolve through complex patterns and intensities of change. Thus, coding change represents a major research challenge, due to the uncertainty surrounding the decision of what may or may not be considered as a change; or simply deciding on a

comprehensive typology of business model change that classifies it according to different intensities (e.g., from incremental to radical change). Snow & Hambrick (1980) reported similar theoretical and methodological problems when measuring organizational strategy. They discussed the challenges researchers face when studying strategy, due to the blurred interplay between intentions and realizations, and to the non-obvious distinction between strategic adjustment and change. Therefore, I suggest that discussing theoretical and methodological issues related to measuring business model change (intended and realized), and developing a comprehensive typology of business model change, is important for subsequent studies.

Sixth, this study investigated the contrast between the theoretical perspectives of effectuation and causation in the process of business model change in early-stage university spin-offs (see Section 5.6). The longitudinal design of the study allowed an analysis of the evolution of behaviour types (causal, effectual, and causal-effectual) for all spin-offs, revealing some patterns over time. Over time, early-stage university spin-offs tend to adopt the behaviors that were initially absent (e.g., causal or combined causal-effectual), and evolve to a full range of behavior types. Hence, entrepreneurs should develop the skills associated with both causal and effectual behaviors, and attempt to integrate causal and effectual behaviors into combined causal-effectual behavior. Ultimately, the decision process for each single business model change should be driven by a combined causal-effectual behavior as much, and as early, as possible.

Finally, this study suggests that the process of business model change follows a "trial-and-error learning" mechanism (Loch et al., 2008: 33), which is appropriate in the presence of uncertainty and changing conditions (Sosna et al., 2010). "Trial-and-error learning refers to actively searching for new information and flexibly adjusting activities and targets to this new information" (Sommer, Loch, & Dong, 2009: 119). Commitment appears to shorten the time between subsequent business model iterations, while market, managerial, and entrepreneurial knowledge seem to reduce the number of iterations necessary to reach a valid (though temporary) solution. This process is driven by the desire of the management team to find the

business model configuration that promises the maximum profit function. A clear conceptualization of the business model system, and of its variables and relationships, is important to enable the development of simulation mechanisms and tools.

6.2.2 How Does Business Model Change Link to Performance?

Choosing the right initial business model configuration (Chesbrough & Rosenbloom, 2002) or design (Zott & Amit, 2007) and managing its adaptation over time has a critical impact on spin-off performance. According to Kaplan et al. (2009), business model change is especially critical during earlier stages. However, few empirical studies have explored the link between business model change and performance (e.g., Malone et al., 2006). Andries & Debackere (2007) argue that the impact of adaptation in the performance of technology-based businesses depends on the sector and on the origin of the firm. They claim that adaptation is beneficial in immature, high-velocity industries, but detrimental in mature, stable industries. Moreover, the quality of adaptation is higher in new technology business units of established firms than in independent new technology ventures. The authors suggest a similar investigation in the context of university spin-offs.

Researchers from the university spin-off stream have also suggested that a better understanding of the determinants of university spin-off performance, and of variations in that performance (Harrison & Leitch, 2010), is also necessary. Shane (2004: 301) has also emphasized the need for more "information about spin-offs so that we can develop explanations of the factors that influence their formation and performance". This study assessed university spin-off performance through a composite measure aggregating 28 different indicators (see Table 4.30 in Section 4.11.3). Performance being such a delicate matter, sensitivity tests were performed to evaluate the consistency and robustness of this aggregate measure. The performance measure showed good stability and robustness under the scrutiny of this sensitivity analysis.

One finding of this study is that high performing early-stage university spin-offs tend to change their intended and realized business models less often (see Section 5.4.5). However, all the spin-offs changed both their intended and realized business models. Therefore, the study does not suggest that changing business models is "bad". In fact, Sull (2004) also found that nearly every startup's business model underwent at least one major change, and countless minor ones. What appears to be happening is that teams with lower levels of market, managerial, and entrepreneurial knowledge seem to have more difficulty in settling into a viable business model. And this difficulty translates into more business model changes, which seems to be associated with poorer performance.

Second, the data reveals that higher performing early-stage university spin-offs are likely to interact earlier, i.e., even before firm incorporation, and more intensively with stakeholders to perform iterative testing to their intended business models (see Section 5.4.5). During this initial and intense period of strategic planning, the entrepreneurs perform iterative planning and speed-testing of their intended business models. Throughout the iterations, the entrepreneurs perform necessary changes in order to reach a viable intended business model to initiate their businesses. These iterations usually require interaction with stakeholders, such as potential customers and industry experts. These propositions corroborate the practice-based principles advocated by lean startup (Ries, 2011) and customer development (Blank & Dorf, 2012) frameworks.

Third, this study reveals some relationships between university spin-off performance, technology scope, business scope, technology-push, and market-pull (see Section 5.5). Generic or platform technologies have broad applications in multiple fields, whereas narrow-scope technologies have narrower applications in fewer fields (Shane, 2004). Business scope is defined as "the firm's variety in products, channels, and markets". Technology-push focuses on technology with no concern for market forces, whereas market pull considers the market as the primary source of ideas (Khilji, Mroczkowski, & Bernstein, 2006). The data suggests that the narrower the business scope (or technology scope) of early-stage university spin-offs, the lower the number of changes in their intended business models, and therefore the

higher their performance. Evidence also indicates a relationship between the driver of innovation (technology-push or market-pull) and the technology scope. In particular, technology-push mechanisms seem to lead to a broader technology scope, whereas market-pull forces seem to lead to a narrower technology scope. Apparently, there is no direct relationship between the degree of technological change (incremental or radical) and the number of business model changes or performance.

Fourth, concerning the causation-effectuation dichotomy, this study found some relationships between the predominance of effectual and/or causal behavior and the performance of early-stage university spin-offs (see Sections 5.6.3 and 5.6.4). This resulted from investigating the effectual and/or causal nature of key business model changes and the respective performance of the university spin-offs. Particularly, data suggests that higher performing early-stage firms are more likely to exhibit all the three types of behaviors (i.e., causal, effectual, and combined causal-effectual). On the other hand, lower performing early-stage firms are more likely to exhibit only purely causal behavior and effectual behavior (i.e., absence of combined causal-effectual behavior). High performing early-stage firms are more likely to develop this wider range of behaviors early on, whereas lower performing firms tend to take more time to develop the behaviors that were initially absent. Over time, causal-effectual behavior becomes dominant in high performing firms, whereas effectual behavior continues to dominate in lower performing firms. These findings suggest that lower performing spin-offs may have less developed strategic planning or analytical capabilities, or exercise these skills less. This results in a less solid trajectory and a more erratic behavior in terms of business model decisions. The statements above hold equally true for changes in the intended business models and in the realized business models. These findings support Andries et al. (2013) argument that simultaneous experimentation (implying a combination of effectual logic and causal planning) seems to lead to long-term survival of ventures operating under uncertainty. However, this thesis adds more detail on the characteristics of low and high performing ventures in terms of effectual and causal behaviors, and how they evolve over time.

Fifth, this study implies that a relative degree of stability in the business model is beneficial in terms of firm performance (see Section 5.6.6). The data indicates that higher performing firms are better at removing uncertainty in the business model decision process. One reason for this is the usually higher levels of experience (and therefore knowledge) of the management team. Moreover, the balanced way that higher performing firms combine causal behavior (e.g., analyzing the market) with effectual behavior (e.g., interacting with the market) allows them to maximize knowledge inflow. This maximum knowledge inflow allows them to minimize uncertainty in their business model decisions.

Sixth, higher performing firms perform early diligent planning (causal behavior), and start also interacting earlier and more intensively with stakeholders to test their business model assumptions (effectual behavior), even before firm incorporation (see Sections 5.4.5 and 5.6.6). This practice seems to lead to a faster consolidation of the initial intended business model, and results in higher stability of business model and goals throughout later stages of development. In sum, higher performing university spin-offs establish a solid strategic plan early (causation), but maintain a mindful attitude towards contingency (effectuation). If an opportunity arises, they evaluate its potential interest for the firm, and consider revisiting their strategic plan. On the contrary, lower performing university spin-offs tend to "over-experiment" (pure effectuation), performing several changes to their business models without the guidance of a solid, consistent plan.

