



NTNU – Trondheim
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How and why do Research Based Spin-Offs change their Business Model?

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Oppstartsdato 15. jan 2014	Innleveringsfrist 11. jun 2014
Oppgavens (foreløpige) tittel How and why do research based spin-offs change their business model?	
Oppgavetekst/Problembeskrivelse We will explore how and why research based spin-offs change their business model through their lifetime to better understand development and success of these ventures.	
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Kandidatene skal ha *individuell* bedømmelse
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Abbreviations

Research based spin-off typology:

RBSO Research Based Spin-Off

ASO Academic Spin-Off

ASU Academic Start-Ups

RBSU Research Based Start-Up

NTBF New Technology Based Firm

USO University Spin-Off

USO University Spinouts

USU University Start-Up

Other:

TM Market for technology

Preface

Research based spin-offs (RBSO) are new firms created to commercially exploit knowledge, technology or research results developed within an academic institution. The phenomenon of RBSOs has become an increasingly important way of transferring technology and knowledge from research institutions into commercial value. RBSOs are characterized by their academic origin and their technology is often based on generic research. These characteristics distinguish RBSOs from other start-ups, and influence their development and behavior. RBSOs consistently underperform compared to other spin-offs and a better perception of how RBSOs act and evolve is important to understand why they underperform and how they can overcome their specific challenges.

Many researchers as well as our own entrepreneurial experience support that initial strategic decisions are important to future performance and survival. A popular way of describing how firms create, capture and deliver value is through the concept of business models. Hence, knowledge of what influences the choices that lead to a RBSO's initial operational business model and how this may change over time will contribute to a better understanding of how they can improve their performance. With this in mind, part one of this master thesis seeks to contribute to the knowledge of what drivers may lead to different choices regarding RBSOs' business model. This is done by an extensive literature study. The second part investigates financial capital as a driver, by tracking the development of 84 Norwegian RBSOs from 2000-2012. This is presented in a second article.

Article one is a literature review concerning drivers for choice of business models among RBSOs. Through a systematic literature search we have identified and analyzed the drivers that lead to the choice of specific types of business models. These drivers were categorized into three internal and three external categories. All drivers was analyzed according to their influence on activity based and growth oriented business model types respectively. How and why RBSOs choose to pursue certain types of activity based and growth oriented business models was found to be largely unexplored in the literature. We also found that financial capital, social capital, support from the parent institution and environmental factors are categories of enabling drivers, by providing the possibility for the RBSOs to choose any desirable business model. However, technology characteristics, market/industry conditions and resources are categories of drivers that directly affect the choice of activity orientation of the business model. In addition, we suggest that drivers in the categories financial capital, human capital, technology characteristics, market conditions and founder's mindset influence the choice of growth orientation.

Article two empirically investigates how financial capital affect the RBSOs' choice of business model, as well as the impact of the change itself. Three hypotheses were investigated in a mixed method approach. Cases of all activity based business model change combinations were found in the sample of 84 RBSOs. Financial capital as a constrainer was found to be dominating. Unsatisfactory financial situation was in particular found to limit which model a firm may change to. In addition, we found that the likelihood of being discontinued was significantly lower for RBSO that had made a business model change compared to others. Further, financial situation was found to have a significant impact on occurrence of activity based business model change, measured over two consecutive years. Lastly, the act of changing business model was found to have a positive impact on firm survival. The framework of drivers for choice of business models proposed in article 1 has shown to be a useful tool in the study in article 2.

Summary in Norwegian

Forskningsbaserte spinoff-selskaper (RBSO) er nye bedrifter opprettet for å kommersialisere kunnskap, teknologi eller forskningsresultater utviklet på en forskningsinstitusjon. Fenomenet RBSOer har blitt en stadig viktigere måte å overføre teknologi og kunnskap fra forskningsinstitusjoner til kommersiell og samfunnsmessig verdi. RBSOer er preget av sin akademiske opprinnelse og teknologien er ofte basert på grunnforskning. Disse egenskapene skiller RBSOer fra andre oppstartsbedrifter, og påvirker deres utvikling og atferd. For å forstå hvorfor RBSOer i større grad mislykkes enn andre oppstartselskaper er det nødvendig å øke kunnskapen om hvordan disse selskapene utvikler seg, og hvordan de overviner utfordringer. Mange forskere, inkludert oss selv med vår egen gründererfaring, finner de første strategiske beslutningen som svært viktige for bedriftenes fremtid. Forretningsmodell er et populært uttrykk for hvordan bedrifter skaper, fanger og leverer verdier. På bakgrunn av dette mener vi at mer kunnskap om hva som påvirker hvilken forretningsmodellen RBSOer velger som den første, og hvordan den endres over tid vil øke forståelsen og bidra til at denne typen selskap kan prestere bedre i fremtiden.

Denne masteroppgaven består av to artikler. Første artikkel er en litteraturgjennomgang for å samle teoretiske bidrag vedrørende hva slags drivere som fører til bedriftenes spesifikke valg av forretningsmodell. Den andre artikkelen undersøker en av driverne, finansielle ressurser, og hvordan den har påvirket 84 norske RBSOer fra 2000-2012.

Artikkel 1 identifiserer og analyserer drivere som påvirker RBSOer og deres valg av forretningsmodell ved hjelp av en omfattende litteraturgjennomgang. De identifiserte driverne ble kategorisert i tre interne og tre eksterne kategorier. Alle driverne ble analysert og deres påvirkningskraft på valg av aktivitetsbaserte og vekstbaserte forretningsmodeller ble identifisert. Hvordan og hvorfor RBSOer velger sin respektive forretningsmodell viste seg å være et svært urørt forskningsfelt. Videre fant vi at finansielle ressurser, sosial kapital, påvirkning fra forskningsinstitusjonen og miljøet rundt RBSOer fungerer som en mulighetskapende faktor som gir bedriftene flere valgmuligheter under valg av forretningsmodell. Teknologiens karakteristikk, marked/industri, og ressurser direkte påvirker hva slags aktivitetsbasert forretningsmodell selskapene velger. I tillegg fant vi ut at finansielle ressurser, menneskelige ressurser, teknologi karakteristikk, marked/industri og entreprenørenes tankesett direkte påvirker hva slags vekstbasert forretningsmodell RBSOene velger.

Artikkel 2 tester empirisk mengden av påvirkningkraft finansielle ressurser har på endringer av forretningsmodellen, og hva som er resultatet av at bedriften endrer forretningsmodellen. Tre hypoteser ble testet ved hjelp av en kombinert kvalitativ og kvantitativ metode. Alle kombinasjoner av endringer mellom aktivitets-orienterte forretningsmodeller ble funnet i utvalget av 84 norske RBSOer. Blant utvalget var finansiell situasjon den dominerende begrensende driver. Finansiell situasjon ble også oppdaget å ha en signifikant utløsende faktor når det kom til endring av aktivitetsbaserte forretningsmodeller, når to års perioder ble analysert av gangen. Til slutt ble det oppdaget at det å endre forretningsmodell har en positiv effekt på overlevelsessevnen til RBSOer.

Drivers that affect the choice of business model in research based spin-offs (RBSOs)

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Abstract

Research based spin-offs (RBSOs) are new firms created to commercially exploit knowledge, technology or research results developed within a research institution. This has become an important type of knowledge transfer that may stimulate innovation and impact of research to society. The business model concept is a useful way of describing how value is created, captured and delivered, and the first business model of a firm will set the path for future performance. Through a literature search and review of relevant studies, we have identified and categorized drivers that affect RBSOs choice of initial business model by combining an activity based and growth oriented business model typology. Our categorization includes the internal categories *resources*, *technology characteristics* and *founders mindset*, and the external categories *market and industry*, *parent institution* and *operational conditions*. This categorization have shown to be useful way of analyzing how and why RBSOs choose their initial business model. In particular, lack of resources, developing push technology and low risk preference was found in the literature to lead towards a low growth or transitional consultancy or TM model. On the contrary, access to sufficient resources is likely to enable RBSOs to choose a high growth product model.

1 Introduction

Research based spin-off companies are becoming an increasingly common and important phenomenon for the society of industrialized countries as well as for the institutions they stem from (Wright, 2007; Shane, 2004; Mustar et al., 2006; Pirnay et al., 2003). This may be due to the changes in society that industrialized countries have experienced. Globalization of markets and technology, information technology and international transportation systems are drivers that has made it unattractive for many western countries to maintain their manufacturing industry. Creating wealth from commercialization of research and development may play an important role in facing these changes.

Spin-offs from universities and research institutions are important means of transferring the knowledge and technology from R&D to commercial value in the society, albeit not the only one

(Helm et al., 2013). Other ways of transferring knowledge and technology are by education, publishing, conferences, contract research, and licensing (Rogers et al., 2001). However, spin-offs are important contributors to technology transfer due to a number of reasons. Where the market for the scientific discovery is undetermined, yet to emerge or non-existent, conventional methods of technology transfer as licensing are difficult. Creating a spin-off is a viable alternative increasingly utilized (Wright et al., 2004b). Further, Bray and Lee (2000) asserts that spin-offs are more effective and may create ten times the income compared to licensing for the parent institution. Spin-offs has also been found to boost regional economic development in terms of exports, employment, taxes paid, R&D and innovation. (Wright et al., 2004b; Heirman and Clarysse, 2004).

The Bayh-Dole Act (1980) was passed in USA in 1980, but it took 23 years before the Norwegian government adopted the same legislation

that allow universities to commercialize research results produced by its employees. Governmental funds (such as FORNY) were created as a mean to increase the birth of research based companies (Borlaug and STEP, 2009). *For governments, this has appeared to offer a means whereby public policy could have a direct and significant impact on economic development.* (Bower, 2003, p. 97). The universities are now trying to unite entrepreneurial mindset and the academic culture together by establishing technology transfer offices (TTOs), science parks, pre-seed funds and motivate the researchers to change their attitude towards a more commercial opportunity thinking.

The increasing spin-off activity and the growing awareness of the importance of them has spurred researchers to get more interested in and conduct more research on this phenomenon (Mustar et al., 2006; Heirman and Clarysse, 2004; Powers and McDougall, 2005). RBSOs generally differ from new technology based firms (NTBFs) in two ways; by their unique academic origin and by their specific and novel technology or knowledge. RBSOs arise in an academic environment where the culture at the university have been shaped over time, including mainly research and teaching, and hence non-commercial mindset (Pirnay et al., 2003). Novelty of the technology often combined with little knowledge of potential markets is characterized as *push technology*, and may cause disturbance in the market (Roininen and Ylinenpää, 2009). To understand the spin-off process and phenomenon, it is essential to understand the heterogeneity of these companies and their behavior. How they act has implications for and influence the technology transfer and wealth creation process (Conceicao et al., 2012). *In order to preserve the impact of such companies in terms of economic and technological development, it is important to study the factors that enhance their development* (Criaco et al., 2013, p. 2).

1.1 Research question

Spin-offs stem from a different environment, with other variables and conditions compared to other new ventures. Their unique origin, initial configuration and impact on society makes RBSOs interesting and necessary to study. The scope of this paper is to investigate why they make fundamen-

tal strategic choices to create, capture and deliver value, commonly regarded as the business model of a firm (Günzel and Holm, 2013). According to Clausen and Rasmussen (2012) it deserves further research to understand what drives research based spin-offs to adopt different business models. Choice of business model should be taken through awareness of the advantages and disadvantages of a given resource and market conditions. A better perception of how these choices are made could hence be useful for spin-offs in the future.

Hence, this paper will deal with the following research question:

What drivers affect the choice of the first operative business model for research based spin-offs, and what type of business model may the different drivers lead to?

We define drivers as factors or causes that forces or directs the company to follow or not follow a distinctive type of business model.

Stinchcombe (1965) argued that the surroundings of the company during founding process influence the characteristics of the venture and may be long lasting. Further, because of the limited resource endowments the initial decisions to be made are crucial for the company (Vohora et al., 2004). Making the wrong decisions would result in lost time and resources, which will slow down the spin-off. The first adopted strategic choices are not necessarily everlasting (Conceicao et al., 2012), hence we will also discuss the dynamic aspect of the business model.

In the next section we will present relevant theory to discuss our findings from the literature search. This includes the resource based view (RBV) and business model theory. From the business model literature we will propose a typology of business models further used in the analysis and discussion. Next, common definitions and terms used for spin-offs will conclude on the definition of RBSOs. We will then present the method of our thorough literature search on drivers for choice of business models. As a tool for analysis, we will propose a categorization for these drivers. This categorization will further be used in the discussion of the identified drivers' effect on business model choices. Hence, we will discuss drivers separately in the three internal and three external

categories. Thereafter, we conclude on our findings and suggest implications for further research. Lastly, we present potential limitations of our literature search and analysis.

2 Theory

2.1 Resource based view

There are generally two prevailing views of the firm in the strategic management literature used to conceptualize firms and evaluate their competitive advantage. The *resource based view* explain competitive advantage on the basis of the firm's internal resources, while Porter's market based view look at inter-firm relations. As a representative for the market based view, Porter (1985) has been a pioneering figure in the field of business strategy with theories on market forces and competitive advantage. The industry analysis framework developed by Porter view the firm's position in the industry as sources of competitive advantage. The theory takes an outside-in perspective and place the source of a firm's competitive advantage in the market by looking at opportunities and threats. The assumptions that firms within an industry control the same resources, and that those resources are highly mobile is underlying in the industry analysis framework (Barney, 1991).

In contrary to the market based view, the resource based view (RBV) portrays an inside-out analysis of the firm and is based on the assumptions of *resource heterogeneity* and that resources are *not* perfectly mobile across firms (Barney, 1991; Peteraf, 1993). It thus rejects the assumptions about homogeneity and mobility (Conner, 1991). This means that different firms in the same market do not have access to the same resources and have different opportunities to acquire strategic resources, and can give rise to lasting inter-firm performance differences (Wernerfelt, 1984; Penrose, 1959). These assumptions are the main difference between RBV and the industry analysis framework, but Wernerfelt (1984) label it *two sides of the same coin*. It is worth noting that the unit of analysis is *the firm* in RBV and *the industry* in the industry analysis framework.

Many RBSOs have long time to market compared to corporate spin-offs (Agarwal and Bayus,

2002; Lofsten and Lindelof, 2005). To analyze a firm based on its position in an industry years before it has any sales in the market makes less sense than looking at its resources and how it can build capabilities to gain competitive advantage. Thus we look at a firm's internal resources to explain its characteristics which is also commonly used among other similar research projects (Mustar et al., 2006).

2.1.1 Resources

Resources have been defined as attributes of a company's physical, human and organizational capital that enable a firm to conceive of and implement strategies to improve efficiency and effectiveness (Barney, 1991). They also involve tangible and intangible assets which are tied semi permanently to the firm (Wernerfelt, 1984) and stocks of available factors that are owned or controlled by the firm (Amit and Schoemaker, 1993). Hence, resources are fundamental in creation, growth and expansion activities of a firm (Brush et al., 1997).

One critique of the RBV is that the definition of resources is too inclusive (Priem and Butler, 2001). It may be useful to view resources and capabilities as capacities that enable a firm's actions (Hodgson, 2008 as in Kraaijenbrink et al., 2010). Intangible resources can be difficult to observe, describe, and value while tangible resources can be physical or monetary. Firm resources can be classified into categories although there is no consensus among researchers on how to classify them (Brush et al., 1997). For the purpose of this paper we will use the classification of Ireland et al. (2003); financial, human and social capital.

Financial capital are tangible assets and includes the firms monetary resources that can be used to acquire other resources, both tangible and intangible, that can be important to the firm (Ireland et al., 2003). Thus it is an instrumental resource (Brush et al., 2001).

Human capital are intangible assets and are the knowledge and skills of the firm's entire workforce. Some knowledge is tacit and will only reveal itself through its application (Grant, 1996). Increase in the firm's total stock of knowledge can be achieved through social interaction between explicit and tacit knowledge, and need to be viewed in the form of human capital (Ireland et al., 2003;

Brush et al., 2001). Human capital can also be enriched through the firm's external social capital.

Social capital can help the firm to gain access to and control resources outside of the firm through its network of inter- and intra-firm relationships (Ireland et al., 2003). In the context of RBSOs, social capital within business is mostly not present at establishment of the firm and need to be achieved.

The capacity of the organization to cooperate and coordinate resources can be seen itself as an intangible resource (Grant, 1991) and *the act of combining homogeneous and heterogeneous resources is a resource* (Alvarez and Busenitz, 2001, p. 772). This leads us to firm capabilities which are defined as a special type of resource, *an organizationally embedded nontransferable firm-specific resource whose purpose is to improve the productivity of the other resources possessed by the firm* (Makadok, 2001, p. 389). Unlike resources, capabilities are difficult to separate into which belongs to the firm and which belong to the entrepreneurs (Ortín-Ángel and Vendrell-Herrero, 2013), since the firm has only contractual rights to its resources not its capabilities. Capabilities can not be acquired, are unique to every company dependent on which type of business model adopted, and take years to develop (Teece and Pisano, 1994). Meaning that entrepreneurs that have cooperated prior to establishment of a spin-off already obtain some capabilities, and will develop others faster than entrepreneurs without (Brush et al., 2001).

In volatile markets, dynamic capabilities defined as [...] *the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments* (Teece et al., 1997, p. 516). They explain how certain firms can stay competitive over time and are especially important to create new resource configurations and capabilities that can sustain competitive advantage (Eisenhardt and Martin, 2000).