Seventh, this study examined resource constraints, coping strategies to overcome those constraints, and how the business model changed as a consequence of these constraints and strategies (see Section 5.7, and particularly for performance implications, see Section 5.7.4). Lower performing firms refer more frequently to resource constraints, suggesting that these firms have, or perceive to have, more resource constraints. These firms not only refer to higher levels of resource constraints, but also to a wider spectrum of constraints. For instance, a high performing firm tends to identify fewer types of constraints (e.g., financial and human resources), whereas a low performing firm tends to identify many types of constraints (e.g., financial, human, and physical resources, reputation, market

knowledge, time, entrepreneurial and managerial knowledge, partners). Therefore, this study reveals that lower performing university spin-offs tend to perceive/project more, and a wider spectrum of, resources constraints. This, in turn, leads them to implement more coping strategies, which trigger a higher number of business model changes, and to a wider range of business model elements.

Finally, higher performing spin-offs frequently mentioned that one of their coping strategies was to focus on key activities and to narrow down the scope of their business (see again Section 5.7.4). This strategic focus was not pointed out by any of the lower or medium performing spin-offs. Therefore, this study suggests that higher performing early-stage university spin-offs are more likely to have a narrower business model, meaning a more focused value proposition, and fewer customer segments.

6.2.3 How Do Business Model Elements Change and Interact Over Time?

Prior research has stated that the elements of a business model are highly interdependent, with changes in one element having implications for the other elements (Morris et al., 2006). Nonetheless, there is still no clear understanding on the dynamics of this system of business model elements. Hence, Morris et al. (2006) suggest future investigations on the relationships between variables that constitute the elements of the business model, and on factors that drive changes in business model elements (Chesbrough & Rosembloom, 2002). George & Bock (2011: 105) similarly emphasize the need to examine the interactions between business model elements over time. On the university spin-off stream, researchers have also called for multilevel studies on the spin-off venturing process (Rasmussen, 2011; Van Burg et al., 2008). Within the firm level, this study goes below the aggregate business model unit of analysis, and analyses change also through the disaggregated unit of the business model *element*.

First, the intended business model element experiencing the most changes was the customer segment (see Section 5.4.4). Entrepreneurs usually start by designing the customer-facing aspects of their business models to achieve an

appropriate fit with the value proposition (Osterwalder et al., 2010). Therefore, the decision process involved in defining the customer segment is the one characterized by more uncertainty. On the other hand, the more internal-facing elements (e.g., key activities, key resources) experienced less changes, both in the intended and realized business models. This happens because, after defining the customer segments, a great part of the market uncertainty is removed, and the decisions to define the more inward-facing elements are usually more straightforward. Hence, this study reveals a relationship between uncertainty and the number of changes in the intended business model. In particular, the higher the uncertainty associated to a certain intended business model element, the higher the number of changes that such element is likely to undergo. Since uncertainty is inversely related to knowledge, then higher levels of knowledge are related to fewer changes in intended business model elements. These findings are aligned with the Loch et al. (2008) argument that external problem areas of the firm (e.g., customer needs, industry readiness) have higher potential for unforeseeable uncertainty, and therefore are characterized by higher levels of uncertainty. Internal problem areas of the firm (e.g., key resources, key activities) are characterized by foreseeable uncertainty, and thus exhibit lower levels of uncertainty. To deal with higher levels of unforeseeable uncertainty, the methods of experimentation or trial-and-error have proved to be effective (Loch et al., 2008).

Second, the data reveals that the intended customer segments change considerably less in higher performing university spin-offs (see Section 5.4.5). The reason for this increased stability in intentions towards customer segments is again related to the earlier and more intense strategic planning executed by higher performing firms. This early iterative testing period, characterized by regular interaction with stakeholders, and in which the intended customer segments changed often but rapidly, removed much of the initial uncertainty. This practice added robustness to decisions in terms of intended customer segments, and enhanced stability during the post-incorporation stage. Hence, this study indicates that earlier intended business model testing results in higher intended customer segment stability, earlier strategic and business model iterative planning and testing, incorporating potential stakeholder feedback, results in higher intended customer segment stability, i.e. lower number of changes in intended customer segments.

Third, the realized key resources changed substantially less in higher performing university spin-offs (see Section 5.4.5). The data suggests that many of the changes that occurred in realized key resources of lower performing spin-offs were triggered by changes in intended customer segments. This is a costly method of experimentation, since firms are mobilizing important resources solely as a consequence of changes in intentions that may never be realized. Therefore, this study reveals that higher intended customer segment stability reduces unproductive changes in realized and intended key resources. This, in turn, mitigates harmful resource consequences (e.g., increased financial constraints) that may arise from unnecessary and wasteful commitments (e.g., recruiting additional human and/or physical resources to develop intended applications that may be suspended or abandoned later on).

Fourth, this study reveals relationships between the scope of the technology or business, and the number of changes in the intended customer segments and value proposition (see Section 5.5.3). General-purpose or platform technologies have broader applications in multiple sectors (Maine & Garnsey, 2006; Shane, 2004). Therefore, narrow-scope technologies will have applications in fewer sectors, thus limiting the range of potential customer segments. Hence, this study proposes that the narrower the technology and/or business scope of a university spin-off, the lower the number of changes in its intended customer segments. Similarly, the lower number of applications and sectors of narrow-scope technologies and/or businesses limits also the range of alternative configurations for the value proposition. Therefore, case evidence suggests that the narrower the technology and/or business scope of a university spin-off, the lower the number of changes in its intended value proposition.

Fifth, data suggests patterns on the proportion of causal and/or effectual behaviors among different business model elements (see Section 5.6.5). The data reveals that customer-facing elements (customer segments, customer relationships, channels, revenue streams) change as consequence of predominantly effectual behaviours. On the other hand, the remaining elements of the business model (value proposition, key resources, key partners, key activities, and cost structure) change by

a balanced mix of effectual and causal behaviours. Customer-facing elements are more 'outwards' facing, since they face the external environment. Therefore, the uncertainty is higher, especially in the case of early-stage ventures (Van de Vrande & Vanhaverbeke, 2012). In the face of high uncertainty, entrepreneurs employ an experimenting, trial-end-error mindset (Loch et al., 2008), which is in line with effectual behaviour (Sarasvathy, 2008). Since uncertainty is lower in inward-facing elements, planning is an appropriate management approach (Loch et al., 2008), which justifies the higher proportion of causal behaviour.

Sixth, the data indicates that higher performing firms tend to establish more partnerships than lower performing firms (see Section 5.7.4). Furthermore, these firms establish partnerships with a wider spectrum of actors, seeking out and embracing cooperation in a broader array of activities. Specifically, higher performing firms partner with customers, distributors, supply chain, universities, and investors, to name a few actors. These partnerships help spin-offs to deliver product to customers, to increase market penetration, to expand geographically, to access resources through piggybacking, to research and develop technology and product, to manufacture the product, and to raise funds, among other activities. Therefore, this study reveals that higher performing early-stage university spin-offs tend to establish more partnerships and with different types of actors, thus triggering more changes in their key partners (KP) business model element.

Finally, this study proposes the conceptualization of the business model as a self-organizing complex system (Levy, 1994; McKelvey, 1997, 1999). The business model is a functional whole, consisting of interdependent parts, i.e., the business model elements. The business model co-evolves with its environment, extending its boundaries beyond the focal firm (Zott & Amit, 2010), and relating to the wider outside world. Thus, constrained by certain parameters, the business model evolves to certain temporary metastable-states, i.e., business model configurations. Those states are temporary, and transitions will occur to other metastable-states. An absolute equilibrium state is never reached, since the environment is in constant flux. Restructuring and external shocks perturb the metastable-state, prompting a transition to another emerging metastable-state (Levy, 1994). Additionally, a second

intended business model subsystem exists and co-evolves with the realized business model subsystem. According to this conceptualization, the terminology business model may sound somehow reductionist. As a complex system that it is, a more appropriate term would be "business model system" or simply "business system".

6.3 THEORETICAL CONTRIBUTION

The aim of this thesis has been to explore the topic of business model change in the context of early-stage university spin-offs. The conducted analysis and discussion culminated in a set of propositions contributing mainly to the business model literature, but providing also some insights to the university/academic entrepreneurship literature.

As mentioned previously (Section 2.3.8), the scholarly literature on business models is massive and fragmented (Wiklund et al., 2010) which hinders integrated and cumulative research in the field (George & Bock, 2011). Some authors argue that most of this research presents a static perspective, studying snapshots of business models at certain moments in time (De Reuver et al., 2009; Sosna et al., 2010). There is, however, an emerging trend that acknowledges the dynamic nature of business models (e.g., Andries et al., 2013; Andries & Debackere, 2007, Demil & Lecocq, 2010; Mason & Leek, 2008). This study contributes to this body of knowledge with a structured review of the vast and fragmented literature on business models, organized by studies which adopt a 'static' approach and by studies which employ a more 'dynamic' view (see Chapter 2). The former stream (read: static) provides more detail on business model definitions and constituting elements, whereas the latter (read: dynamic) provides more insight on how business models change over time.

Scholars both from the business model (George & Bock, 2011; Morris et al., 2005; Svejenova et al., 2010; Zott & Amit, 2007, 2008) and the university entrepreneurship domains (Van Geenhuizen & Soetanto, 2009; Markman et al., 2008) have frequently called for more longitudinal studies. By employing a longitudinal design that collected data at several points in real time, the study

contributes to research on business models with a more 'dynamic' study of business model change. Furthermore, it focuses on the early stage of development, which, according to several researchers, is a stage fertile in business model change (Heirman & Clarysse, 2007; Kaplan et al., 2009). As a result of adopting this research design, which can be considered *per se* a methodological contribution to the field, theoretical contributions to different domains naturally emerged. Therefore, this study contributes to the business model literature by identifying drivers and themes related to the overall *process of business model change*. These drivers and themes were important to guide this exploratory study, and, hopefully, to guide also future studies on business model change. This thesis also introduced new relationships between frequency of business model change and certain constructs (Whetten, 1989) such as commitment, market knowledge, managerial knowledge, entrepreneurial knowledge, and uncertainty (see in particular Propositions 1-3 and Section 6.2.1 for a more thorough discussion).

Several scholars have stated the importance of understanding the relationship between *business model change* and entrepreneurial *firm performance* (Chesbrough & Rosenbloom, 2002; Zott & Amit, 2007, 2008), which is especially critical during early design stages (Kaplan et al., 2009). However, few empirical studies have explored this relationship (e.g., Malone et al., 2006). Additionally, researchers from the university spin-off stream have also called for a better understanding of spin-off performance (Harrison & Leitch, 2010; Shane, 2004). This study contributes to the university entrepreneurship literature by developing a comprehensive measure of entrepreneurial performance comprising a wide range of indicators (see Section 4.11.3). More generally, it extends previous work on growth (e.g., Shepherd & Wiklund, 2009; Steffens, Davidsson, & Fitzsimmons, 2009; Wiklund, Patzelt, & Shepherd, 2009). Shepherd & Wiklund's (2009) literature review identified five common indicators: growth in (1) sales, (2) employees, (3) profit, (4) assets, and (5) equity. Similarly, Wiklund et al. (2009) include an extensive list of constructs and measures related to small business growth. This thesis adds to this work other performance indicators (e.g., based on patents, company value, funding, stage of product development, and entrepreneurs' perceptions) that are informative and appropriate in the particular context of university spin-offs, but also for technology

based firms in general. It also contributes theoretically to the business model literature by introducing a new set of relationships between business model change and entrepreneurial firm performance (Whetten, 1989), in the particular context of early-stage university spin-offs (generalizability is discussed throughout). These relationships are formally expressed in the form of a set of generated propositions (see Propositions 4, 5, 7, 8, 10a-13b, 15, and 16) and are thoroughly discussed on Section 6.2.2.

Business model researchers have repeatedly called for a better understanding of how business models change at the element (e.g., customer segment, value proposition) level (George & Bock, 2011; Morris et al., 2006). Therefore, this study contributes to the business model literature with a more fine-grained understanding of *how business models elements change* individually through time. It also establishes relationships between business model element change and certain concepts such as realized and intended business models, technology and business scope, causation and effectuation, and resource constraints. These relationships are formally expressed in the form of a set of generated propositions (see Propositions 6, 9, 14a, 14b, and 15) and are thoroughly discussed on Section 6.2.3.

Following the overall structure of the data analysis chapter (see Chapter 5), the next paragraphs provide mode detail on specific theoretical contributions of this thesis. It firstly contributes to the business model literature by introducing the notions of intended business models and realized business models, similarly to previous strategic management studies that distinguished between intended and realized strategies (Koh & Venkatraman, 1991; Mintzberg, 1978; Venkatraman, 1989). The confusion between reality and intentions was already implicit in some business model definitions, and became evident in founders' narratives during the first interviews. Nevertheless, the distinct notions of intended business models (relating to future) and realized business models (relating to present) were inexistent in the wide range of literature dealing with business models. This distinction has obvious consequences for a finer understanding of how business models change, for the design of future research, and also for practitioners.

As briefly mentioned in the paragraphs above, this thesis also contributes to the business model literature by establishing relationships between the frequency of business model change (aggregate and by element), firm performance, and constructs such as commitment, market knowledge, managerial knowledge, entrepreneurial knowledge, and uncertainty (see Propositions 1-5). In sum, commitment appears to work as a catalyst of business model change. Higher market, managerial, and entrepreneurial knowledge, and thus lower uncertainty, are related with fewer business model changes and higher performance. Furthermore, higher performing firms interact earlier (before firm incorporation) and more intensively with stakeholders to perform iterative testing to their intended business models. This results in higher intended customer segment stability, and mitigates unproductive changes in realized and intended key resources.

In addition to the business model literature, this thesis contributes also to the specific field of university entrepreneurship with a discussion of the impact of technology and business scope on business model change and spin-off performance (see Propositions 7-9). In sum, narrower business and technology scopes at early-stage are related with fewer intended business model changes, in particular to customer segments and value proposition, and are likely to lead to higher performance. This discussion also contributes to the so-called lean startup (Ries, 2011) and customer development (Blank & Dorf, 2012) frameworks, which originate from the realm of technology entrepreneurship. These frameworks draw mostly on anecdotal evidence, and were lacking a more systematic empirical support.

This thesis contributes also to the ongoing causation-effectuation theoretical debate (Sarasvathy, 2001, 2008). Adopting the business model perspective, it provides a more fine-grained view of the circumstances under which causation and/or effectuation processes are more advantageous. The qualitative, real-time, longitudinal design allowed an identification of the behaviors (causal, effectual, or combined causal-effectual) over time, and the establishment of relationships with university spin-off performance (see Propositions 10a-13b). In sum, evidence suggested that higher performing firms are more likely to exhibit all the three types of behaviors (i.e., causal, effectual, and combined causal-effectual), with a

predominance of combined causal-effectual; lower performing firms are more likely to exhibit only purely causal and effectual behavior, with effectual behavior dominating. The level of detail achieved by adopting the business model element as an additional unit of analysis, also allowed the development of relationships between the proportion of effectual and/or causal behaviors and changes in business model elements (see Propositions 14a and 14b). In sum, outward-facing business model elements are more likely to be changed by effectual drivers, while more inward-facing elements are more likely to be changed by causal drivers.