2.2 Business models

The term business model is used extensively, particularly among practitioners (Baden-Fuller and Morgan, 2010), but also by management scholars (Zott et al., 2011). The business model concept gained increased popularity with the rise of the Internet and the new ways of doing business

that followed (Chesbrough and Rosenbloom, 2002; Hedman and Kalling, 2003; Amit and Zott, 2001). Although the dot-com bubble burst at the beginning of this millennium, the business model concept still maintained a common used term, and became a concept applied to businesses in general. However, both scholars and practitioners use the term to describe a wide range of business characteristics (Zott et al., 2011).

One reason for this heterogeneity of definitions used may be that researchers have tried to define business models from a broad range of perspectives, like e-business, radical innovation, and strategy (Shafer et al., 2005). Regardless of the different definitions and ways of using the term, most researchers seem to recognize that business models describe how a company creates, captures and delivers value (Teece, 2010; Günzel and Holm, 2013).

One of the more comprehensive studies on this topic is George and Bock (2011), who looked at definitions in literature and examined the perceptions of business models by practitioners. Although George and Bock (2011) did not present a conceptual definition, they concluded that the business model concept is based on the underlying dimensions of resource, transactive and value structure. In other words the resources that a firm possess, what they buy, what they sell and what value they create in addition to *how* all this occurs.

Another definition worth to mention in the context of RBSOs is the definition by Chesbrough and Rosenbloom, 2002, p. 529: The business model is *the heuristic logic that connects technical potential with realization of economic value*. However, this definition is based on research conducted on spin-offs from Xerox Corporation's R&D department, which exclusively consists of technical business ideas. Spin-offs from research institutions may not be limited to technical ideas, hence a more general definition should be more suitable. The conceptual definition of the business model that will be used in this setting of analyzing research based spin-offs, is the aforementioned definition by Teece (2010) and Günzel and Holm (2013): *How a company creates, captures and delivers value*.

Key partners	Key Activities	Value proposition	Customer relations	Customer Segments
	Key Resources		Channels	
Cost Structure		Revenue structure		

Figure 1: The business model canvas, Osterwalder and Pigneur (2010).

2.2.1 Business model elements

In order to describe the business model of a company, a conceptual definition may be insufficient as it only provides the overlying logic of the term. By defining business models as a notion of different elements, researchers have provided a tool for practitioners for describing their business model (Osterwalder and Pigneur, 2010; Shafer et al., 2005). The framework of Osterwalder and Pigneur (2010) (The business model canvas) consists of nine elements, or building blocks (Figure 1). However, a literature study by Shafer et al. (2005) identified 42 different components described by various researchers as building blocks of a business model. This illustrates the variety of perspectives and perceptions of researchers defining business models. As Shafer et al. (2005) describes it: *[...] by peering through different lenses, authors are seeing different things.*

The elements of the Business model canvas include key resources and activities, which are used to create and deliver value (Osterwalder and Pigneur, 2010). This is comparable to resources and capabilities as described in RBV. This close connection to RBV is an important link as it provides a basis for analyzing business models of RBSOs through RBV. Another element of the business model canvas that may be related to RBV is key partners, that represents social capital through network as well as available human capital. Customer relations, distribution chan-

nels and customer segments are also elements that contribute to creating and delivering value. Cost structure and revenue stream are the elements that constitutes the value capture part of business models. Shafer et al. (2005) adds *strategic choices* as a component of a business model. However, these strategic choices can be integrated in each of the nine building blocks of the Business model canvas. They lay the basis for what the building blocks should entail as well as how they are organized and coordinated.

2.2.2 Typologies and taxonomies of business models

There are several attempts on classifying businesses by describing their *kind* of business model, e.g. by the freemium-model or the McDonalds-model (Baden-Fuller and Morgan, 2010). These are examples of taxonomies. In the entrepreneurship literature on spin-off companies, most descriptions of business models are based on a *typology* approach. Two common groups of typologies used in the literature embracing spin-offs are activity based and growth oriented business models (Wright, 2007).

The typology approach to describe business models can be related to the element approach as representing a specific set of all or some of the elements. Hence choosing a business model type involves choosing a particular set and organization of building blocks in the Business model canvas.

Activity based business models

Stankiewicz (1994) and Druilhe and Garnsey (2004) use an activity based typology for business models. They proposed that RBSOs are mainly *consultants*, mainly *product oriented* or mainly *technology asset oriented*. The latter is basically a company that develops technology that is sold through licenses and partnerships. Druilhe and Garnsey (2004) adds *software* as a fourth business model type.

We will use the arguments of Stankiewicz (1994) and Druilhe and Garnsey (2004) that a service provider model is less relevant in terms of RBSOs. They argue that the consultancy model is the most frequently used way to deliver services to a customer for RBSOs because of the knowledge transfer nature of RBSOs. Similarly, software-based business models as presented by Druilhe and Garnsey (2004) will not be included in our typology, as software based firms can have a product based or consultancy model. We hence argue that software-based business model is not a distinct activity and that a software could be viewed as a product or as a service. Thus, we will use consultancy and product based as distinct activity based types, where consultancy includes service models and software is covered by both consultancy and product types.

Technology asset oriented type can be compared to what Colombo and Piva (2012) and Conceicao et al. (2012) address as a mode of *market of technology* (denoted TM). Companies in TM typically have a generic or novel technology which is not market ready. The technology needs to be further developed towards a specific market application to be sold through licensing, technology sales, alliances or joint ventures (Conceicao et al., 2012). Using TM as a business model type hence includes a broad range of technology asset oriented firms and will therefore be used further in this article as a distinct activity based business model type.

Growth oriented business models

The second group of studies distinguish RBSOs business model based on their growth orientation. Degroof (2002) explored the growth orientation of 42 Belgian spin-offs and confirmed the three types of growth modes previously proposed by Tiler et al. (1993) (as in Wright, 2007): *Slow growers*, *fast growers* and *transitional growers*. Slow grow-

ers are typically businesses with a few employees and limited ambitions to grow. Firms with a high growth model have high growth ambitions and is configured for growing fast, typically in terms of both revenue and employment growth. Transitional growers are companies that typically start with a low growth model and switch to a high growth model later on. Consultancy firms, R&D boutiques or niche players that later on turns into high-growth product companies are common in this group (Wright, 2007; Helm and Mauroner, 2011). *The difference with the low growers is that the latter already have the ambition to grow at start-up, but for a variety of reasons they postpone exponential growth plans for a few years* (Wright, 2007, p. 70). Transitional growers are by some authors, as for instance Helm and Mauroner (2011) and Clarysse et al. (2003), termed *soft starters*.

Growth oriented models are defined as the input of a start-up process, as opposed to the output. The difference between input and output of growth is described by (Roininen and Ylinenpää, 2009, p. 515): *The growth of a firm may be regarded as both an input and an output of a start-up process: input in terms of what motives and ambitions the founding entrepreneurs have for starting the new company, output in terms of the factual growth of the new venture*. Hence, growth orientation of the business model is determined by the growth ambitions of the founders.

Dynamic view of business model types

Although Stankiewicz (1994) points out that his proposed activity based typology is not necessarily mutually exclusive and that firms can move from one to the other, Druilhe and Garnsey (2004) claims the typology of Stankiewicz (1994) is static. Druilhe and Garnsey (2004) adopts a dynamic perspective *which allows for the way entrepreneurs adapt and modify their business ideas as they gain experience* (Druilhe and Garnsey, 2004, p. 271). In other words that a firm's business model can change over time as a result of a changing resource base and development of capabilities when gaining commercial experience. There may be various reasons for why business models change over time, for example as a response to increased competition in the market, or as exemplified for RBSOs by Druilhe and Garnsey,

Table 1: Typology of business models used in this study.

Typology	Business model types
Activity oriented	Consultancy
	Market of technology
	Product oriented
Growth oriented	Slow grower
	Transitional grower
	Fast grower

2004, 281:

[...] although the scientists initially aimed at licensing their early-stage technology, they eventually set up a development company to move the technology closer to market while redefining their business model and examining various options including production.

A dynamic view of the business model type of a firm hence implies that the initial business model type of a firm is not a final choice. Both the activity type and growth orientation can be altered as the entrepreneurs gain experience during business development. A definite example of the dynamics of choice of business models would be the already mentioned transitional growers.

2.2.3 Business model typology for analysis

To analyze drivers for the choice of business model, a typology based view on business models will be used. As spin-offs simultaneously pursue an activity based model and growth orientation, combining these perspectives covers a broad range of business models that can be described. Applying a dynamic view on business models in addition will form theoretical basis for analyzing how and why certain business models are adapted by RBSOs.

The business model typology framework used in this thesis is summarized in table 1.

2.3 Spin-offs

New ventures established to commercially exploit academic research findings are often expressed

as spin-offs. There are almost as many different definitions of a research spin-off as there are researchers focusing on these firms (Pirnay et al., 2003). Terms like research based start up (RBSU) (Heirman and Clarysse, 2004), research based spin-out (RBSO) (Mustar et al., 2006), academic spin-out (ASO) (Druilhe and Garnsey, 2004), university spin-off (USO) (Pirnay et al., 2003), and many more describes more or less the same phenomena but have slightly different definitions. There are also a variety of definitions for the same expression, and sometimes no definition at all. The literature describes the new established firms in different levels: New technology based firms (NTBFs), research based spin-offs (RBSOs) and university spin-offs (USOs). This is illustrated in figure 2.

New technology based firms (NTBF) represent the upper level, i.e. covering a broad range of companies. The variety of definitions of NTBFs presented by Storey and Tether (1998) illustrates how non-uniform the definitions are. A widely used definition include firms with irregular large expenses related to R&D, and often employ highly educated technical personnel (Storey and Tether, 1998).

A subgroup of NTBFs are research based spin-offs (RBSOs) (Clarysse and Moray, 2004), adding that there are some exploited research result from a parent organization.

Lastly, the third level comprise university spin-offs (USO), adding the criteria that the parent organization has to be a university. It is also common to restrict the population by adding constraints for the founder and his/her relation to the parent organization. Some scholars define USOs as RBSOs, which contributes further to the already confusing spectrum of definitions. In addition, USOs are not necessarily understood as a subgroup of RBSOs, as it can be more related to other aspects at the university than research results.

The variety and overlap of definitions probably relates to the variety of topics and context of research in academic entrepreneurship. A suitable and clear definition is fundamentally important if research findings are able to be generalized and used as foundation for further research. Consequently, there are several attempts on gather-



Figure 2: Levels of spin-offs.

ing previously used definitions, as in Pirnay et al. (2003).

Both Pirnay et al. (2003) and Djokovic and Souitaris (2008) are literature reviews, and Pirnay suggests a new definition based on earlier research. Both also recognize the two dimensions authors use to describe USOs: *founders role* and *technology transfer focus*. Most of the definitions include both the link to the university, and the use of technology origin from the institution (ex. McQueen and Wallmark, 1982; Smilor et al., 1990; Rappert et al., 1999; Carayannis et al., 1998; Nicolaou and Birley, 2003). Vohora et al. (2004) address two major differences and challenges with USO vs. NTBF, namely the lack of commercialization knowledge and different objectives between key stakeholders (university vs. investor). There may also be differences between spin-offs originating from universities and private R&D centers as universities mainly emphasize knowledge transfer through education (Shane (2004)). Nevertheless, both are heavily involved in research and has limited commercial focus, hence share many similarities.

We also exclude corporate spin-offs, as they normally commercialize technology emerged from market needs (*pull technology*), and have other purposes (Roininen and Ylinenpää, 2009; Rasmussen et al., 2012). They also have different initial conditions at start up and benefit from parent corporation reputation (Bathelt et al., 2010).

Another factor that should be covered by a definition of spin-offs is the use of surrogate entrepreneurs, who are professional business developers hired for leading the spin-off process. This is especially useful in situations when the inventor is not able to leave the parent organization (Radosevich, 1995). In addition, the surrogate entrepreneur usually adds higher commercialisa-

tion skills compared to academic entrepreneurs (Franklin et al., 2001; Bower, 2003; Colombo and Piva, 2012). Smilor et al. (1990) among others present a definition that exclude all spin-offs where the founders were not former employees of the parent organization. This is not a suitable definition for this paper as our main focus is the company and not the entrepreneur.

2.3.1 RBSO definition

Pirnay et al. (2003) has made a definition that is well formulated and based on earlier research. We would like to combine it with the definition of Clarysse et al., 2000, p. 546, as cited in Pirnay et al. (2003): *Research based spin-offs are defined as new companies set up by a host institute (university, technical school, public/private R&D department) to transfer and commercialize inventions resulting from the R&D efforts of the departments* (Pirnay et al., 2003, p. 357). As we wish to include public research centers in our definition, a definition as RBSO will be more suited than a broader definition of USOs. Hence, we define a research based spin-off as:

New firms created to exploit commercially some knowledge, technology or research results developed within a research institute (university, technical school, public R&D department).

2.3.2 Stages in the life cycle of RBSOs

In order to analyze RBSOs at their initial stages, it is important to address the development of these firms. Few studies focus on the formation and development of spin-offs (Djokovic and Souitaris, 2008). An exception is Vohora et al. (2004), which is a highly cited paper in the field of spin-offs, and we choose to use their framework to understand the stages RBSOs go through. The companies need to overcome certain thresholds to move from one phase to another, and Vohora et. al. defines them as critical junctures which includes different resources and capabilities that need to be acquired.

The research phase describes the prior phase, where the knowledge or technology is initiated. This is often done by a scientist researching in

a particular field. Moving to the next phase require crossing of the critical juncture *opportunity recognition*. This involves a match between the invention and an unfulfilled market need.

The opportunity framing phase is related to the evaluation of the technology and the commercial potential. In this phase analyses on suitable markets, potential customers, competition and market potential are conducted. The result of this phase should be to find the commercial opportunity generating the highest return of investments. The critical juncture for entering the next phase requires *entrepreneurial commitment*.

The pre-organization phase is when strategic plans are developed and implemented. Strategic decisions are made regarding resources and capabilities now and in the future. This includes what resources and capabilities to acquire and develop, and how to access them. This is the phase that we expect the company to choose the first operative business model. If being able to acquire the necessary financial, human and social capital (cross the threshold of *credibility*), the firm will be able to move to the next phase.

The re-orienting phase present the stage when the venture is ready to offer some kind of value to the customer and generate returns. This phase requires different skills and resources than the previous phases, and the challenge is to be able to locate, acquire, integrate and reallocate the right resources. If the entrepreneurs show the ability to create value from the acquired and developed resources and capabilities, they should be able to cross the critical juncture of *sustainable returns*.

Sustainable returns phase is the final stage proposed by Vohora et al. (2004). In this phase the business is running well, and the technology or knowledge is part of the value offer. The company is now in a transition from being small niche player, to become a noticeable market actor. Normally it is during this phase that the company move from the presence of its parent organization to an incubator or a science park.

In this paper we will focus on the *Pre-organization phase* and the transition to *re-orienting phase* through the choices that are made in this period. It is in these stages that the RBSO need to decide how to create, capture and deliver value to the customer, hence create an operational

business model. According to the definitions of the stages, it is likely to believe that some companies need to adapt changes to their initial business model as they proceed towards the *Sustainable return phase*.

3 Method

3.1 Method of systematic literature review

The literature search was conducted in SCOPUS, and then in ISI Web of knowledge as a quality check, because these databases include the journals relevant to our search. We used search terms connecting RBSOs and other academic spin-off terms with business model related terms. Because of the heterogeneity of definitions for both spin-offs and business model, a variety of terms was used to ensure maximum coverage of relevant literature. Since the business model concept is closely related to strategy and consists of elements that can be discussed separately, terms such as strategy, resources and capabilities was included. A list of all the search words can be found in table 5 in Appendix. Rasmussen et al. (2012) was used as inspiration both for RBSO related search terms and methodologically as they conducted a very thorough study in the same context of RBSOs as this paper.

We conducted the search in Scopus with the code string found in Appendix A.1.1. This resulted in 2943 unique hits where most of the articles stem from irrelevant fields like medicine. A few of the abbreviations, like ASO, are also used in medicine and other disciplines. In addition, combined with common terms like *strategy* or *resources*, the search resulted in many articles of no interest. To narrow down and remove the articles from unrelated fields we restricted the search to the most relevant and highly ranked journals in academic entrepreneurship, as found by Rasmussen et al. (2012). The journals and code string can be found in Appendix A.1.1. This resulted in 88 articles. The same search was conducted in ISI Web of knowledge and resulted in no further articles.

The 88 articles were sorted manually by going through *title*, *abstract* and *keywords*. This screen-

ing was based on the following criterias:

- Main focus on the firm level
- Cover business model terms or related topics
- Mainly focused on RBSOs (or related definitions)

This manual screening process resulted in 39 articles, which was read in full text and analyzed according to our framework for dimensions of analysis, explained further in the next section.

3.2 Method of analysis

In order to assess how the literature covers the choice of business model for spin-offs, the 39 articles chosen as relevant from the literature search was analyzed through a framework with dimensions of analysis. These dimensions were *research approach*, *context*, *direct/indirect description of business model and drivers*, *business model definition/description* and *drivers for choice of business model*.

The first dimension, *approach*, is chosen to assess to validity and generalizability of the drivers through identifying whether the drivers are based on quantitative research, qualitative research or literature review. As a means of assessing how generalizable the findings of the analyzed articles are, as well as the relevance to RBSOs, the next dimension is *context*. Since not all articles use the term business model, an important part of the analysis was to identify and compare how the business model concept was described, either directly or indirectly, and how it was defined. Hence, the dimensions *direct/indirect description of business model or drivers* and *business model definition/description* are included. As the central part of the analysis was to identify drivers for the choice of business model, the last dimension was to identify and collect *Drivers for choice of business model*. The main reason for analyzing the context and the definitions used is to assess the generalizability of our findings. The dimensions of analysis and the reasoning behind these dimensions are described in table 2.