A contribution is also made to the literature on the resource-based view by examining initial resource constraints, and by proposing relationships with business model change and subsequent performance (see Propositions 15 and 16). Data suggests that lower performing early-stage university spin-offs tend to perceive more resource constraints, leading them to implement more coping strategies and triggering a higher number of business model changes. To overcome resource constraints and access more resources, higher performing university spin-offs tend to establish more partnerships and with different types of actors, thus triggering more changes (only) in key partnerships.

This thesis has certain characteristics that distinguish it from previous work in the field. In particular, while Andries et al. (2013) focused on the business model construct, their data was collected retrospectively. On the other hand, Ambos and Birkinshaw (2010) collected data longitudinally but focused on the concept of 'archetypes' rather than business models. Therefore, this thesis contributes to this literature firstly by introducing the notion of intended business models, which differs from the notion of realized business models implicit in previous works. As such, not only the 'actual' business models were followed, as in previous studies, but also the intended business models were tracked longitudinally. This allowed the induction of propositions related to the individual behavior and interaction between these two levels of business models. Secondly, this thesis sheds more light on the drivers of business model change, extending Ambos and Birkinshaw (2010) discussions on the triggers of archetype change over time. Thirdly, this thesis contributes to Andries et al. (2013) work by adding detail and clarity to the link between effectual and causal

behaviors, and firm performance. Moreover, it provides further insight on the circumstances under which causation or effectuation is more advantageous (e.g. demand-facing vs supply-facing business model elements).

To summarize, this thesis contributes mainly to the business model literature, in particular to the emerging stream of business model change, and to research in university entrepreneurship. In particular, it has examined how business models and their constituting elements change in early-stage university spin-offs, and has provided relationships to firm performance. The study has also demonstrated the relevance of the theoretical frameworks of effectuation, causation, resource-based view and complex systems to develop a finer understanding of how the process of business model change unfolds.

6.4 PRACTICAL IMPLICATIONS

This study has showed the diversity and complexity of issues related to the process of business model change in early-stage university spin-offs. The issues addressed have important practical implications for spin-off entrepreneurs, universities, policy makers, and business model educators.

6.4.1 For Spin-Off Entrepreneurs

The findings of this study show that intended and realized business models are distinct and exist simultaneously in a firm. Therefore, in their planning and experimenting activities, entrepreneurs should be aware of this distinction and keep track of both types of business models. In this sense, the realized business model represents the current business model configuration of the firm, whereas the intended business model reflects the firm's desired future configuration and therefore may work as a simulation/testing tool. Hence, entrepreneurs should experiment first with intended business models and then carefully decide what changes to realize, especially if they require costly resources. Furthermore, entrepreneurs should also triangulate information from several sources (e.g., industry experts, customers,

market research) before realizing changes. These practices will reduce ineffective changes in realized business models, therefore mitigating potentially harmful resource consequences.

This study encourages entrepreneurs to perform early diligent planning, even before firm incorporation. Furthermore, entrepreneurs are encouraged to start interacting early and intensively with stakeholders to test their business model assumptions. The early involvement of stakeholders in this process provides a valuable feedback for subsequent business model iterations. This leads to a faster consolidation of the initial intended business model, and to higher business model and goal stability during later stages of spin-off development. Though a solid plan is crucial, entrepreneurs should adopt a mindful attitude towards contingency. If an unexpected opportunity emerges, entrepreneurs should evaluate its potential interest, and consider refining the plan. These implications complement the discussion of Barr et al. (2009) that novice entrepreneurs strongly resist 'iterating' early on, though multiple iterations create a high level of self-efficacy in which entrepreneurs develop confidence and a sense that they should not expect it to be easy.

The findings also indicate that entrepreneurs should combine causal (e.g., planning) and effectual (e.g., interacting with stakeholders) behaviors when making decisions on their business models. They should avoid extreme behaviors such as either planning too much behind the desk (pure causation), or engaging in a highly experimental mindset (pure effectuation). A hybrid behavior appears to maximize knowledge inflow, therefore minimizing uncertainty in business model decisions. However, in business model elements where uncertainty is higher (e.g., customer-facing elements), entrepreneurs should increase the predominance of effectual behaviors. In the face of uncertainty, a more experimental approach is appropriate (Loch et al., 2008). On the other hand, in inward-facing elements, since uncertainty is lower due to higher information available, entrepreneurs may increase causal behavior (e.g., planning).

Evidence suggests an inverse U-shaped relationship between number of business model changes and spin-off performance. Hence, entrepreneurs should be aware that both the absence of change and the exaggeration of change may signal

poor performance. They should also acknowledge that higher performing university spin-offs tend to change both the intended and realized business models less often. However, in highly turbulent environments, where uncertainty is higher, entrepreneurs have to experiment more with their intended business models, therefore increasing the frequency of change. A similar phenomenon happens in the presence of generic technologies, since entrepreneurs need to iterate more to find the optimum combination of products-markets.

The findings suggest that entrepreneurs with generic (or platform) technologies should briefly explore and test their different market applications, and identify their 'potential' product-market portfolio before incorporation, since investors tend to value this multiplicity. But after incorporation, entrepreneurs should focus in one or few applications, and queue the remaining. They should choose either one product to few markets, or few products to one market. Evidence appears to suggest that working initially with several products and several markets leads to poorer performance. Therefore, entrepreneurs should strive to narrow down the scope of their businesses and keep their focus on key activities. Spin-offs based on generic technologies usually adopt a technology push strategy. However, combining this strategy with a more pro-active market-pull approach helps to narrow down the business scope and consequently enhances performance. This practical implication reinforces the algorithm of Barr et al. (2009) in which entrepreneurship students firstly identify 'technology-product-market' (TPM) linkages, and subsequently improve and select among them by grounding and challenging in market and technical realities.

The study further stresses the importance of having high levels of market knowledge, managerial knowledge, and entrepreneurial knowledge. If entrepreneurs do not have the complete knowledge set, they should consider its development or acquisition. Acquisition can be materialized through hiring people with complementary skills. These people can be integrated in executive functions or non-executive functions, such as in advisory boards. This implication further emphasizes the relevance of diversity in team composition for technology commercialization

activities, as argued by previous studies (e.g. Phan, Siegel, & Wright, 2009; Thursby, Fuller, & Thursby, 2009).

Entrepreneurs are strongly encouraged to establish several partnerships with a wide spectrum of actors. They should also seek for and embrace cooperation in a broad array of activities. This multitude of partnerships facilitates access to resources, thus reducing resource constraints. This practice induces more changes in the key partners element, but leads to higher performance. Siegel (2009) mentions the relevance of leveraging the benefits of the numerous public-private partnerships that have recently emerged as part of the rise of the technology-based economic development movement. This study emphasizes this argument and extends it by reinforcing the importance of establishing a wide array of partnerships with the private sector as well.

Finally, the practical implications discussed in this study are inspired on a sample of early-stage university spin-off entrepreneurs. When compared with 'typical' entrepreneurs, these entrepreneurs are likely to have less business experience and usually deal with new technologies and uncertain markets. Therefore, it can be argued that this study's propositions may also have implications for the wider population of 'non-spin-off' novice entrepreneurs or managers striving to adapt their business models in environments of high market and technology uncertainty.

6.4.2 For Universities and Policy Makers

University and policy makers should provide access to a wide array of networks, and stimulate the establishment of both private and public partnerships (Siegel, 2009) with different actors, to cooperate in a broad array of activities. They should also help entrepreneurs by providing them with access to "test beds" and/or entrepreneurial ecosystems, as a recent paper by Levie (2014) suggests, even before incorporating, to test the initial technological and market assumptions. The importance of understanding and leveraging the university commercialization ecosystem has been recently discussed in a special issue of the Journal of

Technology Transfer on "Teaching Technology Commercialization" (Nelson & Monsen, 2014). This initiative would increase entrepreneurs' engagement with the market, through talking to customers, partners, competitors, and other actors. The important information collected in the form of feedback, would remove some of the uncertainty associated with the process of spinning-off and increase entrepreneurs' confidence (Barr et al., 2009).