From the 39 articles, 12 articles were found to describe directly or indirectly a link between drivers and business models and forms the basis for the analysis and discussion of this paper. A

detailed and comprehensive description of our approach and tables of the results can be found in appendix A.

4 Analysis

4.1 Identified drivers for choice of business model

By analyzing the 12 selected articles (see table 7 in the appendix) a number of drivers that potentially will influence choices of business model was found. Several of the articles proposed drivers for choice of business model according to our definition without using the term business model. Conceicao et al. (2012) was the only article found that links drivers to a specific activity based business model type.

Drivers found are presented in table 3. These drivers were described in a variety of contexts, for example in the case of Bower (2003) who explores how business models are selected in the biotechnology industry. Some of the articles only briefly mention some factors that may influence the business model. One example is Zahra et al. (2007), who focus on how corporate and university spin-offs differ in performance, but also mentions that initial resources and parent organization rules will influence business model elements such as key resources later on.

4.2 Categorization of drivers for choice of business model

Our categorization of the drivers for choice of business model found in our sample is summarized in table 4.

In order to analyze the drivers for choice of business model in relation to the business model typology presented in section 2.2.2, the drivers were categorized. The basis for this categorization was to separate between internal and external factors, based on the propositions of Porter (1985) and Barney (1991) that firms are influenced from the inside (RBV) and outside (market based view). In terms of internal drivers, the classification of resources into financial, human and social capital (Ireland et al., 2003) fits several of the drivers we identified. Financial and human capital as drivers was found explicitly in

Table 2: Dimensions of analysis of articles found relevant in the literature search.

Dimension of analysis	Description/Reasoning	Purpose
Approach (methodology)	Research methodology used in the article. Important for assessing validity of our findings.	To assess validity of our findings.
Context	Institutional, geographic, market specific, technology or firm specific context in the article. The spin-off term and definition used is important factors	To assess the relevance to RBSOs in general.
Direct/indirect description of business model and/or drivers	Whether the article describes business models and/or driver for choice of business models directly or indirectly.	To assess how accurately the articles describe business model, the business model concept and drivers in relation to our definition. Will affect the accuracy of our findings.
business model definition/description	Which definition of business model the author uses, either explicitly or implicitly through related terms. Also which approach (elements or typology for instance) or which type of typology perspective.	To compare the definition and typology with ours as a measure of the relatedness to our research question.
Drivers for choice of business model (or related strategy)	The core of the analysis. Which drivers the author describes as affecting the choice of business model or related strategy concept.	Identify drivers that are directly or indirectly mentioned as influencing the choice of business model or business model elements.

Clarysse et al. (2000) and Colombo and Grilli (2005) and social capital was found as "contacts" in Druilhe and Garnsey (2004). Hence, the first category is labeled *Financial, human and social capital*. Drivers that were identified as internal drivers but not defined as financial, human or social capital was "The entrepreneur's ideas and intentions", "Perceived risk for founders", "Specific technology" and "Broadness of technology". The latter two drivers are both about the specific technology used by the firm to create value. Hence the second internal category is defined as *Technology characteristics*. The first two drivers are cognitive factors such as ideas and perception. These can be related to entrepreneurial mindset, which is a common topic in the research field of entrepreneurship (Shane, 2004; Ireland et al., 2003). Since the founders of the RBSOs are those that constitutes the internal mindset, the third internal category is defined as *Mindset of founders*. A starting point for categorizing external factors is the outside-in approach, based on Porter (1985), who emphasizes the role of the market and industry forces in competitive analysis. Hence, the market and industry should be an important part of external forces,

and the first external subcategory is defined as *Market and industry*. Window-of-opportunity and size of the domestic market was two of the drivers identified in this category. A central influencing factor on RBSOs is the parent institution they stem from. The parent institution's strong impact on RBSOs are described by several central authors in the academic entrepreneurship literature (Wright, 2007; Shane, 2004). Several of the authors in our sample explicitly mention the parent institution as a driver that influences the business model or related concepts. Thus, the second subcategory of external factors is *Parent institution*. External factors that are not from the market/industry or the parent institution are explicitly mentioned by one of the papers in our sample, Heirman and Clarysse (2004), as "environmental factors". They argue that macro-economic factors as well as socio-cultural community specific factors influence the resource base of RBSOs. These factors can be seen as environmental conditions that the RBSO operate in, hence we define the third and last category of external factors as *Operating conditions*.

Table 3: Drivers for choice of business model.

Drivers	Paper	Context
Perceived risk for founders, investors Timing of project. Change of markets and technology during development. Prior knowledge and experience of founders.	Bower (2003)	Biotech business model
Lack of resources and capabilities. Window of opportunity. The entrepreneurs' ideas and intentions.	Vohora et al. (2004)	RBSO development
Resource need. Entrepreneurs relevant knowledge/experience and contacts.	Druilhe and Garnsey (2004)	Activity based typology of ASOs
Human capital.	Colombo and Grilli (2005)	Growth of NTBFs
Technical, commercial and managerial skills.	Colombo and Piva (2012)	Academic NTBF performance
Environmental conditions. The specific technology. Career history and experience. Financial resources. Parent institute culture.	Heirman and Clarysse (2004)	Activity based typology of RB-SUs
Initial resources. Parent organization rules.	Zahra et al. (2007)	Performance of CSOs and USOs
Licencing possibilities.	Kollmer and Dowling (2004)	Licencing
Size of domestic market.	Autio and Yli-Renko (1998)	Growth of NTBFs
Broadness of technology.	Clausen and Rasmussen (2012)	Business model and innovativeness of RBSOs
Novelty of technology. Academic founders. Perceptions on appropriability. Patent protection. Parent patents.	Conceicao et al. (2012)	Drivers for market for tech. business model

Table 4: Categorization of drivers for choice of business model and some corresponding drivers from table 3.

Internal categories	External categories
Financial, human and social capital	Market and industry
Examples:	Examples:
Commercialization and management experience	Market evolvement
Technical and industry knowledge	Window-of-opportunity
Network	Size of domestic market
Financial resources	Effectiveness of patents
Technology characteristics	Institution
Examples:	Examples:
Broadness of technology	Parent institute culture
Novelty of technology	Parent institute rules
Mindset of founders	Operating conditions
Examples:	Examples:
Risk willingness	Environmental factors
Ideas and intentions	

5 Discussion

The categorization of the drivers will be used as a basis for the discussion. To understand the underlying logic of this choice the impact of each category will be discussed separately.

5.1 Internal drivers

Financial capital

Several authors in our sample mention financial resources through more general terms like resources (Vohora et al., 2004), resource need (Druilhe and Garnsey, 2004) or initial resources (Zahra et al., 2007; Heirman and Clarysse, 2004). None of these authors directly link financial resources to a specific business model type. A reason for this could be that financial resources are *instrumental* by having an indirect influence on the business model through enabling acquisition of other resources like physical assets and human resources.

To discuss how financial resources can influence the business model of RBSOs on its own, we distinguish between sufficient and insufficient financial capital. Sufficient financial capital is likely to enable the entrepreneur to choose the desired business model from the start (Ireland et al., 2003). If the entrepreneur have growth ambitions, sufficient financial capital will enable a high growth model.

Insufficient financial capital may force the founders to start up as a consultancy service to finance the technical development and then switch to a product based or TM oriented business model. This transition typically occurs when the technology is ready and the required funding is raised. This is observed by several authors (Druilhe and Garnsey, 2004; Heirman and Clarysse, 2004), and represents a transitional growth model. This transitional orientation of some RBSOs reflects a dynamic process of choosing business model, that in this case is driven by technical development results and availability of financial capital. Hence, insufficient financial capital may lead to a transitional growth model.

Summarized, financial capital drivers seem to influence the choice of business model in the following ways:

- Sufficient financial capital increases the RBSOs freedom of action to chose from the available business models.

- Insufficient financial capital narrows the freedom of action to choose from the available business models and may lead towards a low growth consultancy or TM oriented business model.

Human capital

Human resources will impact the ability to construct and combine resources (Brush et al., 2001). In addition, the human capital of RBSOs are characteristic in terms of having extensive technical, but often a lack of commercialization and management experience (Colombo and Piva, 2012). Nonetheless, Heirman and Clarysse (2004) and Colombo and Piva (2012) propose that the combination of technical, managerial and industry specific commercialization experience affects how and what kind of resources are acquired, and hence which business model to pursue.

Bower (2003) describes knowledge and experience as an important driver for choice of which business model and market to pursue within the biotech industry. Especially knowledge and experience in management and commercialization is mentioned as crucial for the choice of initial strategy. Another context where human capital is seen as an important driver is in the growth orientation of RBSOs, as investigated by Colombo and Grilli (2005). They propose that human capital affects the availability of venture capital and financial resources in general, and hence enables a high growth model. They also emphasize that growth abilities also depends on what *kind* of knowledge the RBSO possesses. Particularly, managerial and industry knowledge and experience was found to have positive effect on growth, while the effect of technical knowledge on growth was rather small.

Druilhe and Garnsey (2004) investigate how human capital affects the business model in terms of activity type. Different activity types requires different skill sets; previous experience with one or more of the models may lead to choosing similar types again because they have skill sets based on these models. As a result, Druilhe and Garnsey (2004) suggests a link between knowledge and a consultancy model:

For scientists engaged in pre-competitive research, the most suitable opportunity may be to provide "knowl-

edge services” on a consultancy basis to make use of the scarce knowledge they have that is valuable to customers (Druilhe and Garnsey, 2004, p. 271).

Conceicao et al. (2012) claims that if the founders do not possess any industry experience from the past, it is more likely that they pursue a TM oriented business model. Hence establishing a possible link between lack of industry experience and the choice of a TM oriented business model.

As mentioned in section 2.1, human capital changes dynamically with changes in the knowledge base. As a result, how human capital act as driver for choice of business model changes along with the development of the RBSO.

A summary of the drivers described as human capital will hence be:

- The presence of extensive human capital enables RBSOs to pursue high growth business models.
- Extensive technological knowledge and marginally entrepreneurial experience in the spin-off team lead the founders to choose consultancy as business model.
- Absence of industry experience in RBSOs directs the founders to choose TM oriented business model.

Social capital

Social capital is mentioned as an influencing factor for choice of business model by Druilhe and Garnsey (2004) and Vohora et al. (2004). Druilhe and Garnsey (2004) describe social capital through *contacts*, which they closely relate to relevant experience and knowledge and hence affects business model similarly as human capital. This is consistent with RBV in viewing contacts as a source of relevant knowledge and experience. Social networks may be an effective source of both tacit and explicit knowledge, hence give access to resources that can lead to sustained competitive advantage (as presented in section 2.1). Social network should therefore be highly important for companies evolved from a non-commercial environment where information asymmetry between industry/market and the academic surroundings force the spin-off to gain commercial knowledge.

Researchers that have built their career in the academia will most likely have personal as well

as professional network in academia. This network may not be particularly useful for business development purposes because individuals in academia probably lack relevant knowledge about the market (as also noted by e.g. Zahra et al., 2007). Hence they are less likely than other entrepreneurs to have a social relations to investors that may provide financial and human capital. Since founders of RBSOs mainly have academic backgrounds they will have reduced access to tacit and complex knowledge about the market. This may be a reason why RBSOs sometimes pursue low growth consultancy as their initial business model, to build a commercially oriented network that can be useful when shifting to a product-based model later on. Hence, a network of mainly non-commercial actors may be a driver for the choice of a transitional growth model.

Social capital in the form of network can also increase the likeliness of obtaining venture capital (Shane and Cable, 2002). In that sense, a relevant and large network may lead to financial capital, which again may be an enabling factor for choice of activity based and growth oriented model.

The following link to choice of business model has been found:

- Social capital enable the RBSOs to choose the business models available by the increased access to both financial and human capital. If the latter is not present, it could force the entrepreneurs to choose a TM oriented business model.
- Lack of social capital may seem to lead to a transitional growth model.

5.1.1 Technology characteristics

The RBSOs differentiate from other new ventures by more often being based on push technology. This means that these companies need to allocate both resources to develop the technology, and to make the market ready (Roininen and Ylinenpää, 2009). Hence, we expect technology characteristics to affect what kind of strategic opportunities the spin-offs are able to chose from, which is supported by Pirnay et al. (2003). Even though Mustar et al. (2006) claim that few studies have focused on technological characteristics, we found some interesting links to business model choice.

Conceicao et al. (2012) claims that start-ups exploiting push technology are more likely to chose TM oriented business models. Although they do not state why, we suggest the high level of resources required to teach the customer the new technology may be a barrier. TM business models may then be adapted since the RBSOs often do not have easy access to that kind of experience or resources. In addition, Heirman and Clarysse (2004) reports that RBSOs normally possess a patented technology, and this may influence a spin-off towards choosing a TM or product oriented business model as there are few incentives for starting a consultancy firm based on patents. The choice between product and TM may depend on whether the technology is close to market or novel. Product based business models are often chosen from those who possess close to market technology (Heirman and Clarysse, 2004).

Heirman and Clarysse (2004) also claims that broadness of technology attract venture capital and more experienced managers. Broadness of technology usually result in several market opportunities, hence attracts venture capitalists. Since VC is often related to growth, there are reasons to believe that broadness of technology leads the founders towards choosing a high growth business model.

If the technology stem from generic research, it is more likely to be a push technology (Druihe and Garnsey, 2004). This means that the spin-off sometimes need more time in the opportunity framing phase (section 2.3.2), and gain knowledge and revenue through consultancy or contract research (Mustar et al., 2006; Heirman and Clarysse, 2004). If the founders in addition have growth ambitions for the future they would adapt a transitional business model.

RBSOs that commercialize knowledge and skills that is not proprietary, tend to chose consultancy as business model. They are most likely to grow minimally or nothing at all (Heirman and Clarysse, 2004). These statements argue that consultancy correlate with low growth business model in the context of RBSOs, but may not be generalized since it depends on the founders ambitions and goals.

Thus, the following directions of influence from technology characteristics have been assessed:

- Highly innovative and novel technology seems to direct the founders to choose TM oriented business models. If the application area of the novel technology seems indistinct, the founders are more likely to commercialize their knowledge through consultancy, and later change to product business models (transitional growth).
- RBSOs that exploit opportunities through pull technology, seems to choose product based business models.
- Platform technologies increase the RBSOs window of opportunities, hence enable high growth business models.

5.1.2 Mindset of founders

Both Vohora et al. (2004) and Bower (2003) suggests that cognitive factors are important for choice of business model. Vohora et al. (2004) argues that the commitment of entrepreneurs is a critical juncture to proceed from opportunity phase to pre-organization phase, and plays a critical role in the initial business model creation. They do not, however, specify *how* these ideas and intentions affects the choice of business model. According to Shane (2004), some common motivations for starting RBSOs are wealth, status and a desire to bring the technology into practice.

Some entrepreneurs may be driven by the ambition of self employment, and may not desire any growth at all. Autio and Yli-Renko (1998) concludes from their survey of 392 NTBFs in Finland that most of the firms did not have growth as a key goal at all. Although intentions and motivation may be seen as an obvious influencing factors on the choice of business model, there may be different intentions of starting a business for RBSOs than for other start-ups. This difference is emphasized by Criaco et al. (2013):

[...] academics often create USU (university start-up) as a mean of continuing a line of research they are interested in or as a lifestyle company (Migliorini et al. 2010) targeted not at maximizing returns for its shareholders but at keeping their lead researcher status at the parent university (Vohora et al. 2004; Siegel et al. 2007). (Criaco et al.,

2013, p. 3)

Another cognitive factor mentioned in our sample is *perceived risk by founders and investors*, mentioned by Bower (2003) in the context of how biotechnology firms should choose business model and which applications to pursue. The willingness to take on a high risk may be associated with high ambitions, which may cause the entrepreneur to pursue business models with large potential financial upside, but also with a large potential downside. However, the perceived risk may lead to any model based on the risk preference of the founder, and perceived risk may be seen as an enabling driver.

However, if the risk *preference* of the founder is low, this may lead to a low growth consultancy model, as consultancy is the activity based model that is closest to research (Druilhe and Garnsey, 2004).

Perception of risk may also change while developing the firm and the technology as knowledge about the market and the technology is obtained and developed into capabilities. A proof-of-concept prototype that confirms or exceeds the expectations of the entrepreneurs may reduce their perceived risk. Hence the business model or elements of the business model might be changed as a result of knowledge acquisition and development of capabilities.

To summarize the founders mindset, the following direction of influence in terms of business model choice is:

- Founders mindset and motivation greatly influence the choice of business model. More precisely low risk preference leads the founders to choose low growth consultancy business models.

5.2 External drivers

The focus of the following three sections will be on the external driver categories *market and industry*, *institution* and *operational conditions*.

5.2.1 Market and industry

Do RBSOs tend to choose business models according to an *industry standard*? We found evidence of this in our sample. The RBSO *Genentech Inc.*

founded in 1976 is considered to have founded the biotechnology industry, and even before they had proven the technology they announced their strategy of becoming a fully-integrated human/animal healthcare company who would make and market therapeutics (Bower, 2003). According to our framework, we can classify their business model as high growth and product oriented. When Genentech went public in 1980 they had become *one of the key influences in the environment of other biotechnology companies* (Bower, 2003, p. 101). Their business model, referred to by Bower (2003) as the *Genentech model* had created an acceptance in the market and the spin-offs following them benefited from this acceptance and chose the same model. This is a clear example of RBSOs choosing a business model according to an industry standard.

As the biotechnology industry matured, the credibility of technical capability and the promise of a cancer cure ahead was not enough and a new model of the focused, specialist company emerged. The new model was to offer outstanding expertise in one step of the process. *Startup strategies have evolved to reflect this, and companies now more commonly present themselves as specialist niche operations with a limited number of problems to surmount in order to meet their objectives, rather than would-be integrated pharmaceutical companies* (Bower, 2003, p. 102). This shows that evolving markets change the industry standard over time, which again influence RBSOs choice of business model.

Conceicao et al. (2012) claim that the entrepreneurs' *perceptions* about the level of appropriability in an industry influence their choice of business model.¹ If the level of appropriability is high, RBSOs are more inclined to operate in the TM.

In their study of Finnish new technology based firms, Autio and Yli-Renko (1998) indicates that

¹The appropriability regime of an industry describes the ease of imitation. *Appropriability is a function both of the ease of replication and the efficacy of intellectual property rights as a barrier to imitation* (Teece, 2000, p. 19). When the technology is inherently difficult to replicate and the IP system can effectively provide legal barriers to imitation the level of appropriability is high. Assets can be the source of competitive advantage if there is a strong regime of appropriability or the assets are non-tradable (Teece, 2000). This aligns with the fundamental assumptions of RBV.

the size of the domestic market can be too small to make room for the growth usually associated with going international. They also point out that selling the company to a bigger company with existing international distribution channels can be a more feasible way to scale up the business and that a high potential for growth makes it more likely for the company to be acquired by a larger firm. Would this imply that the RBSOs with small domestic markets either go for a low growth business model to be able to survive comfortably in the domestic market, or a high growth model to attract potential buyers? The size of the domestic market thus affect the choice of growth oriented business model. RBSOs can be forced to pursue an international market already from the start as a consequence of a too small domestic market.

Hence, drivers within market and industry that have been discussed as affecting choice of business model can be summarized in the following way:

- A future window of opportunities in the market seems to lead the founders to choose transitional growth business models.
- RBSOs that experience high level of appropriability are more inclined to choose a TM oriented business model.
- Size of market restrict the growth of the RBSOs, meaning that small markets leads to low growth business models and the opposite.

5.2.2 Parent institution

As mentioned in the introduction there is a significant difference between other start-ups and RBSOs, namely the institutional origin of the latter. The academic mindset and entrepreneurial culture in the parent organizations are fluctuating or not even present at all, hence expected to influence RBSOs (Pirnay et al., 2003).

Clausen and Rasmussen (2012) states that TM oriented business models have a broad impact range on market, and consultancy contribute less in transferring the technology widely. Since policy makers empathize national economic growth, they would arrange more for companies that choose these kind of business models before others. The parent institutions need their employees for doing research, and may influence the founders to choose business models closer to their operation.

If there is a TTO at the institution, they would favorize the high growth business models leading to commercial success. This conflict of interests have raised the need for surrogate entrepreneurs, who are able to deal with the different stakeholders. The parent institution ability to attract, adapt and use surrogate entrepreneurs affect the possibilities for the spin-offs.

Further, we argue that parent institutions are potential great enablers by providing RBSOs with more choices through available resources and supportive initiatives. Initiatives like forming highly competent TTOs and create funds for pre-seed capital may enable RBSOs to develop their technology into something attractable for investors and venture capitalist. The parent institution may also affect the culture in a way that founders are more motivated and are allowed leaves of absence. If this is not present, we suggest that the institution may influence the founder to choose a TM oriented business models, and in some cases low growth business models. The question if the institution directly tend to influence towards one particular type of business model is still unanswered, but opens up to a highly interesting topic for further research. Nevertheless, from the above discussion we propose that:

- Parent institutions that are able to create a supportive environment for the spin-off increases the RBSOs freedom of choosing the business model desired by its entrepreneurs.

5.2.3 Operational conditions

External factors that are not from the market/industry or the parent institution are only mentioned by Heirman and Clarysse (2004). In their study on how RBSOs differ they state that [...] *the availability of venture capital, a strong entrepreneurial community and a massive influx of government funding impact the firms' access to resources (Saxenian, 1994; Roberts, 1991; Schoonhoven et al., 1990; Deeds et al., 1999)* (Heirman and Clarysse, 2004, p. 252). Hence by enabling access to financial, human and social capital, spin-off companies have more alternatives when choosing business model.

Policymakers and media influence the society, and in the end what is socially accepted or not. If

entrepreneurship is highly accepted and communicated in a positive way, researchers will be inspired to take the leap of commercializing their ideas. However, whether the RBSO founder chooses a consultancy, TM or product oriented business model depends on the motivation and other previously mentioned drivers.

A influx of government funding will affect the business model choice similarly as described for financial capital. Hence more high growth models and TM or product based models will probably be chosen. Since governmental funding in the end is controlled by political agendas, it may not be a neutral support. It is likely to believe that policy makers favorize employment and tax income increasing business models, as they contribute more to national economic growth. If true, this implies that it is harder to be granted governmental funding if pursuing a consultancy model, and especially if its growth orientation is low.

Other operational conditions that may affect the choice of business model is the natural environment, demographic, social structure and overall national and international economic structures and conditions. These are used as control factors in the study of Heirman and Clarysse (2004), hence their effect on RBSOs are controlled for but not investigated further.

Because of the enabling characteristics of drivers from environmental factors, it is hard to identify or establish any direct links to the choice of business models. There is little doubt that environmental factors have an impact on RBSOs, but this correlation, especially in terms of business models, seems to be a somewhat unexplored topic.

The following connections between drivers within operational conditions and choice of business models have been discussed:

- Environmental conditions may act as an enabler for growth orientation through financial government support and general entrepreneurial culture.

6 Conclusion and implications

6.1 Identification and categorization of drivers

We have identified and categorized drivers that may influence how RBSOs choose their initial business model by using a typology of business models based on activity type and growth orientation. As activity type and growth orientation are simultaneously pursued by RBSOs, this typology combination has shown to cover a broad range of business models studied in the literature.

Drivers for choice of business model proposed by the literature as leading to specific activity types (consultancy, product or TM) are found within financial capital, technology characteristics, market conditions and founders' mindset. Lack of financial, human and social capital, developing a push technology and low risk preference is proposed by the literature as drivers leading towards a consultancy or TM business model. Similarly, developing a pull technology, high risk preference may lead towards a product model.

The growth orientation of the business model (low, transition or high growth) is by the literature proposed to be directly affected by financial capital, human capital, technology characteristics, market conditions and founder's mindset. Lack of commercialization and management experience, and exploitation of push technology are proposed by the literature to lead to transitional growth. We anticipate that lack of social capital, and future window of opportunity may lead to transitional growth model, and that low risk preference among founders may lead to low growth orientation.

However, several of the drivers, as sufficient financial, human and social capital, act as enabling factors. These drivers enable the entrepreneurs of RBSOs to choose their desired business model. However, the choice may be affected by other drivers more directly towards a specific business model type, both activity based and growth oriented.

Our findings show that our proposed framework of categories (figure 3) is a promising tool for analyzing drivers of the choice of business model for RBSOs. As the definitions for both RBSOs and business models differ significantly in light of the

variety of contexts and topics used in the literature, it has been useful to investigate the drivers in separate categories.

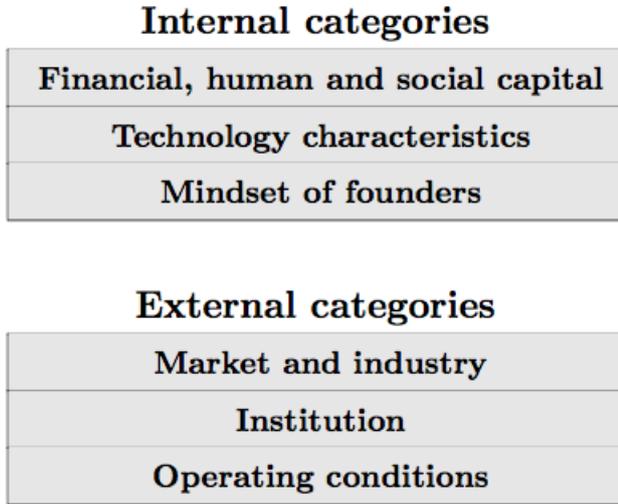


Figure 3: Categorization of drivers for choice of business model.

6.2 Change of business model

We have addressed drivers that influence the *initial* business model choice, but both Stankiewicz (1994) and Druilhe and Garnsey (2004) discuss how business models change over time. As mentioned earlier, resource base, capabilities, market conditions and environment are in constant change. RBSOs need to adapt to rapidly changing conditions by reconfiguring its resource base and its capabilities, explained with *dynamic capabilities* in section 2.1. Business models describe how resources are being used to create, capture and deliver value. Hence, business models will also be in constant change. As we showed in section 2.2, business models can be viewed both as a set of elements (Osterwalder and Pigneur, 2010) or as a combination of an activity and growth oriented typology. We suggest that it would be rational to adopt a dynamic view of business models with this typology. Every business model is unique in its structure, hence a change in business model would be the same as choice of a new business model. In the context of research it is easier to measure the business model as a static variable, as a point measure in time. We propose that our framework is useful also when investigating change

in business models over time.

6.3 Implications for RBSOs and policy makers

Human capital seems to play a central role in choosing business model. This may imply that entrepreneurs of RBSOs should be aware of what kind of knowledge and experience they possess, and make sure they have a combination of commercial industry experience, market knowledge and technical knowledge.

Choosing or designing business model is a dynamic process. The determinants for which business model to choose changes over time. Hence, the design and redesign of business model should be viewed as an indispensable learning process.

RBSOs are often supported by governmental funds through TTOs or seed funds. Although not directly investigated by the authors in our sample, policy makers can probably influence the choice of business model. If so, policy makers should then influence the choice of business model to models that maximizes value creation for society. This can for example be to give incentives to start up with a high growth model.

Lockett and Wright (2005) suggest that the technology transfer offices need to obtain the sufficient amount of business development knowledge and experience to support the spin-offs in their development. We have already addressed the importance for the founders to possess industry and market experience (social capital). TTOs need to provide sufficient knowledge, experience and financial resources so that the RBSOs are able to attract investors and venture capitalists.

6.4 Implications for further research

In this study, the literature on drivers for RBSOs choice of business model has revealed itself as a largely unexplored territory. An explanation may be the complex and dynamic nature of how and why RBSOs choose specific business model types. In our sample, Conceicao et al. (2012) is the only article that directly investigates drivers that affects RBSOs choice of business model, in this case drivers that leads to a specific activity type. A better understanding of the process that leads to a choice between various activity based and growth

based business models will be valuable for spin-off generation and academic entrepreneurship in general, as also supported by Druilhe and Garnsey (2004).

In addition, few authors in the entrepreneurship literature on RBSOs use the term business model. Instead, more general and traditional terms such as strategy, resources and capabilities are often used to describe how firms create, capture and deliver value or elements in this process. Considering the heterogeneity that exists in the definition of RBSOs as well as the business model concept in the entrepreneurship literature, this may be a significant source of confusion and prevent viable theory building. A literature review of how the business model concept is defined and described in relation to the various definitions and typologies of RBSOs would therefore be useful.

A frequently mentioned phenomenon in our sample in this study is that a low growth consultancy is often an initial business model before switching to a product based model later on (Heirman and Clarysse, 2004; Druilhe and Garnsey, 2004). This may have an effect on value creation for society because consultancy is a low growth business model. We suggest that lack of market knowledge, lack of financial resources, and intentions such as self employment may be drivers for this choice. An inductive longitudinal case study would give valuable knowledge on this topic, where the RBSOs should be studied over time to expose the dynamic development of the company. It would also be useful to view the drivers in relation to the stages the RBSOs are in to explore the dynamic effects, and we propose to use the stage framework of Vohora et al. (2004).

Most drivers found in this study are dynamic: their importance and impact change over time. This supports a dynamic view on business models. But the business model concept is often described in a static way (Mustar et al., 2006). A longitudinal study of how and why RBSOs change business models over time may contribute to a better understanding on how the different drivers for choice of business model change over time and how they influence each other.

Some of the categories we have used for the drivers in this paper seems to be particularly unexplored. Although resources are frequently men-

tioned as a driver for choice of business model, social capital seems to be an underestimated factor. According to RBV, social capital is an important factor for obtaining financial and human capital and should hence be an important driver for choice of business models as well. Another category that seems underestimated is operational conditions. These factors are important in the field of strategic management, but seems somewhat ignored in the literature on RBSOs. We therefore suggests further investigation on how social capital and operational conditions affect RBSOs choice of business model. Further, parent institution is addressed as an enabling driver, and we have not found indications on whether it influence directly on one or more types of business models. As indicated in section 5.2.2, this would be a interesting topic of research.

Finally, we have not investigated which business models that are most favorable in terms of performance. Which factors and drivers that lead to the optimal business model for RBSOs may be an interesting topic for further research. Another highly interesting topic is the effect of changes from one business model to another. More specifically, a study of how these changes may affect the likelihood of failing may provide valuable knowledge to RBSOs. Though knowledge on the effect of business model changes, these firms may be better prepared to make the right strategic choices.

7 Limitations

Since we are only using literature as empirical basis for discussion, the method of literature search is probably the greatest limitation. Because we conducted a specific literature search with limitations on journals proposed from Rasmussen et al. (2012), there is a chance that we excluded research that would be relevant to this paper, both in the field of RBSOs and other contexts. We also used the backward snowball effect to find other relevant literature through reference listings. It might be an uncertain method, since the starting point could be wrong (Jalali and Wohlin, 2012). Apart from using *business model*, *strategy*, *resources* and *capabilities* in the search term, there could be other words relevant to business model. Hence we may miss literature of interest. We have cho-

sen not to include generic literature that describe other startups like corporate spin-offs, possibly imposing limitations on our discussion and conclusion. A more described weakness and strength analysis of the method can be found in appendix A.

The drivers identified in our sample are mentioned in a variety of contexts. Some articles are focused on specific industries, geographical areas, or technologies. In addition, as described in section 2.3, the variety of spin-off related terms in the literature is large as well as the fact that many authors put different meanings in similar terms. Our perception of the relatedness to the general context of RBSOs as we define it may be an important source of error.

An important limitation of the findings in this thesis is that several of the drivers found in literature to have a link to a specific business model type is only found in one article. Hence the validity and generalizability of these drivers are constrained by the validity and generalizability of the findings in the article they are proposed.

Even though literature related to RBSOs are limited, strategic management literature represent huge topics of research. A more comprehensive literature review on these fields may have revealed theoretical contributions that would have increased our ability of making anticipated links between drivers and the choice of business model types.

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A Method

A.1 Article search

Since our topic has already been exposed to many years of research it is important to find and use the prior literature. Most of the literature was identified during our specific literature search, and others were recognized through references in those articles, commonly referred to as *backward snowballing* (Jalali and Wohlin, 2012). Research reviews are helpful, but do not cover all literature. Based on this it is necessary to search different databases for relevant literature. We decided to use both SCOPUS and ISI Web of knowledge to ensure quality. Both databases include highly relevant journals for our research question.

First we collected search terms, and then combined them so that we would include the most relevant expressions. Rasmussen et al. (2012) was an inspiration in our work since the article describes an extensive literature search method in the same context of RBSOs as us. This makes it highly relevant to look at for search terms and journals. Our research question address topics that are not extensively and often not explicitly covered in the current literature. To cover literature that mention drivers to choice of business model without expressly using the term business model, we added relevant search terms like *resources*, *strategy*, *capabilities* and *configuration*.

Table 5 shows a list of all words included in the search in a more comprehensive way than the complete code string.

A.1.1 The literature search

Our first iteration resulted in 2943 hits in SCOPUS.² Medicine, Engineering and Agricultural

²The search gave 2943 hits in Scopus. The code string used:

```
TITLE-ABS-KEY((RBSO* OR RBSU* OR NTBF* OR
USO* OR SBEF* OR ASO* OR "research based spin*" OR
"science based spin*" OR "academic entrepreneur*" OR
"faculty entrepreneur*" OR "scientist entrepreneur*" OR
"science based entrepreneur*" OR "university spin*" OR
"academic spin*" OR "new technology based spin*" OR
"university start*" OR "research based start*" OR "science
based start*" OR "new technology based start*") AND
("initial configuration*" OR "resource configuration*"
OR "business model*" OR "development capabilit*" OR
"start configuration*" OR capabilit* OR "resource*" OR
```

Table 5: List over all words included in the search.

Origin	Combined with
research based spin*	initial configuration*
science based spin*	resource configuration*
academic entrepreneur*	business model*
faculty entrepreneur*	development capabilit*
scientist entrepreneur*	start configuration*
science based entrepreneur*	capabilit*
university spin*	resource*
academic spin*	strateg*
new technology based spin*	
university start*	
research based start*	
science based start*	
new technology based start*	
RBSU, RBSO, NTBF, USO, SBEF, ASO	

and Biological Sciences was the three subject areas with most hits, 1748 hits in total. Obviously it was a requirement to narrow the search to find the relevant articles.

Rasmussen et al. (2012) has made a comprehensive search in the same field as this thesis. They first made a wide search and came up with 919 articles that was manually sorted. The resulting 127 articles' references was examined, and a list of the most cited journals was made. Since Rasmussen et al. (2012) already had made such a thorough method, we decided to use his list of journals in our search. Djokovic and Souitaris (2008) is a literature review on spin-offs from academic institutions that strengthen our decision. They sorted their literature search according to journals, and 4 of the most cited journals are included in Rasmussen et al. (2012).