Universities, and also policy makers, should develop or provide access to entrepreneurial training programs that promote both causal and effectual behaviors. These training programs should mimic the business model decision processes of high performing university spin-offs, and simulate the way these firms gather information to feed decision processes. These firms combine causal approaches (e.g., strategic planning) with effectual approaches (e.g., partnerships, interaction with customers) to maximize the removal of uncertainty. Particularly, in higher informed contexts, they slightly emphasize the proportion of causal approaches; on the other hand, in higher uncertainty contexts, they slightly emphasize the proportion of effectual, trial-and-error approaches, involving multiple iterations (Barr et al., 2009). For example, customer-facing business model elements are more outward-facing, and therefore more prone to uncertainty. Therefore, the definition of these elements requires a more effectual approach, such as interacting with potential customers or industry experts, to test entrepreneurs' assumptions.

Entrepreneurs would also benefit from training experiences that help them to narrow down their products and markets. University entrepreneurship programs should help spin-off entrepreneurs to separate potential products and markets (their portfolio) from what should be their immediate focus after incorporation (few products or few markets). Evidence has repeatedly suggested that a narrower scope and focus on key activities leads to higher performing university spin-offs. Since commitment accelerates the process of business model change, supporting mechanisms should favor the higher committed academic entrepreneurs that are willing to cut the "umbilical cord" with the lab., and/or bringing in experienced entrepreneurs to drive the business forward.

Universities and policy makers should also stimulate nascent academic entrepreneurs to perform strategic planning and iterative business model testing. Entrepreneurs should also be strongly encouraged to interact with stakeholders such as customers and industry experts. Furthermore, university initiatives to train spin-off entrepreneurs should stress that the earlier and more intense this interaction, the better – ideally, before spin-off incorporation. Again, this engagement may be facilitated by building a bridge to a network of potential stakeholders to complement the typical scientific networks of academic entrepreneurs, and more generally by providing resources to foster university entrepreneurship in all its forms (Shah & Pahnke, 2014).

Finally, universities and policy makers should facilitate experiences that inculcate the practice of thinking and planning (developing and testing intended business models), but also of entrepreneurial acting "outside the lab".

> *"People who have acted entrepreneurially are seen to possess a more accurate picture of reality than those individuals who have not acted."* (McMullen & Shepherd, 2006: 137)

Action brings reactions, which provide valuable feedback, and allow calibration with the real world "out there". This outward-facing attitude develops more realistic expectations and enhances the learning curve, when compared with predominantly "behind the desk" planning approaches.

6.4.3 For Business Model Education

The business model canvas (Osterwalder et al., 2010) adopted for this study is currently one of the most widely used business model education/training tools across the globe. Therefore, the findings of this thesis have also important implications for business model education or training.

Firstly, educators should create awareness in their trainees of the distinct notions of realized and intended business models, and how to map and use them. For instance, while realized business models reflect the actual configurations of their

businesses, intended business models may work as simulation tools to facilitate business model iterative testing. Mapping and clearly distinguishing both types of business models is important in design/planning activities, and even for the trivial purpose of communicating.

Educators should also encourage their trainees to strongly commit to their change/entrepreneurial projects, since this accelerates the process of business model change. They should also encourage trainees to learn as much as possible about the markets, management and entrepreneurship, both from codified sources and from experimentation and interaction with others, since this seems to decrease the number of changes necessary to converge to a viable business model solution. In fact, the process of market discovery and business modelling is inherently ambiguous (Phan, 2014), and programs that increase prospective entrepreneurs' levels of confidence are needed. Therefore, new pedagogical approaches aiming at accelerating technology commercialization (e.g., see D2M – Discovery to Market in Phan, 2014) are being developed and refined, motivated by this increasing demand in the marketplace for the knowledge and skills they deliver.

This thesis also suggests educators to promote among their trainees early and intensive interaction with stakeholders for iterative business model testing. This practice seems to stabilize customer segments, and mitigates unproductive changes in realized and intended key resources (KR). Also, educators should advise their trainees to prioritise their technological applications and target markets, even if they have platform technologies. They should be encouraged to narrow the scope of their businesses, i.e. focus in few customer segments (CS) and in a narrower value proposition (VP), especially during earlier stages or if resource-constrained. This implication is in tune with the emerging, progressive transition occurring in technology management education from analytic planning frameworks typical of traditional MBA-focused programs towards more interaction-focused programs such as entrepreneurial 'boot camps' (Clarysse, Mosey, & Lambrecht, 2009).

Finally, educators should encourage the combination of causal and effectual approaches. In particular, when designing more outward-facing elements (i.e., CS, CR, CH, R$) trainees should emphasize effectual behavior, whereas when dealing

with more inward-facing elements (i.e., VP, KR, KP, KA, C$) trainees should favor causal processes. Educators should also encourage their apprentices to pay special attention to key partnerships (KP), since establishing more partnerships and with a higher variety of actors provides better access to resources, therefore mitigating resource constraints. For instance, in their special issue discussing the teaching of technology commercialization, Nelson and Monsen (2014) emphasize the importance of close partnerships between the technology commercialization office, as well as close linkages between science, engineering, business, law and other groups.

6.5 OTHER EMERGENT ISSUES

Throughout the longitudinal interviewing period, other unforeseen issues have emerged. In particular, when conducting the first monthly interviews focused on the business model, the issue of 'funding' emerged as a relevant category to consider and include in this enquiry:

> *"We had a little bit of success with a TSB (Technology Strategy Board) grant application" (CEO Firm A, month 0)*
>
> *"There's grant funding, and there's investment funding (...)" (CEO Firm C, month 0)*
>
> *"We're driven by grants. Obviously we can get grants for developing parts of this." (CSO Firm D, month 0)*
>
> *"If we were trying to raise money today for the first time, it would be much more difficult than it was 12 months ago. We were lucky to get the money when we did." (CBO Firm E, month 0)*
>
> *"At the start, the money comes in from funding for the capital project." (Director Firm G, month 0)*
>
> *"The most important thing to make us work is get money. We'd be absolutely dead. We have to have investment money." (CSO Firm H, month 0)*

Similarly, the entrepreneurs often talked about their 'goals' when they were asked about how their business model elements have changed. Understanding goals or objectives is important to understand entrepreneurs' growth ambitions or intentions. The relevance of capturing entrepreneurs' goals over time became evident during the first month of interviewing:

> *"At the moment, I would just be quite happy to reach that sort of critical mass, where the company was established, had its own offices and had a steady set of (...) 10 employees" (CEO Firm A, month 0)*

> *"We have objectives, and within those objectives we have financial forecasts. And with financial forecasts, we're going to different sectors. " (CEO Firm C, month 0)*

> *"Well, we have [customer] segments, there's short-term objectives, medium-term objectives, and long-term objectives. (...) The long-term objective is that the company will have enough money to develop its own products, independently of companies in the existing markets." (CSO Firm D, month 0)*

> *"We do not intend to grow the company, to employ hundreds of people, to start doing expensive clinical trials. (...) This is an early exit, early deal. (...) That is what we intend to do." (CBO Firm E, month 0)*

These categories (funding and goals) are not typically considered in the Business Model Canvas framework (Osterwalder et al., 2010). Therefore, I created two new categories, which were then added to the nine elements of the framework, and tracked throughout the longitudinal period (see Chapter 4 for a detailed description of the evolution of firms' funding and goals).

As one of the entrepreneurs explained, the funding available conditioned the evolution of their goals, and ultimately the scope of their business model:

> *"To manage three [projects] we would have required to have raised about 11 million pounds. The one we went with, we're going with just over 2 million. So, we had to make some choices. (...) So, it was the financial climate which*

really forced us to have to concentrate. As it happens, as a reflection, I think that it was probably a good idea anyway." (CBO Firm E, month 0).

In this particular case, the lower availability of funding forced the team to prioritize their goals and narrow the scope of their business model, with an apparent benefit in terms of performance. This suggests a relationship between funding, goals, the business model, and firm performance. It would be interesting to have more insight on how funding availability and entrepreneurs' goals affect the evolution of firms' business models, and ultimately their performance.

Some of the spin-offs entrepreneurs mentioned that the mechanics of their business model could not be entirely captured by the Osterwalder et al. (2010) Business Model Canvas:

"This does not fit very well into… This is not a standard business model. So, when you try and fit it into a classification like that [read: Business Model Canvas], it becomes difficult." (Director Firm G, month 0)

This 'difficulty of fit' with the canvas seems even more prominent in particular sectors, such as biotech companies, where the definition of certain business model elements (e.g., customer segments, channels) becomes 'blurry'. In fact, many of these companies are setup to be acquired even before generating any revenue at all. Future research could shed more light on these 'issues of fit' when applying the business model canvas to specific business activities and sectors, and consider the adoption of a modified version of the canvas for certain types of firms, such as university spin-offs.

6.6 LIMITATIONS OF THE STUDY

This study does, of course, have limitations, as all theorizing efforts have (Weick, 1995b).

"Theories and models are always simplifications. If they were as complex as reality, they would not be useful." (Siggelkow, 2007: 21)

Most of the limitations are typical of qualitative case study designs and are shared by previous similar studies (e.g., Eisenhardt, 1999). Section 3.8.1 has already discussed the research quality of this multiple case study, namely by explaining how construct validity, external validity, and reliability have been dealt with. In particular, I explain how the constructs were defined and operationalized, and describe the various triangulation tactics used to strengthen this study's research quality. Concerning external validity, I explain also the use of theory and replication logic (Eisenhardt, 1989, 1991), the fundamental reason for choosing a multiple rather than a single case design (Dyer & Wilkins, 1991). Finally, the issue of reliability is explored. I present the structure of the case study database (see Table 3.6) and explain how a chain of evidence was maintained. In sum, Section 3.8.1 attempted to explain how generic case study design limitations were specifically addressed in this study. The paragraphs that follow introduce additional limitations, many of them emerging throughout the data collection and analysis processes, and explain how they have been addressed.

A first issue, common to all case study research, concerns the generalizability of this study's findings to a broader context. The research was undertaken in the context of early-stage university spin-offs from a single university in the UK. Although generalizations from only eight cases may have limited reliability, the richness of the longitudinal design allowed the formulation of propositions about the idiosyncratic nature of the process of business model change. Some scholars argue that "classic case studies" (Dyer & Wilkins, 1991: 613), usually single cases, yield more deep and paradigm-shifting insights (Kuhn, 1970). However, the choice of multiple cases over a single case, as happens in this study, "typically yields more robust, generalizable, and testable theory than single-case research" (Eisenhardt & Graebner, 2007: 27). I believe that a study of spin-offs from other universities and geographic locations will hold similar findings, but this issue can only be answered by further research.

Second, this study was limited to early phases of the business model change process in university spin-offs, and had a limited longitudinal timeframe of 12 months. Propositions were based on longitudinal data from several sources

comprising this period, and on varied retrospective data from earlier periods. Therefore, some of the propositions concerning spin-off performance could be enhanced by subsequent measurements of performance at later stages.

Third, I noticed that sometimes the interviewees had considerable difficulty in remembering how business model elements changed in their businesses. And occasionally, triggered by other memories, they would remember additional business model changes throughout the conversation. I also realized that every now and then the interviewees were not even aware of some changes. These are typical 'non-awareness' and memory decay issues, which are substantially more limitative in retrospective designs. In fact, according to Eisenhardt & Graebner (2007: 28), "real-time cases employ longitudinal data collection of interviews (...) which help to mitigate retrospective sensemaking and impression management". Hence, these limitations were mitigated by combining longitudinal and retrospective designs.

Fourth, the interviewees might have occasionally and deliberately omitted information on business model change, because they considered it to be sensitive and wanted to protect their companies. In certain situations, I was notified of these omissions; in other moments, I would not even be aware that that information was being omitted. In retrospect, some of the interviewees informed me that they omitted information in previous interviews, due to important on-going negotiations, and then we would correct/update that information. Though these situations obviously introduce limitations, I was aware of that and tried, whenever possible, to minimize errors.

Fifth, some of the interviewees seemed busier than others. These apparently busier interviewees would often attempt to rush through the interviews, saying that no changes have really occurred, or diminishing the importance of the few changes that occurred. When faced with this situation, I always asked if they would prefer to reschedule the interview, and explained the importance of describing changes as accurately as possible for the research quality of the study. These busier interviewees might have omitted occasionally some information. Also, some of them would take the interviewing sessions more seriously than others. These interviewees were

willing to dedicate more of their time to the interviewing process, and thus might have provided more detailed information.

Sixth, though I intended to perform monthly interviews during the 12-month interview period, keeping this frequency steady was a major challenge. Entrepreneurs are usually very busy people, travelling constantly and often re-scheduling appointments due to unexpected events. Some informants were also more available than others, which resulted in more frequent and regular interviews.

Seventh, the investigator (myself) served as an observer and interpreter throughout the research process. Moreover, participants were also playing the role of observers and interpreters throughout the process. Therefore, in both cases, investigator-observer-interpreter and participant-observer-interpreter, investigators and participants faced "the problems of the observer's perceptual and cognitive limitations, and also the problem of the observer not being aware of some key events" (Van de Ven & Huber, 1990: 216). Therefore, the exercise of observation and interpretation, performed by two different actors (investigator and participant) introduces additional biases. However, certain scholars argue that the investigator's previous practical and theoretical experiences, and thus subjective knowledge, "should be viewed as an asset and not a liability" (Fendt & Sachs, 2008: 450), provided that he or she clearly explains which philosophical stance is adopted and which prior knowledge is brought to the study.

A final limitation concerns the process of coding changes in the business model elements, and the subjectivity associated with those decisions. As argued previously, such matters have been discussed extensively in the realm of organizational strategy (Snow & Hambrick, 1980). To minimize the error introduced by investigator's subjectivity, several researchers were involved in parts of the coding process. Despite the limitations described above, I believe that this study contributes with some important insights and future directions for business model, university spin-off, and more generally, entrepreneurship research. I subscribe the words of Leitch, Hill, and Harrison (2010: 80) regarding the practice of interpretivist research: "with due care and attention, interpretivist entrepreneurship research is capable of producing rich data through which respondents' experiences, perceptions,

and beliefs may be accessed, thus adding significantly to the understanding of entrepreneurial behavior".

6.7 FURTHER RESEARCH

This inductive multiple case study generated propositions related to business model change in university spin-offs. Further research, using larger samples of spin-offs from different universities and geographies, is needed to corroborate these propositions. In particular, existing national databases of the full population of university spin-offs, such as TASTE project in Italy (led by Riccardo Fini), FORNY program in Norway (led by Einar Rasmussen), and Spinouts UK in the U.K. (led by Mike Wright), can be assessed to test some of these propositions. In fact, the research team led by Rasmussen et al. (2014) is, at the time of writing, coding data of science-based firms from a business model perspective, to explore quantitatively some of the insights generated by this thesis. This project will extend the study's findings to a broader context, thus enhancing generalizability, one of the limitations previously identified. Additionally, since this study focused on a 12-month period after firm incorporation, more longitudinal research on upstream and downstream stages, and preferably for longer periods, could also bring further insights into the process of business model change.

A distinction between intended and realized business models was elaborated throughout this study. Future research would benefit from acknowledging the difference between intentions and realizations, and from formulating research methodologies in a way that captures separately their dynamics. This would add another layer of granularity to the study of the process of business model change, and possibly generate insights more reflective of reality. Since intentions are deeply rooted in the entrepreneurs' minds, the propositions generated in this study could be further developed through other complementary research methods such as diaries (e.g., Williams & Alliger, 1994; Zwijze-Koning & Jong, 2005). According to Bartel (2001: 407), "self-reported diaries that ask specific questions about recent events avoid retrospective biases". Therefore, this method would mitigate considerably the

typical ‘non-awareness’, memory decay, and retrospective sensemaking limitations identified in the previous section.