The next step was to restrict the search with regards to journals. We based the selection of journals on the ranking made by Rasmussen et al. (2012), and added *Long Range Planning* to the list due to the journal's focus on busi-

```
"strateg*"))
```

ness models, something Rasmussen et al. (2012) did not consider. The second search was restricted to the following journals: *Long Range Planning, Research Policy, Journal of Business Venturing, Journal of Technology transfer, Technovation, Management Science, Strategic Management journal, R & D Management, Industrial and Corporate change, Small Business Economics, Entrepreneurship Theory and Practice, Administrative Science Quarterly, American Economic Review, Academy of Management Review, Organization Science, Academy of Management Journal.*

Our second iteration was more refined than the first, and applying the journal filter resulted in a list of 88 articles in total, a reduction from 2943 articles.³ The reason for such a dramatic decrease in numbers is the amount of irrelevant subjects, like medicine, that was included in the search without journal filter.

As a quality control an identical search was conducted in ISI Web of Knowledge. This did not add any relevant articles to the result from SCOPUS.

As a second quality check a second journal filter was applied. The previously mentioned journals was removed from the search, and a list of journals relevant to business model literature was added: *Long Range Planning, MIT Sloan Management Review, Strategy and Leadership, Thunderbird International Business Review, Academy*

³Journal filter gave 77 hits in Scopus. The code string used:

```
TITLE-ABS-KEY((RBSO* OR RBSU* OR NTBF* OR
USO* OR SBEF* OR ASO* OR "research based spin*" OR
"science based spin*" OR "academic entrepreneur*" OR
"faculty entrepreneur*" OR "scientist entrepreneur*" OR
"science based entrepreneur*" OR "university spin*" OR
"academic spin*" OR "new technology based spin*" OR
"university start*" OR "research based start*" OR "science
based start*" OR "new technology based start*") AND
("initial configuration*" OR "resource configuration*"
OR "business model*" OR "development capabilit*" OR
"start configuration*" OR capabilit* OR "resource*" OR
"strateg*")) AND EXACTSRCTITLE("Long range plan-
ning" OR "Research Policy" OR "Journal of Business Ven-
turing" OR "Journal of Technology transfer" OR "techno-
vation" OR "Management Science" OR "strategic Manage-
ment journal" OR "R & D Management" OR "Industrial
and Corporate change" OR "small Business Economics"
OR "Entrepreneurship theory and practice" OR "adminis-
trative science quarterly" OR "american economic review"
OR "academy of management review" OR "organization
science" OR "academy of management journal")
```

of Management Executive, Harvard Business Review, Business Horizons, Journal of Business Research The list of journals was generated based on readings from literature reviews and references in articles found in the second search. This search contributed only with one extra article from SCOPUS, which was not relevant, and no extra articles was found in ISI Web of knowledge. By this it is reasonable to believe that our second search was good enough to build the theoretical foundation of our topic of research.

The searches was conducted 22.10.2013.

A.1.2 Selection of relevant articles

All 88 articles was manually sorted by title, abstract and keywords, resulting in 39 relevant articles that is the basis for the literature review. To find the relevant articles from the list of 88, some criterias was established. In contradiction to Rasmussen et al. (2012) we do not want to exclude theory from before 1990. Our opinion is that early phase research need to be included as well as the latest, and otherwise we might exclude literature that is important for our field of research. The articles that deal with our specific topic will be selected by the following criterias:

1. Is the content relevant for research based spin-off phenomena (general analysis)?
2. Does the article discuss the company or the environment?
3. Does the article deal with the choice of business model, strategy or resources?

The articles selected for analysis through search and screening are presented by reference and title in table 6.

Table 6: Articles selected for analysis through literature search and screening criterias.

Reference	Title	Relevance
Bathelt et al. (2010)	A knowledge-based typology of university spin-offs in the context of regional economic development	Not relevant
Wright (2012)	Academic entrepreneurship, technology transfer and society: where next?	Not relevant
De Coster and Butler (2005)	Assessment of proposals for new technology ventures in the UK: characteristics of university spin-off companies	Not relevant
Goldfarb and Henrekson (2003)	Bottom-up versus top-down policies towards the commercialization of university intellectual property	Not relevant
Bower (2003)	Business model fashion and the academic spinout firm.	Relevant
Baglieri and Lorenzoni (2012)	Closing the distance between academia and market: experimentation and user entrepreneurial processes.	Not relevant
Mustar et al. (2006)	Conceptualizing the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy.	Relevant
Vohora et al. (2004)	Critical junctures in the development of university high-tech spinout companies.	Relevant
Druilhe and Garnsey (2004)	Do academic spin-outs differ and does it matter?	Relevant
Wright et al. (2004a)	Entrepreneurship and university technology transfer	Not relevant
Colombo and Grilli (2005)	Founders' human capital and the growth of new technology-based firms: A competence-based view	Relevant
Colombo and Piva (2012)	Firms' genetic characteristics and competence-enlarging strategies: A comparison between academic and non-academic high-tech start-ups	Relevant
Ganotakis (2012)	Ganotakis, P. Founders' human capital and the performance of UK new technology based firms	Not relevant
Doutriaux (1987)	Growth pattern of academic entrepreneurial firms	Not relevant
Heirman and Clarysse (2004)	How and why do research-based start-ups differ at founding? A resource-based configurational perspective	Relevant
Jong (2006)	How organizational structures in science shape spin-off firms: The biochemistry departments of Berkeley, Stanford, and UCSF and the birth of the biotech industry	Not relevant
Colombo et al. (2006)	In search of complementary assets: The determinants of alliance formation of high-tech start-ups	Not relevant
Zahra et al. (2007)	Knowledge conversion capability and the performance of corporate and university spin-offs.	Relevant
Kollmer and Dowling (2004)	Licensing as a commercialisation strategy for new technology-based firms	Relevant
Leitch and Harrison (2005)	Maximising the potential of university spin-outs: the development of second-order commercialisation activities	Not relevant

Continued on next page

Table 6 – continued from previous page

Reference	Title	Relevance
Autio and Yli-Renko (1998)	New, technology-based firms in small open economies - An analysis based on the Finnish experience	Relevant
Candi and Saemundsson (2008)	Oil in water? Explaining differences in aesthetic design emphasis in new technology-based firms	Not relevant
Colombo and Grilli (2010)	On growth drivers of high-tech start-ups: Exploring the role of founders' human capital and venture capital	Not relevant
Shane and Stuart (2002)	Organizational endowments and the performance of university start-ups	Not relevant
Clausen and Rasmussen (2012)	Parallel business models and the innovativeness of research-based spin-off ventures	Relevant
Lofsten and Lindelof (2005)	R&D networks and product innovation patterns - academic and non-academic new technology-based firms on Science Parks	Not relevant
Lockett and Wright (2005)	Resources, capabilities, risk capital and the creation of university spin-out companies	Not relevant
Lindelof and Lofsten (2003)	Science Park location and new technology-based firms in Sweden - Implications for strategy and performance	Not relevant
Karlsson and Wigren (2012)	Start-ups among university employees: the influence of legitimacy, human capital and social capital	Not relevant
Conceicao et al. (2012)	The commercialisation decisions of research-based spin-off: Targeting the market for technologies	Relevant
Wright et al. (2004b)	The formation of high-tech university spinouts: The role of joint ventures and venture capital investors	Not relevant
Clarysse et al. (2011)	The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship	Not relevant
Criaco et al. (2013)	"To have and have not": founders' human capital and university start-up survival	Not relevant
Ortín-Ángel and Vendrell-Herrero (2013)	University spin-offs vs. other NTBFs: Total factor productivity differences at outset and evolution	Not relevant
Smilor et al. (1990)	University spin-out companies: Technology start-ups from UT-Austin	Not relevant
Powers and McDougall (2005)	University start-up formation and technology licensing with firms that go public: A resource-based view of academic entrepreneurship	Not relevant
Dettwiler et al. (2006)	Utility of location: A comparative survey between small new technology-based firms located on and off Science Parks - Implications for facilities management	Not relevant
Lubik et al. (2013)	Value creation from the innovation environment: partnership strategies in university spin-outs R & D Management, 2013, 43, 136-150	Not relevant
Wood (2011)	A process model of academic entrepreneurship	Not relevant

By reading and analyzing the 39 articles in full text, 12 articles were found to be directly relevant to our research question and selected to form the sample that is the basis for the analysis section and discussion in this thesis. These article was selected based on the same criterias as when selecting the 39 articles based on title, abstract and keywords, as well as the criteria of directly or indirectly identifying or contributing to identifying drivers for choice of business model. An overview of the 12 articles is given in table 7

A.2 Assessment of the methodology

A.2.1 Critical review

Our literature search is imprinted by the time limit of the project. A more comprehensive search would have been favorable, but have not been done because the scarcity of time. Since we restricted the search to a selection of journals, the method might exclude other important research work in the field. Hence the use of Rasmussen et al. (2012) for choosing which journals to include represent a limitation of the literature search.

In order to reduce the amount of search results and to get more relevant results in terms of the research question, the literature search is limited to include literature on spin-off companies. However, there is most probably literature on start-ups in general that do not mention spin-offs explicitly, but still contain relevant findings for spin-off companies and our research question that is not covered by our search.

The literature search in this study was conducted in two databases, ISI and Scopus. These databases are known as the most relevant databases for literature on entrepreneurship and business in general, but there are still other databases that may include relevant material for our study. Hence, a search in other databases may improve the quality and completeness of the literature search. In addition, the literature search was limited to the title, abstract and keywords of the articles in the databases. By searching through the full text of the articles instead, the search result may include more relevant articles.

Another potential weakness of the method in this study is the use of search terms that are business model related. The words used to de-

scribe concepts that are relevant for business models are *strategy*, *resources* and *capabilities*. These are based on which words that are mostly used in the literature we have read on business model as well as our own perception of the concept. Hence we may have missed some words that may give more relevant hits.

A.2.2 Strengths

Although the use of the literature search method of Rasmussen et al. (2012) was mentioned as a limitation it is clearly also a strength. The comprehensive assessment of which journals that contains the most cited articles on spin-off companies is a quality assurance of the journals that we choose to focus on in our study. Another study that supports the use of specific search on the journals found by Rasmussen et al. (2012) is Djokovic and Souitaris (2008). In his review of 102 articles on RBSOs he listed the journals with, according to cited articles, in which the journals with the most cited articles are included in our literature search.

Focusing on articles from the journals with the most cited articles is in itself a quality assurance for the literature that is analyzed in this study. We consider these journals to receive the largest amount of articles on the relevant topic. ISI and Scopus is also a strength in terms of quality assurance of the articles because the articles contained in these databases are peer reviewed and hence must meet a certain standard.

The framework itself takes form as a table with the dimension as headers of each column. Each article to be analyzed is placed in one row in the table and the analysis of this article is conducted according to the topic or dimension in each column. This table, with the analysis of the 12 articles forming our sample is presented in table 3.

The identified drivers for choice of business model are presented in table 3 and categorized in table 4 in section 4 and further discussed in section 5.

Table 7: Articles found relevant for the research question, as presented in table 6

Reference	Approach	Context	Direct/Indirect	business model definition/description	Drivers for choice of business model
Bower (2003)	Case study. Phenomenon-driven	Biotechnology NTBFs from the US.	Direct on drivers, indirect on business models	As business strategy, and market strategy	Perceived risk for founders, investors. Timing of the project. Change markets and technology during development. Prior knowledge and experience of the founders.
Mustar et al. (2006)	Literature review	NTBFs in general	Direct	Typology and dynamic business model. Uses definition of Chesbrough and Rosenblom, 2002	Not mentioned
Vohora et al. (2004)	Case study of nine USOs from seven different UK universities.	USOs from top 10 UK universities, broad range of technologies	Indirect on business models	Not specified	Lack of resources and capabilities. Social liabilities. Window-of-opportunity. The entrepreneurs ideas and intentions
Druilhe and Gar-nsey (2004)	Case study of nine ASO from Cambridge university, UK	9 Different types of ASOs.	Direct	The activities of a company, how this is resourced, the way it creates value and how returns are to be realized.	Resource need. Entrepreneurs relevant knowledge/experience and contacts
Colombo and Grilli (2005)	506 Italian NTBFs	Italian NTBFs, manufacturing and service business.	Indirect	Element of business model	Human capital
Colombo and Piva (2012)	505 Italian NTBFs	Italian NTBFs, manufacturing and service business.	Direct	Distinguish between product/service business models, and high technology/R&D business models	Technical, commercial and managerial skills

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Table 7 – continued from previous page

Reference	Approach	Context	Direct/Indirect	business model definition/description	Drivers for choice of business model
Heirman and Clarysse (2004)	Empirical, quantitative study	99 RBSUs in Flanders	Direct on drivers, direct on business model-types	Typology: VC-backed, Prospectors, Product startups, Transitional start-ups	Environmental conditions. The specific technology. Career history and experience. financial resources. Parent institute
Zahra et al. (2007)	Quantitative and empirical	91 CSOs and 78 USOs, most high tech, some low tech, from USA	Indirect on drivers, indirect on business model-elements	Does not mention business model, but business model elements such as resources and activities	Initial resources, parent organization rules, Knowledge conversion capabilities
Kollmer and Dowling (2004)	Quantitative and empirical	Biopharmaceutical industry from USA	Direct on drivers, indirect on business models	Only licensing mentioned	Licensing possibilities
Autio and Renko (1998)	Survey from 392 NTBFs in Finland	New technology based spin offs in Finland	Direct on drivers, indirect on business model	Not specified	Size of domestic market
Clausen and Rasmussen (2012)	Empirical study of 82 young norwegian RBSOs.	Norwegian RBSOs, 2-7 years old	Direct	Dynamic and parallel business models. Definition: The activities of a company, how this is resourced, the way it creates value and how returns are to be realized.	Breadth of technology
Conceicao et al. (2012)	Hypotheses tested on 80 European RBSOs	80 European RBSOs from 6 countries	Direct on drivers, indirect on business models	Is looking at firms that operate in the "market for technologies"-type business model	Novelty of technology. Academic founders. Perceptions on appropriability. Patent protection. Parent patents. Incumbent control complementary assets

Cause and effect of business model transitions for research based spin-offs (RBSOs)

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Abstract

Research based spin-offs (RBSOs) have become an important way of transferring knowledge from research to commercial applications. However, by being born in an academic environment they differ in many ways from other new ventures. Without industry experience it may be difficult to survive in rapidly changing markets. Hence, understanding how to adapt to these changes through changing their business model will be important for policy makers as well as the entrepreneurs. In this study we have conducted a longitudinal analysis of why RBSOs change their business model and how changes in business model affects the likelihood of failing. Our sample included 84 norwegian RBSOs supported by the FORNY-programme. By using a mixed method approach, we found that financial capital was a dominant driver for changes between different activity based business model types. Unsatisfactory financial situation was in particular found to limit which model a firm may change to. In addition, we found that the likelihood of being discontinued was significantly lower for RBSO that had made a business model change compared to others. The framework for analyzing drivers for choice of business models proposed by Skarbø et al. (2014) has shown to be a useful tool in this study.

1 Introduction

Imagine you are a scientist at a university, conducting generic research to bring the world one small step further. By chance you recognize from yesterday's result that there is an indication of a new semiconductive material, far easier to control and produce. This could either be a huge opportunity to change the total semiconductor industry with your findings, or a total failure resulting in waste of effort, resources and time.

Starting a new venture based on novel technology or knowledge is not an easy task, especially not for researchers, who often lack commercial experience (Druilhe and Garnsey, 2004; Colombo and Piva, 2012). Answering questions such as how to turn the technology into a profitable product and what the customer need may demand both network and industry experience (Shane and Cable, 2002; Bower, 2003). Still, these are some of the questions *research based spin-offs* (RBSO)

have to deal with every day.

Transferring knowledge by starting new firms has become an increasingly common and important phenomenon as well as a topic of great interest among researchers in strategic management (Wright, 2007; Shane, 2004; Mustar et al., 2006; Pirnay et al., 2003). While RBSOs contribute to making new technology useful for society, others question the effectiveness of technology transfer by the means of spin-off companies (Lambert, 2003). Although only a few RBSOs contribute to increased economic growth and wealth (Wright et al., 2004), the risk of spending time and financial resources in vain is worth the attempt according to an increasing number of policymakers and scholars (Wright, 2007). Norway adapted the counter version of the Bayh-Dole Act in 2003 and an increased focus on spin-off generation and development has followed. However, Norwegian RBSOs do not seem to perform satisfactory in terms of growth compared to international cases (Bor-

laug and STEP, 2009). Being able to describe how RBSOs make strategic choices in their early years will be crucial for assessing how to maximize the effectiveness of technology transfer and wealth creation.

Heirman and Clarysse (2004) states the importance of dynamic change of firms, since dynamic processes lead to value creation and growth. Created value and growth are closely related to the firms business model, as this describes how a company creates, captures and delivers value (Teece, 2010; Günzel and Holm, 2013). The concept of business models has been used by practitioners for years, but has until recently been disregarded by academic researchers (Zott et al., 2011).

What kind of business model the companies choose in their early years has an impact on their future performance and how they survive in an rapidly changing environment (Vohora et al., 2004; Zott and Amit, 2007). Often business models are described in a static view, which will give a picture of a company at one point in time, without capturing changes and development. However, as firms are dynamic in nature, their business model will also be subject of dynamic changes (Mustar et al., 2006).

The business model of a firm can also be viewed as a choice made by the entrepreneurs or founding team. Thus, in order to choose the most suitable model, it is important to understand the underlying drivers for these choices. We define drivers as factors or causes that forces or directs the company to follow or not follow a distinctive type of business model. This paper builds on the literature review Skarbø et al. (2014), where internal and external drivers influencing the choice and change of business model were identified and categorized. The categorization of drivers was found to be a useful framework for analyzing business model choices. Hence, it is used in this paper to empirically analyze how and why RBSOs change their business model as well as the impact of these changes.

Financial capital is an essential resource for RBSOs, and found to be a strong driver for choice of business models (Skarbø et al., 2014). As a first step to assess our findings, we wish to further analyze how the financial capital affects RBSOs in terms of changing business model. In addition,

we wish to explore whether a change in business model influences the likelihood of failing by discontinuation of the firm. Hence, our research question is *How does financial capital affect a change in business model and how does a change in business model influence the likelihood of failing for RBSOs?*

Our sample consists of 84 RBSOs from a population of 475 Norwegian spin-off companies, selected through a thorough screening process. The data on each firm is unique in the context of RBSOs as it includes year by year information for each firm. This database is the foundation of our thorough analysis of annual reports and related media coverage of 100 firms. Hence, our research on this data contributes to a better understanding of how RBSOs develop over time. By tracking changes of the companies over time we aim to provide unique contributions to this particular field of research.

First, all relevant theoretical definitions for this research will be presented. RBSOs will be defined based on existing literature, and the two main perspectives of RBSOs' business model used in this paper will be presented. These are the activity based typology and the elements of the business model. Further we will describe how the drivers for choice of business model found in Skarbø et al. (2014) relate to the mentioned activity types and elements. Second, we will discuss theory and prior research that will result in three proposed hypotheses relevant for our research question. Further we will present the method used to sample and collect data, and how we used the data to test each hypothesis. The results from the hypothesis testing will then be discussed and compared to similar studies, one hypothesis at a time. Lastly, conclusions, limitations, and further research will summarize and assess the findings.

2 Theoretical background

Research on academic entrepreneurship has been dominated by a high degree of heterogeneity both in terms of definitions and context used by the scholars (Pirnay et al., 2003). This prohibits theory building and further development of this relatively new field of research. Although definitions of the term RBSO varies, several authors have

made considerable contributions for reviewing earlier definitions as well as proposing a general definition (Pirnay et al., 2003). Based on the work of Pirnay et al. (2003) and Clarysse et al. (2000), the definition of RBSOs in this paper is:

New firms created to exploit commercially some knowledge, technology or research results developed within a research institute (university, technical school, public R&D department).

For institutions and policy makers to maximize the value creation of publicly funded research it is important to understand how RBSOs transfer their technology or knowledge to the marketplace in products and services. This is described by the concept of business models. The general definition of business model is recognized by scholars as the heuristic logic in how a company creates, captures and delivers value (Günzel and Holm, 2013). However, the business model concept can also be viewed as a set of elements (Osterwalder et al., 2004) and as activity based business model types (Wright, 2007; Mustar et al., 2006).

Following the argumentations of Skarbø et al. (2014), this paper will be based on three types of activity based business models; product based, consultancy and market of technology (TM). Product based types represent firms that develop and offers a product to a market. In this paper we define consultancy models as representing both pure consulting firms and service providers, which is also used by Druilhe and Garnsey (2004). Companies with a TM model typically have a generic or novel technology which is not market ready. The

technology needs to be further developed towards a specific market application to be sold through licensing, technology sales, alliances or joint ventures (Conceicao et al., 2012).

Skarbø et al. (2014) also used growth oriented typology of business models, which is divided into low growers, high growers and transitional growers. The growth orientation is further defined as the intended growth, rather than the actual growth of the firm. Growth may be both in terms of revenue and employees.

An activity change is referred to as a change from one of the activity types to another. When the companies have changed one or more of the elements in the *Business model canvas* in figure 1 without changing the activity, we will use the term element change. This will for example involve a change in market segment or key partners in a way that clearly alter how the firm creates, captures and delivers value.

As firms can be viewed as bundles of resources (Barney, 1991), business models can be seen as a description of how the resources should be configured. Hence, resource based view (RBV) is a valuable framework to identify and explain the characteristics of RBSOs (Autio and Yli-Renko, 1998; Brush et al., 2001; Heirman and Clarysse, 2004). Capabilities are abilities, routines and skills to manage and coordinate the resource base and can itself be seen as an intangible resource (Grant, 1991). A firm's ability to reconfigure its capabilities as a response to rapidly changing environments are called dynamic capabilities (Teece et al., 1997). Because RBSOs often are based on novel technology in an international market, dynamic capabilities have become increasingly important for sustained competitive advantage (Teece and Pisano, 1994). In addition, every business model require a unique set of resources and capabilities (Zott and Amit, 2010), and a change of business model would then require presence of dynamic capabilities. Accordingly, we argue that RBV is the most adequate theoretical lens for this paper.

The importance of understanding the dynamics of spin-offs is also stressed by Vohora et al. (2004). They identified five steps in the life cycle of spin-offs. Two of these are highly relevant for the firms analyzed in this paper; *the re-orienting phase* and *sustainable returns phase*. Between each of the

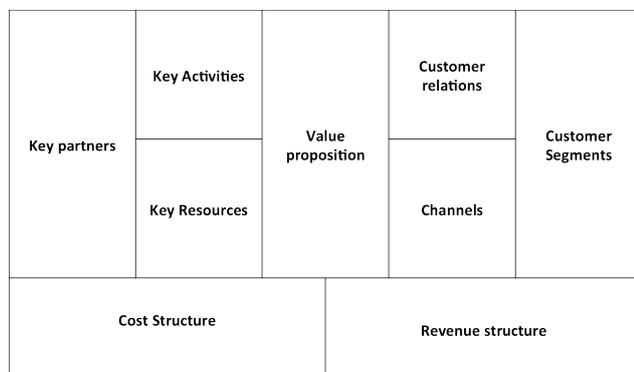


Figure 1: The Business model canvas, Osterwalder and Pigneur (2010).

stages there are critical junctures that needs to be overcome to move to the next stage. The RBSOs enters the re-orientation phase when overcoming the threshold of credibility, which involves forming a founding team and acquiring initial resources. The company is now offering value to a customer in order to generate returns. The critical juncture for moving from re-orientation to sustainable returns phase is the threshold of sustainability, which leads the company to gain recurring revenue. Although the phases represents new activities and resources, the process is not linear and involves iteration back and forth between previous phases. In order to analyze the behavior of RBSOs, the critical junctures and phases will be used in this paper.

2.1 Drivers for choice of business model

By reviewing the literature on business models and spin-offs, Skarbø et al. (2014) identified and categorized drivers leading to or enabling the choice of activity- or growth based business model types. The categorization of drivers for choice of business model types proposed by Skarbø et al. (2014) included three internal and three external categories of drivers and is presented in figure 2.

RBSOs with novel and advanced technology generally have a long time to market (Lofsten and Lindelof, 2005; Bower, 2003). To analyze a firm based on its position in an industry years before it has any sales in the market makes less sense than looking at its resources and how it can build capabilities to gain competitive advantage. Therefore we will analyze the RBSOs from a resource based view and thus look at the RBSOs' internal drivers. Financial resources are instrumental in the sense that they can be used to acquire other resources the firm needs and play a crucial role in the development of RBSOs (Brush et al., 2001; Wright, 2007). Thus it is relevant and important for all RBSOs. This is why financial drivers for the choice of business models are the main driver researched in this paper.

3 Hypotheses

In order to answer our research question, we will propose three hypotheses. The first hypothesis

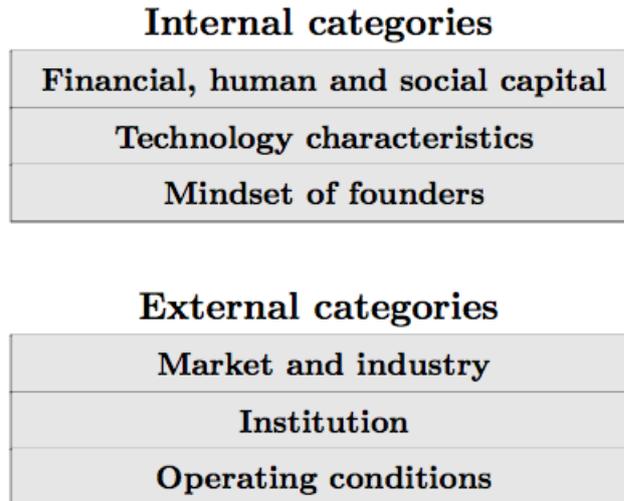


Figure 2: Categorization of drivers for choice of business model.

will treat the different types of activity based business model change and the associated drivers. In hypothesis 2 we propose that changes in business model are related to the financial situation of the RBSO. In hypothesis 3 we argue that change in business model can be used to overcome critical junctures and thus have an impact on survival.

3.1 Transitions between activity types

A change in one activity based business model to another can have six different combinations, as there are three different activity types in the definition we use. These combinations are:

- *Consulting to product*
- *Consulting to TM*
- *TM to consulting*
- *TM to product*
- *Product to consulting*
- *Product to TM*

One of these combinations, consulting to product, Skarbø et al. (2014) identified as a phenomenon called *soft starters* or *transitional growers*. Soft starters are RBSOs that start out with a consulting model while developing their product, both in order to gain experience and raise funding (Druilhe and Garnsey, 2004; Heirman and Clarysse, 2004). They differ from low growers by their *ambition* to grow at a later stage. This transition from a low growth consulting company to

a potentially high growth product oriented company, is characterized by a change in activity based business model.

Soft starters have gained attention in research on RBSOs (Heirman and Clarysse, 2004; Druilhe and Garnsey, 2004). Even though Stankiewicz (1994) states that firms may alter between the different activity types, there has not been focus on the other combinations of activity based business model changes. In their study of RBSOs, Conceicao et al. (2012) questioned companies about the source of their current and future revenue streams and 45% of the firms anticipated a different main source of revenue in the future. However, they do not provide any further details or rationale for this observation.

In Skarbø et al. (2014) it was found that financial capital may act both as an enabler and as a direct driver for choice of business model. Insufficient financial capital tend to constrain the possible choices of business models for RBSOs, and typically lead to the choice of lower growth oriented models. In terms of activity based changes, this should generally result in changing from product to either consultancy or TM because product development is resource demanding (Druilhe and Garnsey, 2004). Product companies are also generally more capital intensive than TM and consulting (Druilhe and Garnsey, 2004; Heirman and Clarysse, 2004). Depending on the technology foundation (type, maturity etc.), TM and consulting can be more or less capital intensive than the other. Hence, a change from consultancy to TM could be caused by a financial driver both as enabler and constrainer, and vice versa for a TM to consultancy change. A constrainer possibly prohibits the choice of a desired business model (Skarbø et al., 2014). Access to financial capital enables the firm to choose a more resource demanding business model if desired by the founders. This implies that changes from TM to product is also likely to occur. Hence we propose that all types of activity transitions should be present among RBSOs.

Hypothesis 1a: All combinations of activity based business model change is represented among RBSOs.

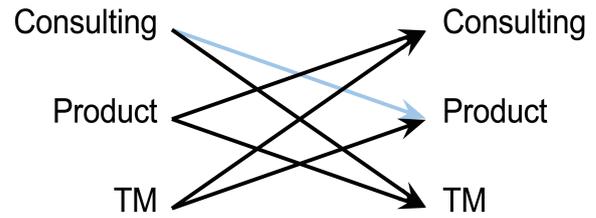


Figure 3: Transitions between activity based business models, soft starters in grey.

Furthermore, as financial capital can act both as an enabler and constrainer for the choice and change in business model, it plays a role in transitions from a high growth to a low growth model as well as the opposite (Skarbø et al., 2014). For RBSOs, the three activity types consultancy, product and TM is generally regarded as having different growth orientation. There are generally more product oriented companies among high growth RBSOs, while consultancy orientation typically represents the low growth companies. Hence, transitions from one activity type to another often involves a change in growth orientation, which implies that financial capital should play a role in all transitions between different types of activities. Thus we propose that financial capital will be a driver for all activity based transitions of business model, either as an enabler or a constrainer.

Hypothesis 1b: We expect to find financial drivers as a constrainer in changes from product to TM or consultancy, as an enabler from TM or consultancy to product and both enabler and constrainer between TM and consultancy.

3.2 Financial situation as driver for change in business model

An important element of the business model of a firm is its key resources. As financial capital is instrumental by being used to acquire other resources, the business model and financial situation of an RBSO are highly related. Skarbø et al. (2014) proposed that financial capital can act both as an enabler and a direct driver for the choice of

business model. Sufficient financial capital will enable the entrepreneurs to choose the desired business model (Wright, 2007), which may again be determined by the ambitions of the founding team or the industry standard for instance. On the other hand, insufficient financial capital can direct the founders to adapt changes in order to secure funding, and through this prevent the company from maximizing the growth potential available. Accordingly, inadequate financial resources may act as a constraint to which business model the firm can adopt.

The importance of financial capital to cross critical junctures in the development of RBSOs is stressed by Vohora et al. (2004). Especially in threshold of credibility, availability of financial capital plays central role, as it enables acquirement of crucial resources: *During this pre-organization phase, a key imperative is raising sufficient financial resources (seed finance) with which to acquire other necessary resources* (Vohora et al., 2004, p. 164).

Kirwan et al. (2006) presents a framework of the needs for new technology based firms, and amplifies the importance of financial capital in all development phases. If not present, the companies will experience certain constraints that eventually will slow down the growth of the firms (Colombo and Grilli, 2005). Financial resources enables acquirement of other resources, it affects the resource base of any new venture (Brush et al., 2001; Ireland et al., 2003). Financial capital can enable and attract human capital that could transform into intangible assets, which may contribute to sustainable competitive advantage (Barney, 1991).

Skarbø et al. (2014) found that financial capital affects the choice of the initial business model, and we propose that this holds through the evolvement of RBSOs. Thus, we propose that changes from one business model to another will also be driven by the financial situation of the firm.

H2: Changes in business model are dependent on financial situation.

3.3 Business model change and effect on likelihood of failure

Hypotheses 1 and 2 are focused on drivers for change of business model. Another highly rele-

vant topic is what the consequence of a change in business model would be. According to Zott and Amit (2007), the choice of a suitable business model has a crucial impact on the performance of new ventures. Every business model determine the resource need and how they are combined and used in a unique way to create, capture and deliver value (Zott et al., 2011). A change in business model therefore results in a new combination of resources and capabilities, and this change demands effort from the firm in the form of human and financial resources. Another factor that may cause the change to be resource demanding, is *structural inertia*. The latter can be explained as *an organization's inability to enact internal change in phase of significant external change* (Gilbert, 2005). As a result, a change in business model may increase the likelihood of the firm being discontinued, as proposed by Hannan and Freeman (1984).

However, the ability to adapt to rapidly changing environments (e.g. market changes), and restructure the companies resources represents dynamic capabilities. A reorganization of resources demanded by a change in business model may also be a result of dynamic capabilities, which are highly important for the performance of RBSOs (Teece et al., 1997). Changes in business models can hence be a tool for overcoming the critical juncture to enter the sustainable returns phase. This is also proposed by (Vohora et al., 2004, p. 159): *In arriving at this phase of development (the sustainable returns phase), the USO will have addressed many of the early uncertainties via the resolution of its precise business model*. In addition, financial capital is one of the critical resources in order to maintain the companies strategic entrepreneurial ability, and gives the necessary slack to seek and exploit new opportunities.

New ventures that fail to reach the sustainable returns phase will fail to generate sufficient sales revenue and will eventually have to be discontinued or iterate to a previous phase. As the sustainable returns phase requires re-combination of resources, changes in business model should increase the likeliness of an RBSO to reach this phase and survive. We argue that dynamic abilities serve the companies to become successful stronger than the negative effect of resource requirements. Conse-

quently, we propose that RBSOs that change their business model are less likely to be discontinued than RBSOs that do not undergo a change.

H3: RBSOs that change their business model are less likely to be discontinued than those who do not.

4 Data and methods

To get a better understanding of RBSOs we will apply a mixed method approach when investigating the hypotheses, in this manner we will answer questions from more than one perspective. (Creswell et al., 2003, p. 212) has defined mixed method as:

A mixed methods study involves the collection or analysis of both quantitative and qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research.

The qualitative and quantitative results may be divergent or contradictory and thus lay the foundation for extraordinary reflection compared to using either qualitative or quantitative data. A qualitative review of all the companies was conducted to collect data. When conducting the reviews we noticed cases that made decisions where financial constraints clearly was a driver. This further strengthened our motivation to investigate financial drivers for choice of business model and the impact quantitatively.

Hypothesis 1 was analyzed qualitatively, while hypothesis 2 and 3 were analyzed quantitatively, and the interpretation of the data is brought together in the discussion. This way we can look at both causal description and causal explanation. The robustness of our quantitative analysis is strengthened by the mixed method approach. The knowledge we gained about the variables in the qualitative review of the RBSOs is a strength in the quantitative analysis. Our method is called a concurrent triangulation strategy, where there are two concurrent data collection phases and where data is integrated during the interpretation phase (Terrell, 2012). How we do this will be further described in the following sections.