The study identified the most relevant drivers of business model change, as well as several themes related to this process. However, the findings relate these drivers and themes to the whole business model, as one indivisible unit. Therefore, it would be interesting to investigate which drivers induce greater impact on each of the business model elements. For instance, the driver “develop technology/products to meet customer demand” might be triggering changes more in certain elements than others.

The difficulty of coding business model change, due to the different intensities of change, has been discussed above. In the realm of strategic management, researchers have proposed a classification that distinguishes between strategic change and adjustment (Snow & Hambrick, 1980). Future research could attempt to develop a similar typology for business model change, with two or more types, reflecting more accurately the broad spectrum of ‘change intensities’ that extends from incremental to radical.

This study has suggested that certain actors outside the organizations’ boundaries, such as customers, investors, or distributors, have a striking impact on how the business model develops over time. However, this issue has not been explored in detail. Hence, further research could investigate how the whole range of external actors (e.g., customers, suppliers, distributors, competitors, investors, universities, government agencies, and others) influence each of the business model elements over time.

The study has also collected the intended and realized business models for each case according to the perspective of a second informant. This information was collected at two moments in time: at the beginning and at the end of the 12-month longitudinal period. Preliminary findings appear to indicate that venture performance increases with greater alignment of perceptions concerning intended and realized business models across the management team. This issue needs more thorough

investigation. Potential insights would contribute to the literature on entrepreneurial teams and performance.

This thesis has proposed a conceptualization of the business model as a self-organizing complex system (Levy, 1994; McKelvey, 1997, 1999). Such a conceptualization serves as an alternative theoretical perspective to examine the process of business model change. An interesting and challenging research avenue would be to further explore this conceptualization by using complexity and systems theory in the context of business model change, which, according to some authors, has been predominantly atheoretical (Zott et al., 2011). Moreover, future research could also develop further this conceptualization and operationalize it through simulation methods using computer software. According to Davis, Eisenhardt, and Bingham (2007: 481), "simulation is especially useful in the "sweet spot" between theory-creating research using such methods as inductive multiple case studies (Eisenhardt, 1989) and formal modeling (Freese, 1980), and theory-testing research using multivariate, statistical analysis (Pfeffer, 1993)".

It has been suggested that entrepreneurs with generic/platform technologies should narrow their scope after firm incorporation, by opting for one product to few markets, or few products to one market. Barr et al. (2009) describe these different configurations as Technology-Product-Market linkages (T-P-M). Some of the cases reported in this study focused their development on one product for one market; other cases also developed one product but adapted it to different markets; other cases developed several products for one or several markets. Therefore, one interesting research avenue would be to understand if there is an optimum combination of product(s)-market(s) that minimizes the time to reach a viable business model in university spin-offs. This combination would most probably be dependent on certain context variables. Hence, the identification of these variables and their configurations would also be of relevance.

This study has distinguished between technology scope and business scope, and examined their relationship with the number of business model changes and early-stage firm performance. Further research could develop a more fine-grained conceptualization of scope types that defines and relates with enhanced clarity

technology scope, business scope, product scope, channel scope, and market scope. Understanding how scopes types evolve over time in early-stage spin-offs, or more generally, in early-stage technology-based firms, and how they affect performance, could be relevant for early-stage spin-off entrepreneurs striving to make "scoping" decisions.

Finally, the university spin-offs selected for this study have been supported by several different providers of start-up capital (e.g., government, venture capitalists, business angels, industrial partners, investment banking, self-funding). Different types of investors may have different kinds of expertise that will affect differently the way spin-offs grow (Clarysse et al., 2007), and the way the business model develops. Hence, it would be interesting to better understand the role of different financiers and financing mechanisms on how the business model shapes, and subsequent impact on spin-off performance.

As evidenced above, the field of business models presents a variety of stimulating and challenging research avenues. A more dynamic paradigm that captures the complexity of business model change has just begun to emerge. This study attempted to provide a richer understanding of this phenomenon and simultaneously a basis for more rigorous and productive enquiries on this topic. I hope it inspires future research not only in the university spin-off context, but also in other settings involving business model change.

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8 APPENDICES

8.1 INTERVIEW GUIDES

8.1.1 Interview Guide / Questionnaire for First Interview

Spin-off generic info

- Name of the interview participant
- Position/role of the interview participant
- Name of the company
- Department (e.g. engineering)
- Industry (e.g. software)
- Specific domain (e.g. virtual marketplace)
- Business description
- Number of employees
- Stage of the company (nascent, NB or EB)

Founding team

- Founding team (e.g. 4 professors + 2 team members)
- Name, age, background and past experience of founding team members
- Market knowledge (e.g. extensive industry experience, knowledge of customer's needs and behaviours, knowledge of competitors)
    - Rate it from 0 to 10: ____
    - Number of years working in or close to this market: ____
- Managerial knowledge (e.g. SME management experience, worked in companies)
    - Rate it from 0 to 10: ____
    - Number of years working in a company: ____
- Entrepreneurial knowledge (e.g. new venture creation experience)
    - Rate it from 0 to 10: ____
    - Number of years working as an entrepreneur: ____
    - Number of companies created: ____
- Commitment of the founding team to the project:
    - Rate it from 0 to 10: ____

Opportunity identification and development

- Approximate date of initial idea
- Context of initial idea (e.g. stumbled into an opportunity)
- Approximate date of incorporation
- Most critical resource for initial opportunity development (e.g. one professor's industry experience)
- Source of basic technology and competence (e.g. university research and industry experience)

Technology and market development

- Major performer of technology development (e.g. founders)
- Other performers of technology development (e.g. industrial partners)
- Major roles in market development (e.g. founding team)

Funding

- Has the spin-off received any type of external funding? Y/N
- Initial funding (e.g. self-funded)
- Major source of funding (e.g. public grants)
- Additional funding sources (e.g. industry)

Company performance

- Already incorporated? Y/N
- Estimated time-to-market
- Date of first sale
- Estimated date of first sale (if no sales)
- Date of first customer order
- Estimated date of first customer order (if no orders)

Info/documentation to request

- Business plan
- Presentations
- Reports
- Notes
- Videos
- Audio
- Website
- Press releases
- Other

8.1.2 Interview Guide / Checklist for Second Interview

Company:_____ Date: __ / __ / _____

1. Customer segments

Which are your types/groups of customers (different groups of people or organisations)? Have they been changing since the beginning? What? When? How? Why? Who?

2. Value proposition

What value/benefits do you offer to each type of customers? Have they been changing since the beginning? What? When? How? Why? Who?

3. Channels

Through which channels are you communicating, selling and distributing your products/ services to your customer segments? Have they been changing since the beginning? What? When? How? Why? Who?

4. Customer relationships

What type of relationship are you establishing and maintaining with each of your customer segments? Have they been changing since the beginning? What? When? How? Why? Who?

5. Revenue streams

What and how is each of your customer segments paying for your products/services? Have they been changing since the beginning? What? When? How? Why? Who?

6. Key resources

What are the most important resources to make your business model work? Have they been changing since the beginning? What? When? How? Why? Who?

7. Key activities

What are the most important activities that your company does? Have they been changing since the beginning? What? When? How? Why? Who?

8. Key partners

Who are the most important partners in your business network? Have they been changing since the beginning? What? When? How? Why? Who?

9. Cost structure

What are the most important costs in your business? Have they been changing since the beginning? What? When? How? Why? Who?

10. Funding

What are your sources of funding? Have they been changing since the beginning? What? When? How? Why? Who?

11. Goals

What are your top goals for the spin-off (or idea) during this year? How/why have you decided to go for these goals? Have they been changing since the beginning? What? When? How? Why? Who?