4.1 The context: RBSOs in Norway, funded by the FORNY-programme

The FORNY-programme was established in 1995 to support commercialization of publicly funded research in Norway. The general objective of the programme is to increase wealth creation in Norway through commercialization of research based business ideas (Borlaug and STEP, 2009). In the beginning, 1995-2003, FORNY was operated through "commercialization units" (CU) at research institutions in Norway, targeting researchers at universities, university colleges, research institutes and university hospitals. After new regulations in 2003 where universities and university hospitals were entitled ownership in ideas originating from research and ideas by employees, Technology Transfer Offices (TTOs) were established at the universities and affiliated with the FORNY-programme. These took over the tasks of the CUs, and over a period of a few years the CUs were phased out. There are currently seven TTOs affiliated with the FORNY-programme (Rasmussen et al., 2012). The TTOs specialize in supporting researchers to go from idea to business. Most of the TTOs in Norway are jointly owned by the research institutions.

The FORNY-programme supports ideas from all public funded research in Norway. As the TTOs register all ideas from the research centers employees, the FORNY-programme enables an overview of all RBSOs established in Norway from the beginning of the programme. Those RBSOs that are established by students who commercialize technology or knowledge developed without involvement of employees are not included in the FORNY-programme.

The FORNY-database of RBSOs is regarded as a representation of the population of Norwegian RBSOs. The database is not limited to certain geographic areas in Norway nor an industry. The firms in the database are typically high tech companies within ICT, Medtech/health and energy sectors (Borlaug and STEP, 2009).

The list of companies and the available data about the companies in the FORNY-database is unique in an international setting, as this amount and type of data is not readily available in other countries.

4.2 Data collection

Our data collection is part of a comprehensive research initiative at the Norwegian University of Science and Technology (NTNU) and Bodø Business School and is structured in *three* steps.

The database contains publicly available information on all FORNY-supported firms. This information comprise of annual reports and media coverage. In Norway, all private companies are obliged to deliver an annual report including, but not limited to, information on income statement, balance, cash flow statement, the nature of business, subsidiaries, R&D activities and going concern assumption (*Norwegian Accounting Act, d 3*). Annual reports are made publicly available after submission. In addition, information about the RBSOs from media coverage was collected through an extensive search in Retriever¹, covering both print and online media. This information was collected as a part of a previous evaluation of FORNY, and made available to our research team.

First step was to select the sample and collect and structure the data. The annual reports in Norway from before 2000 are not yet digitized, thus companies established before 2000 were not included due to the limited access to the annual reports. It is not uncommon for spin-offs to take more than ten years before their growth rate begins to accelerate (Lawton Smith and Ho, 2006). Hence, consistent data over a long period of time is essential to study the development of business model. This is why we chose to focus on companies established in 2000 to 2003, as they contain more historical data. The 100 firms in our sample were randomly selected within this timeframe to ensure a representative sample of the total population of 475 RBSOs, with controls from 2004-2012. Table 1 shows the distribution of companies in the population based on the year of establishment.

The database for analysis is based on an Microsoft Office Excel template for organizing the data of each firm. This template was developed by the research group, in an iterative process. To ensure consistency of the data regardless of which team member extracted the data, an initial test was conducted. Three members of the

¹Retriever is the largest news search engine for the Nordic region, covering both print and online media. See www.retriever-info.com.

team coded the same company, then the resulting files of data was compared. The template is designed for input information from the database of the companies' annual reports and media coverage. In addition, Brønnøysund Register Centers web pages² was used to gather information on establishment date, board changes, emissions and changes in CEO.

The coding template consists of three parts. One page with general information, a summary of the qualitative data and any unexplained issues and key variables. A second page with information on the legal entity with dates and information of important events. The third page is a thorough year by year review of the annual reports with information on R&D activity, customer sales, financial status and change in activities/nature of business. In addition, a complete list of up to the ten largest owners were recorded every year. In order to ensure that all changes in business models were identified and registered, the definition of a business model change in the template was defined as a change in nature of business. It is a legal requirement to state among others the nature of business in the annual report, and consequently a change from one year to the next would be discovered.

The team of qualified master students and PhD candidates registered all relevant information in the outline from the 100 companies founded between 2000-2012. Every outline was quality assured by one of the PhD candidates in the research team at NTNU. With our sample, this added up to more than 900 annual reports coded by the team.

The *Second* step of our data collection was to ensure that all companies in our sample were RBSOs by our definition. All the 100 cases were manually reviewed to check if they complied with the definition of RBSO presented in this paper. When information was not available in the database, TTOs or research centers were contacted to verify the origin of the companies. Eleven companies were removed because they were either corporate spin-offs or other new ventures that were outside our RBSO definition. As a result, the sample size was reduced from 100 to 89 companies.

In the *third* step, the initial activity based business model of all firms in the sample was analyzed.

²www.brreg.no

Table 1: Distribution of companies selected from 2000-2012

Established	2000	2001	2002	2003	2004	2005	2006-2012
Coded	14	29	19	14	5	8	11
Not coded	11	6	12	9	14	27	180
Total companies	25	35	33	22	19	35	191
% coded	56%	83%	58%	64%	26%	23%	6%

We have interpreted the dominant activity based business model element, from what the companies report in their provided annual report. All firms registered with "yes" or "unknown" on changes in the variable *nature of business* was re-assessed to conclude on whether a change in business model had occurred or not. The definition of a business model change we used was either a change in activity type (consulting, product or TM) or a change in one or more of the elements in the business model canvas. The latter, an element change, was further defined as a change in one or more elements that indicates a clear change in how the firm create, capture and deliver value.

For five of the companies assessed in step three we were unable to come to a conclusion. As an inconclusive measure of business model change would represent a source of error when testing the hypotheses, these firms were removed from the sample. However, firms were not excluded if one of their business model changes was concluded to be valid. During the third step five more companies were removed and 84 RBSOs represent the sample size used in this study.

4.3 Method of hypothesis tests

As the hypotheses was tested separately with different approaches, the method for each test will be presented separately. H1a and H1b was assessed by a qualitative approach and will be presented first. H2 was tested with a chi-square test and H3 by binary logistic regression. These tests and the variables used will be further explained in each respective method presentation.

4.3.1 Method for investigating H1

To test hypotheses 1a and 1b, a qualitative approach was used because the number activity based changes in the sample was relatively small (16 activity transitions). In addition, the assessment of whether a change was influenced by financial capital as an enabler or constrainer required a qualitative examination of the firms. All RBSOs with one or more changes in activity based business model was used for testing hypothesis H1a and H1b.

During the third step of the data collection, all changes in business model was characterized as an activity or element change. An activity change represents a transition from one activity type to another. As previously mentioned, these transitions may have six different combinations: *Consulting to product*, *consulting to TM*, *TM to product*, *TM to consulting*, *product to consulting* or *product to TM*. H1a was supported if all combination were present in our sample.

All activity changes were further analyzed to assess the reason for changing activity, based on the statements in the annual reports. The framework of Skarbø et al. (2014) was used to describe these influencing drivers for the transition. All drivers described as financial capital, was then assessed as either enabling or constraining. H1b was supported if financial capital was represented as a driver for change in activity type in all six combinations of activity transition as well as being found as both enabler and constraining driver in the overall sample.

4.3.2 Method of testing H2

To test H2, a quantitative approach was chosen to enable a generalizable estimate for the population.

Table 2: Variables used for test of H2.

Type	Variable	Attributes
Dependent variable	business model change event	yes = 1, no = 0
Independent variable test 1	Satisfactory financial status 1*	yes = 1, no = 0
Independent variable test 2	Satisfactory financial status 2**	yes = 1, no = 0

*Satisfactory financial status same year as change.

** Satisfactory financial status same year and year before change.

As H2 proposes that changes in business model are dependent on financial situation, the null hypothesis, H_0 , for testing H2 is *business model changes occur independent of financial situation*. The sample for testing H2 was each year of operation reported from all 84 RBSOs, which represents 755 years in total. A Pearson’s chi-square test was chosen for testing H_0 , as the relatively large sample size provides a good basis for accurate results from a chi-square test.

Two separate tests for H2 were conducted by testing each of the independent variables in table 2. This was done in order to compare the impact of having sufficient financial capital the same year as the change in business model against sufficient financial capital the year before as well as the same year. The reason for this comparison lies in the nature of the historical data on each firm. In our sample, each year of the RBSO from establishment to 2012 or discontinuity was coded with data on financial status and whether a change in business model had occurred or not. However, the effect of financial situation will vary depending on if the business model change occur early or late in the fiscal year. To exemplify, a change of business model early in the year may cause financial havoc, which would be reported in the annual report. But in that case it would be a *result* of the change rather than the driver. In order to solve this issue, we decided to perform two tests. The first test compare each year’s financial situation against a business model change or not. The second test analyzed the financial situation in two-year periods and checked for business model change or not.

Thus we should be able to assess the effect of financial situation on business model change in a process perspective.

Table 2 shows the variables used to test the null hypothesis of H2. The dependent variable *business model change event* represents a change in business model one year in the sample, as described above. The independent variable *satisfactory financial status 1* is the financial situation the same year as the dependent variable is registered. Furthermore, the independent variable *satisfactory financial status 2* represents the financial situation the year before as well as the same year as *business model change event*. As shown in table 2, a value of 0 in each of the independent variables represent insufficient financial capital. We defined the latter as a lower equity than the share capital or equity lost. This information was collected in step three of the data collection, and is assessed by analyzing the statement and balance sheet each year from each of the RBSOs. A value of 1 for each independent variable thus involve a larger equity than share capital.

The test of independent variable 1 included 755 years. As the test of independent variable 2 involved data from the year before business model change was coded, this sample did not include the first year of operation of the RBSOs. Hence the sample size for test two included 671 years, regarded as events.

When a company contained a year of unknown business model change, the year was treated as “no” in the dependent variable. Accordingly, this will lower the likelihood of an overrepresentation of business model changes.

The chi-square tests were conducted through bivariate cross tabulation between *business model change event* and the independent variables 1 and 2 respectively. P-values below 10 % were considered as significant dependency, resulting in rejection of H_0 . The cross tabulations are presented in table 8 and 9 in section 5.3.

4.3.3 Method of testing H3

Binary logistic regression was used to test hypothesis 3. This was chosen as the dependent variable *Business model change* is binary, and because of the possibility to control for other variables. H3 proposes that RBSOs that change their business

Table 3: Variables used in test of H3

Type	Variable	Attributes
Dependent variable	Discontinued	yes = 1, no = 0
Independent variable	business model change	yes = 1, no/unknown = 0
Control variable	Age	Number of years
Control variable	Software	yes = 1, no = 0
Control variable	Biotech	yes = 1, no = 0

model are less likely to be discontinued than those who do not. Hence the null hypothesis, H_0 , for testing H3 is that *the discontinuation of RBSOs is independent of change in business model*. The sample for testing includes all 84 companies in the sample. The variables used in the regression is presented in table 3.

Discontinued is the dependent binary variable assigned 1 if the legal entity of the company have been discontinued because of other reasons than acquisition, and 0 if the company was still operating in 2012 or have been acquired. The reason for rating acquired firms as not discontinued is because being acquired is commonly regarded as a success. Hence the variable discontinued can be interpreted as a measure of failure. This is consistent with the definition of failure in several studies related to RBSOs (Criaco et al., 2013; Cressy, 2006)

The independent binary variable *business model change* is assigned 1 if a company have reported one or more business model changes in elements or activity type, and 0 if not. *Business model change* is tested against *Discontinued* and H_0 is rejected within a 10% significance level.

The control variables used to test H3 are *Age*, *Software* and *Biotech*. *Age* is defined as the number of years the legal entity of the RBSO has existed from its year of establishment until 2012. Higher *Age* of the RBSOs is expected to increase the likelihood of business model change because the company then may have overcome more phases and critical junctures, which each require a change in resource and capability base (Vohora et al., 2004). In addition, for new ventures, the chances

of failure first increases steeply and then descend gradually to reach a small long run failure rate. This may be explained by the impoverishment of initial financial resources because of unsuccessful market strategies and subsequently increased human capital (Cressy, 2006).

RBSOs being based on software or biotech may differ largely from each other in several ways. In the variable biotech, both biotechnology and pharmaceutical RBSOs are included. These firms differ from other new ventures because of the large potential returns, but at the same time high risk caused by scepticism, ethical issues and resource demanding development (Bower, 2003). Because of the large requirement for testing and verification, these companies need more time and resources to commercialize technology than other RBSOs (Mustar et al., 2006). Software, on the other hand, represent RBSOs that Druilhe and Garnsey (2004) identify as generally less resource demanding companies to develop. They may also differ from each other in terms of likelihood of changing business model or being discontinued, hence should be controlled for in the test of H3.

To assess the robustness of the logistic regression we tested for multicollinearity by analyzing the correlations and variation inflation factors (VIF) between all variables. An upper threshold of the VIF score is commonly accepted as 10 (Freund et al., 2006). Similarly, the upper limit for acceptable correlation coefficients is 0.8 in absolute value (Field, 2009). The correlation matrix is presented in table 11 in section 5.4. In addition, the fit between the observed data of the variables in the regression was assessed by observing the pseudo R^2 values Cox & Snell R^2 and Nagelkerke R^2 . An increase in these values when introducing the control variables confirms that the control variables contributes to a better fit of the resulting regression model.

5 Results and discussion

In this section we will first present descriptive statistics for our sample with comparisons to similar studies. Then the results from testing the hypotheses will be presented and discussed separately. Lastly, the results of all hypothesis test is summarized in table 13.

5.1 Descriptive statistics

The sample consist of a variety of different companies, both in industry and lifespan. Figure 4 show that the sample includes a broad specter of business areas but medtech/health and ICT represent the most frequent industry. The spin-offs originate mainly from the research environment from the region around Trondheim and Oslo, and some from other areas like Kristiansand, Stavanger, Bergen and Tromsø.

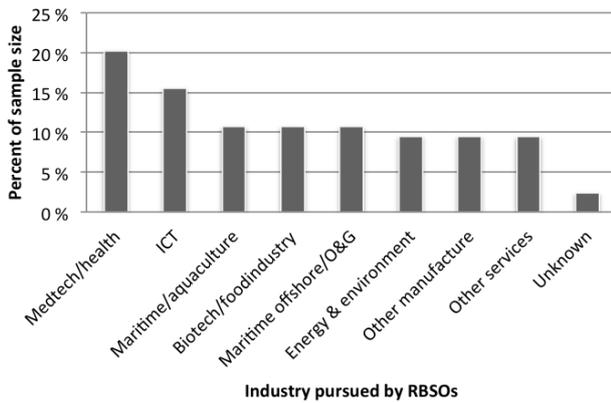


Figure 4: Industry distribution of the sample.

Compared to similar research projects like Colombo and Piva (2012), Smilor et al. (1990), Clarysse et al. (2000), and Conceicao et al. (2012) our sample differs. Most of the latter articles concerning European companies report high frequency of biotech, medtech and software. What distinguishes Norwegian spin-offs in industry focus is the share of maritime/aquaculture and maritime offshore/O&G. Aquaculture in the terms of salmon breeding and maritime industry related to the Norwegian commitment in the shipping and oil and gas industry. Aerospace industry is not present in our sample, and differs from some other countries in Europe such as Italy (Colombo and Piva, 2012). The difference in distribution could be due to various reasons. As most of the researchers use different definitions of RBSOs, different types of parent institutions are included/excluded. What kind of core knowledge the parent institution possess and their direction of research will affect the technology/knowledge RBSOs exploit. Also, the industrial configuration established around the research environment as well as the national industry structure influences

the particular need for research and innovative solutions.

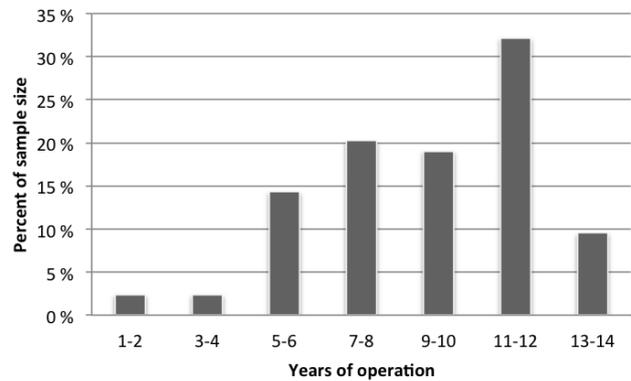


Figure 5: Distribution of years of operation.

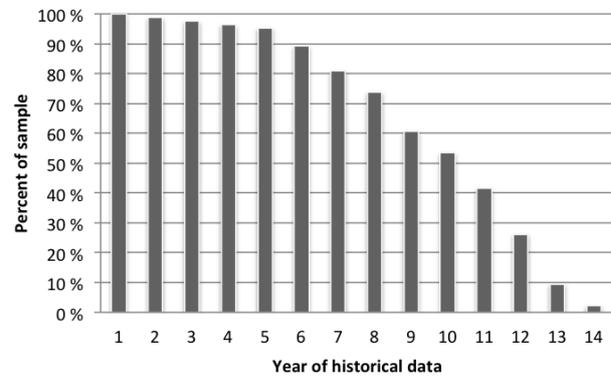


Figure 6: Historical data of the sample.

Figure 5 show the distribution of the companies in terms of how many years they have operated. About 32% of the companies in our sample has 11-12 years of operation, and only a few lived for 1-4 years. According to figure 6, about 72% of the sample contain at least 8 years of historical data. This illustrate that our sample includes extensive data from the first 8 years of the companies' life-cycle. 24% of the companies failed and were discontinued. 13% of the companies were acquired by another company and 5% where merged with another company with an unknown endstate. This means that a quarter of the sample has already discontinued their company, and about half of the sample is still in operation. On average the companies have existed for 9.3 years with a median of 10 years.