12. Additional changes

Anything else you find interesting to mention not covered above? Has it been changing since the beginning? What? When? How? Why? Who?

8.1.3 Interview Guide / Checklist for Third and Subsequent Interviews

(Monthly)

Right now:

1. (***customer segments***) Which are your types/groups of customers (different groups of people or organizations)? Did they change? What changed? When? How? Why? Who inspired your decision?

2. (***value proposition***) What value/benefits do you offer to each type of customers? Did it change? What changed? When? How? Why? Who inspired your decision?

3. (***channels***) Through which channels are you communicating, selling and distributing your products/services to your customer segments? Did they change? What changed? When? How? Why? Who inspired your decision?

4. (***customer relationships***) What type of relationship are you establishing and maintaining with each of your customer segments? Did it change? What changed? When? How? Why? Who inspired your decision?

5. (***revenue streams***) What and how is each of your customer segments paying for your products/services? Did it change? What changed? When? How? Why? Who inspired your decision?

6. (***key resources***) What are the most important resources to make your business model work? Did they change? What changed? When? How? Why? Who inspired your decision?

7. (***key activities***) What are the most important activities that your company does? Did they change? What changed? When? How? Why? Who inspired your decision?

8. (***key partners***) Who are the most important partners in your business network? Did they change? What changed? When? How? Why? Who inspired your decision?

9. (***cost structure***) What are the most important costs in your business? Did they change? What changed? When? How? Why? Who inspired your decision?

10. (***funding***) What are your sources of funding? Did they change? What changed? When? How? Why? Who inspired your decision?

11. (***goals***) What are the top goals for your business? Did they change? What changed? When? How? Why? Who inspired your decision?

12. Were there any additional changes (not covered previously), or any emerging issues that you would like to share?

8.2 EVIDENCE OF FIRST AND SECOND LEVEL CODING

Table 8.1 Coding Structure and Sample Interview Transcripts

2nd-level Codes	1st-level Codes	*Sample interview transcripts*
REALIZED BUSINESS MODEL CHANGE	Customer Segments	*"If other sectors come along and say, you know, like chemical industry did out of blue, and want a contract, want to develop something, we're not gonna say no, obviously."* (Firm D, month 9)
	Value proposition	*"Our value proposition is changing as well, because we are doing more basic research to look at a fundamental property, which should lead to more efficient devices, which should lead to more optical output from less input, in optical drive power. So, that becomes very important."* (Firm C, month 6)
	Channels	*"Just wee changes I've made. What I've said in here is TV shopping, ideal home channel. So, we're going on to ideal home shopping channel, ok? (...) Our market research basically told us that it was an unassisted sale. One of the barriers to people buying the product was they didn't understand how they would use it, or what they would connect it to. So, we feel that if we can do a kind of a presentation to people, a video, then it will improve our sales."* (Firm B, month 11)
	Customer Relation-ships	*"We're using a CRM [Customer Relationship Manager] system now. (...) The CRM system has all customers in it. (...) Just a sensible progress, helps you manage sales more effectively."* (Firm B, month 4)
	Revenue Streams	*"We've got the first contract. It's very small [laughs]. But not that small…We have an additional source of income… It's a development contract… Essentially, the company pays us to provide them with samples to test their systems. (...) We're not setting out to be a contract research company, but we're not turning our face against doing it. It will be part of what we do, but it's not focus of the company."* (Firm D, month 7)
	Key Resources	*"We've got another engineer who is joining this month, but that's funded, so we're not paying for it. (...) We've also appointed a non-exec director yesterday. So, a new non-exec director who has lots of experience of startups, major corporations, selling companies, and technically very very capable."* (Firm C, month 6)
	Key Activities	*"So, our key activities changed because of that. (...) We're going for managing engineering and development to actually prosecuting engineering and development. (...) I would say the first [managing E&D] takes still 60% of our time, but it's much more about managing and engineering the building of the device, rather then development anymore. (...) Number two [raising money], we're spending less time, because we think we've solved the funding for the SPV."* (Firm G, month 5)
	Key Partners	*"We've got one more key partner, because we're now moving ahead with the development of a project for [company name], which is a SPV that we setup and that we own. We've entered into an agreement with [new partner 1] to help us with the development of that project. (...) And we have one more new partner, which is a technical partner, helping us with designing the rotor blade for the turbine. And that's a Dutch company called [new partner 2]."* (Firm G, month 8)
	Cost Structure	*"Some of our initial development costs are reduced, you know. So, up when you first start making a product, you spend a lot of money on different materials. Once it becomes stable, the cost of continuing to manufacture is lower, because you've not got that non-recoverable engineering element at the start. And so, that's why I think that the materials balance has gone down a little bit, and the human resources, because we've taken on additional people, they've got up a little bit."* (Firm F, month 10)

Table 8.1 Coding Structure and Sample Interview Transcripts (cont.)

2nd-level Codes	1st-level Codes	*Sample interview transcripts*
INTENDED BUSINESS MODEL CHANGE	Customer Segments	*"There have been changes in the customer segments. We've had 2 approaches by major companies who want things, which we didn't expect to provide so soon. (...) This company wants a technology in a number of different segments (...): Oil & gas, packaging, and food safety. (...) I mean, these are all wishlists at the moment, I mean, these are areas that we're now possibly developing, but this is still under negotiation."* (Firm D, month 4)
	Value proposition	*"Our value proposition will be changing in relation to the roadmap. (...) So, we are looking for additional products abroad, and from China, that we can use to increase our range quickly, without a lot of development. (...) Other products to increase the energy egg product range. (...) Some of them will be integrated, and some of them will be standalone."* (Firm B, month 10)
	Channels	*"We're just starting to look at distributors in other countries, because we kind of have our own sales force throughout the world, but there is now a move to start looking at additional distributors in European countries apart from where we have our sales force in Denmark, UK, and France."* (Firm H, month 5)
	Customer Relation-ships	None of the intended business models underwent changes in customer relationships.
	Revenue Streams	Added another potential revenue stream coming from consultancy. *"One of our sales guys decided to offer consultancy to John Lewis. (...) Just consultancy about how they should manage their ranging of energy efficient products."* (Firm B, month 9)
	Key Resources	*"We're looking to bring on more engineers and project managers. (...) Because of the growth now, we're looking to get at least 2 people in next month, and then another 2 people by October. And then in the following year, grow the business to over 20 people."* (Firm C, month 12)
	Key Activities	None of the intended business models underwent changes in key activities.
	Key Partners	*"We've got serious discussions going now with a number of additional partners to extend the route to market. They're beginning to happen, but you know, it's not there till it's there, if you know what I mean. (...) These guys are [existing key partner], they are very good in specific geographies, but they don't cover all the geographies we're interested in."* (Firm F, month 6)
	Cost Structure	Referring to future (or intended) cost structure, not actual. *"We're trying to get the cost down through manufacturing. So, we're trying to improve the margin by decreasing our manufacturing cost. [SC: These would continue to be your main costs?] Yes, and premises as well. Premises would be a new one."* (Firm B, month 10).

Table 8.1 Coding Structure and Sample Interview Transcripts (cont.)

2nd-level Codes	1st-level Codes	*Sample interview transcripts*
OTHER EMERGING CATEGORIES	**Funding**	*"We're starting to get some significant grant funding as well. (...) It has always been part of our strategy to try and raise grant funding to match the funds we have from our investor. And it's just taken us a little longer to achieve that than we thought so. This isn't a deviation from strategy. It's actually the execution of our original strategy. (...) We had to deal with the long lead time, and engineering items first. And we've done that. So now we need to focus on the more operational deployments."* (Firm G, month 9)
	Goals	*"So, I think I would refine the goal to say: single licensing, but ideally with research collaboration in parallel. (...) Because the key there is the resource would come from the partner. We would not have to go and raise more money with existing investors or even worse, venture capital. Venture capital does not work easily with business angels. It becomes a very difficult relationship. So, we prefer not to mix oil and water, if you like."* (Firm E, month 6)