Similar studies to ours, as Clausen and Rasmussen (2012) and Heirman and Clarysse (2004)

include firms with lower age, 2-7 years and 5-12 years (average of 7 years) respectively. As the average age in our sample is 9.3 years, we regard our sample as providing enough historical data for enabling considerable contributions.

5.1.1 Initial business model characteristics

Table 4: Initial business models within our sample

Initial business model	Propotion of sample
Consultancy/Service	15.5%
Product	71.4%
TM	4.8%
Unknown	8.3%

Table 4 shows that 71.4% of the companies in the sample chose product orientation as initial business model. As a comparison, Helm and Mauroner (2011) had only 40% product oriented business models in their sample of non academic RBSOs. Academic spin-offs are known to be more product oriented than non academic spin-offs (Roininen and Ylinenpää, 2009), which can explain why there are differences between the studies. 4.8% of our sample started with TM as their initial business model, and 15.5% with consultancy. In comparison, Helm and Mauroner (2011) identified 24% of their sample as pursuing a service business model, in which they include both consultancy and TM.

A possible explanation for the low frequency of TM may be because some of the other firms report that they are developing a product or being consultants although they in reality pursue a combination of TM model. Clausen and Rasmussen (2012) report that half their sample in a high extent followed more than one business model at the same time. Clausen and Rasmussen (2012) define parallel business model as companies pursuing several opportunities at the same time. Another explanation may be that the similar studies look at the firms through a single point in time, where some firms may already have changed from a product to TM model.

5.2 Expected activity based business model change (H1)

In this section we will investigate the hypotheses H1a and H1b. The first test, H1a, will be based on a categorization of the activity based business model changes to check if all combinations are represented. Further, the investigation of H1b is a comprehensive review of all the RBSOs that has one or more changes in activity based business model to find the potential drivers. A discussion will follow the results before hypothesis two is treated.

5.2.1 Representation of activity transitions

H1a: All combinations of activity based business model change is represented among RBSOs.

Table 5 display the initial business models of the RBSOs, and the number of activity based business model changes. Four companies change their activity twice, thus 14.3% of the companies have a change in activity based model. 7 of 16 activity changes were from product to TM, and distinguishes from the other. Our results indicate that the most common change in our population is from product to either consultancy or TM. All combinations of activity based business model change is represented among the RBSOs in our sample. Hence, hypothesis 1a is supported.

As all combinations of activity transitions was found, this may confirm our assumption that the changes are made from a low to high growth orientation or vice versa. This may further support our proposed link between financial capital and activity based changes in business model.

5.2.2 Activity based transition representation

Hypothesis 1b: We expect to find financial drivers as a constrainer in changes from product to TM or consultancy, as an enabler from TM or consultancy to product and both enabler and constrainer between TM and consultancy.

To find the drivers for the changes, every company was reviewed in detail. A summary of the result is displayed in table 6. The table

Table 5: Initial business model and overview of total activity changes

Initial business model	Number of companies	Activity change of business model	Number of changes
Consultancy	13	Consultancy to TM	2
		Consultancy to product	1
Product	60	Product to TM	7
		Product to consultancy	4
TM	4	TM to product	1
		TM to consultancy	1
Unknown	7		
Total	84	Total	16

show a firm by firm overview. Financial drivers were found as a constrainer in all activity based transition types except for the soft starter where it was found as an enabler. However, as financial resources acted as a constrainer in the one company that changed from TM to product orientation hypothesis 1b cannot be supported. The results are still interesting, as financial drivers was found in 13 out of 16 changes. In the following discussion we will go through all the activity based change combinations.

Table 6: Review of activity based business model changes and corresponding drivers.

RBSO	Change	Description	Driver	2nd change	Description	2nd driver
Synthetica AS	Consultancy to product	Start production of unique vitamin standards	Good finances and market opportunity, enabler			
New Index AS	Product to consultancy	Acquired, changed to contract research for parent company.	Acquired			
Isocare AS	Product to consultancy	States that consultancy will give financial room for development.	Poor finances, constraint			
Intellexi AS	Product to consultancy	Start to offer consultancy due to low income from their software.	Poor finances, constraint	Consultancy to TM	They wish to sell their technology because of the financial crisis. All employees were fired.	Poor finances, constraint
CGENE AS	Product to consultancy	Produced luminescent mice. State that it might be more valuable for the customers to get specially made mice, rather than a "standard" luminescent mouse.	Market adaptation	Consultancy to TM	Has a patent for a "luminescent-gene" in mice. Starts licensing to other companies.	Unknown
G-FLOW AS	Product to TM	No customers. Has patent, is actively trying to get licensing deals to get other to commercialize the technology	Poor finances and market adaptation, constraint	TM to consultancy	New owner affiliated with one of the founders. Seems like there is no market for neither product nor technology, with consulting as a survival strategy.	Poor finances, constraint
Optinose AS	Product to TM	Equity lost. From product to developing technology.	Poor finances, constraint			
Uni Targeting Research AS	Product to TM	Two years after startup, they changed to only develop and sell technology, seemingly due to lack of financing.	Poor finances, constraint			

Advanced Biopolymers AS	Product to TM	Changed to licensing/selling the technology after the IPR was secured, seemingly due to lack of financing.	Poor finances, constraint			
Biosergen AS	Product to TM	<i>plan</i> to produce and sell, then shifts focus to partnership or licensing. Not explicitly stated why business model is changed, but the company has poor finances for many years.	Poor finances, constraint			
DTECH AS	Product to TM	Equity lost and poor finances forced the company to dismiss a production line in Hungary. The market had disappeared while the factory was built.	Poor finances and market adaption, constraint			
Nordiag	TM to product	Changed their business model to sell kits with test equipment due to financial constraints	Poor finances, constraint	Product to TM	Sold the sample preparation business and returned to their original activities of tests because the sale did not appear as profitable as expected.	Poor finances and market adaption, constraint

Table 7: Identified drivers leading to activity change in sample.

Activity based change	Financial constraint	Financial enabler	Unknown / other
Consultancy to TM	1		1
Consultancy to product		1	
Product to consultancy	2		2
Product to TM	7		
TM to product	1		
TM to consultancy	1		

To present and discuss the qualitative results we will first have a look at the change from consultancy to product oriented business model, the so called soft starters, and then go through the activity changes in the order of table 6.

Consultancy to product, soft starters

The one soft starter we found, *Synthetica AS*, represents 1.2% of our sample, and is considerably lower fraction than studies like Heirman and Clarysse (2004) and Helm and Mauroner (2011) with 22% and 24% respectively. Heirman and Clarysse (2004) conducted a qualitative analysis of 99 Belgian RBSOs, and report that 22 of them are soft starters. Notably, they use a slightly different definition of RBSOs, and also include corporate spin-offs and individual start-ups in the study. Only 24 of the companies in their study are academic spin-offs. Helm and Mauroner (2011) studied 153 RBSOs from *non academic* German public research organizations, and identified 36 soft starters. Their definition of RBSOs is closer to the one we have used in our study, except that they exclude academic spin-offs which are represented greatly in our sample.

Synthetica AS was started in 2000 and initially offered custom organic synthesis and medicinal chemistry services, including developing chemical/molecular compounds. This is contract research which fall into the consulting category. In

2004, they started producing and selling vitamin standards, as the only global supplier of these standards. Thus, they changed to a product oriented model. However, Synthetica continued its contract research while setting up the production. Furthermore, in 2006 the *research* on vitamin standards was spun out in the subsidiary *Syntavit AS*.

Synthetica started out as a research boutique where the academic founders could perform similar activities as in their academic work. According to Druilhe and Garnsey (2004) this is the most accessible market opportunity for academic founders. We found no clarification in our data whether the founders behind Synthetica had *ambitions* to develop a product company from the start, or if they only reacted on an emergent market opportunity. The fact that Synthetica preserved their consulting services may imply the latter. In addition, Synthetica had positive results every year since startup. This can be characterized as a financial enabler. Their intentions can be difficult to determine without an interview with the founders, as their business model contains elements from different activity based business models. This is a good example showing that activity based business models as a typology are easy to separate in theoretical discussions, but challenging when used as a tool for empirical analysis.

There might be several reasons for why our results show very few soft starters and differ from other studies. Heirman and Clarysse (2004) showed that the academic RBSOs in their sample were inclined to have a VC-backed starting configuration³ and the transitional start-up category was mainly made up of independent start-ups. The academic spin-offs in their sample was underrepresented among soft starters. As such, our results is consistent with these findings. Hence it seems like the fraction of transitional start-ups are prominently smaller for RBSOs than other new ventures. The explanation provided from Heirman and Clarysse (2004) is that academic spin-offs generally attract more venture capital than independent firms because of their proprietary technology.

³Heirman and Clarysse (2004) use the categorization VC-backed start-ups, Prospectors, Product start-ups and Transitional start-ups.

Change from product orientation to consultancy or TM

Poor financial situation is the common denominator for the companies changing from a product oriented business model. It seems like a change to consultancy is a strategic choice made merely to survive, while a change to TM generally can be seen as a way to recover costs. The latter argument might not apply to Biosergen AS and other biotech companies that are in an industry with a strong appropriability regime. Market adaption is also an identified driver in some of the cases. The general impression is that the RBSO has a poor product to market fit which leads to a poor financial situation.

Changes between TM and consultancy

It is notable that change between TM and consultancy only occur as a firm's second change. Intellexi AS changes from product orientation to consultancy due to financial constraints and the second change is from consultancy to TM, also due to financial constraints. They were struck by the financial crisis in 2009 and could not afford to have any employees and thus consulting was no longer an option. The last resort was to sell off the technology, and seems like a rather desperate move. This is also reflected in the fact that Intellexi was discontinued in 2011.

G-Flow AS changed from product orientation to TM as they were running out of money in pursuit of customers. The plan was to get another commercial actor to commercialize their technology. The second change was from TM to consultancy, and it seems like one of the founders took over the company as a personal consulting firm as the plan of licensing did not succeed. This is a typical "consult or die"-situation we also noted in some of the product to consultancy change companies.

Cgene AS stands out from the other companies in that neither financial constraints nor enablers are drivers for their business model changes. They state market demand as a driver for the first change from product to consultancy. The driver for their second change from consultancy to TM is not stated. However, it seems like the consultancy part is continued past the second change, and Cgene thus have elements of different activities in their business model.

Cognitive vs. real

Vohora et al. (2004) states that the founders' perception of what business to create is an important aspect of the threshold of entrepreneurial commitment. The initial business model of each of the companies in our sample are determined from what the board of directors and the CEO articulate in their annual report. In that regard, the initial business model in our sample can be viewed as a *cognitive* business model in the minds of the founders that may, or may not, be operational. We argue that some of the founders communicate their cognitive perception of the firms future business model, but generates income through consultancy activity or TM. This implies that they in reality act like a consultancy company, and develop a product on the side, like a soft starter. We propose that this "cognitive vs. real" business model misalignment results in an under-reporting of business model changes, and that some product companies that is recorded without change in business model is in fact is a soft starter, as an example.

5.3 Financial situation (H2)

H2: Changes in business model are dependent on financial situation

Table 8: Bivariate cross tabulation between change or no change in business model and financial situation same year. Numbers are each year of operation of the 84 RBSOs.

		Satisfactory financial situation same year	Not satisfactory financial situation same year
Change of business model	of	23	19
No change of business model	of	462	251

Table 9: Bivariate cross tabulation between change or no change in business model and financial situation same year and year before. Numbers are each year of operation of the 84 RBSOs.

	Satisfactory financial situation*	Not satisfactory financial situation*
Change of business model	15	27
No change of business model	361	268

*Financial status in two subsequent years.

Table 10: Results from chi-square tests of business model change on the two independent variables of H2 respectively.

	N	df	Chi ²	p-value
Test 1*	755	1	1.739	0.187
Test 2**	671	1	7.51	0.006

*business model change and financial situation same year.

** business model change and financial situation same year or year before.

The results from both chi-square tests of H2 are presented in table 10. Bivariate cross tabulations between the dependent variable *business model change* and the two independent variables are presented in table 8 and 9 respectively. The result of the first chi-square test shows that there are not significantly more business model changes occurring the same year as poor financial situation ($p = 18.7\%$). However, the second test suggest that H_0 can be rejected as the p-value is 0.6%. Thus, there are significantly more business model changes that occur when insufficient financial capital has been reported two subsequent years, prior and including the year of change.

Although the p-value of the first test was not significant, its value of 18.7% still indicates that there may be a connection between poor financial situation and change in business model. This is further confirmed by the significant p-value of the second test. Hence, business model change seems to be affected by financial situation as proposed by Skarbø et al. (2014). However, insuffi-

cient capital affects change of business model more strongly than satisfactory financial status. As a consequence, RBSOs may be more likely to change their business model because they *have to*, rather than because they *can*. This is consistent with the qualitative analysis of H1b, where most changes in activity types were found to be constrained by poor financial situation.

The changes in business model in our sample seem to depend more on the financial situation over time rather than the same year as the change. This may confirm that changing business model is a result of a process that might last more than a year rather than a discrete event that occurs as a response of an immediate situation. Furthermore, by being more likely to change business model after two subsequent years of insufficient finances than one year, it is likely that the RBSOs postpone the required change until absolutely necessary. This is supported by the findings of H1b, where for example Intellexi AS changed business model seemingly as a last resort move.

Vohora et al. (2004) describes how RBSOs need to overcome critical junctures and stages to achieve sustainable returns, but every critical juncture may require a change in the resource base. If there are not enough financial resources available, the firm is forced to provide the resources in other ways, or change to a more suitable business model to their resource base. Hence an explanation of why the RBSOs are more likely to change business model when they are forced to because of insufficient financial capital may be that they are trying to cross a critical juncture. The most relevant critical juncture for the RBSOs in our sample is the threshold of sustainable returns, as they have already entered the re-orienting phase when establishing the company and initial organization.

The test of H2 did not separate activity and element changes as the hypothesis was based on business model changes in general. However, there may be differences between these two perspectives on business model. As previously mentioned, activity transitions imply a change in several elements simultaneously, while an element change may only involve a change in one element. Hence an activity change should be viewed as a larger reorganization of the resource base rather than an

element change. The analysis of H1b revealed that most activity changes were conducted while being constrained by insufficient financial capital. The 15 changes made after two years of *sufficient* finances in our sample may be RBSOs refining their business model towards sustainable returns as described by Vohora et al. (2004). This refinement is likely to involve element changes as a way of optimizing the present activity type. Hence element changes may be more likely when the company has sufficient access to financial capital, which may be an interesting topic for further research.

5.4 Effect of business model change on survival rate (H3)

H3: RBSOs that change their business model are less likely to be discontinued.

Whether or not a change of business model affects the likelihood of the RBSO being discontinued, was tested using binary logistic regression. The correlation matrix of the variables used in the regression is presented in table 11 and the result is presented in table 12.

The logistic regression resulted in a p-value of 0.072, hence H_0 can be rejected at a 10% significance level. Thus, H3 is supported and the test shows that companies that change their business model in our sample are less likely to be discontinued than others. The odds ratio value of 0.137 indicates that the companies that are not discontinued are over 7 times more likely to have changed business model at least once.

The correlations between the variables are shown in table 11. The negative correlation between *software* and *biotech* is expected as they are mutually exclusive. As the correlation between software and biotech is stronger than the correlation between each of these variables and the dependent variable *discontinued*, this may cause multicollinearity problems. To test the impact of these correlations, we calculated the variance inflation factors (VIF) for the regression. The maximum score of the VIF test was 1.39, hence below the commonly accepted threshold of 10. Thus we can neglect the existence of multicollinearity problems (Freund et al., 2006). The fit between the observations and the regression model was found to increase when introducing the control variables,

Table 12: Logistic regression for likelihood of being discontinued, controlling for age, software and biotech.

		Std. error	p- value	Odds ratio
Business change	model	1.107	0.072	0.137
Age		0.122	0.008	0.723
Software		0.65	0.823	1.156
Biotech		0.743	0.219	2.491

as both the Cox & Snell R^2 and Nagelkerke R^2 values increased by 0.092 and 0.139 respectively when including age, software and biotech in the regression.

As shown in table 12, *age* is more significantly contributing to explain the variable *discontinued* than *business model change*. However, this is expected as most of the RBSOs in our sample were founded between 2000 and 2003. Hence, those that have failed will have a lower *age* than others because non discontinued firms still operate in 2012. Software and biotech do not significantly contribute to failure ($p = 0.823$ and 0.219 respectively), but biotech seems to be contributing more than software. The odds ratio of biotech is 2.491 compared to 1.156 for software, which further supports that biotech firms are characterized by higher risk.

In light of RBV, our findings are likely to support the importance of developing dynamic capabilities. The presence of dynamic capabilities makes the entrepreneurs capable of adapting to changes in market conditions and other external factors by combining resources and capabilities in new ways. As described by Skarbø et al. (2014), the choice of business model is affected by external factors as for instance market- and environmental conditions. Hence changing the business model may be the result of dynamic capabilities, which further supports that our findings confirms the positive impact of change.

A possible explanation for why RBSOs that change business model are less likely to be discontinued may be that they have had a choice between discontinuing their current business or change to survive. As indicated by the results of

Table 11: Correlation matrix for the variables used on the logit regression for testing H3.

	(1)	(2)	(3)	(4)	(5)
(1) Discontinued	1				
(2) Business model change	-0.322**	1			
(3) Age	-0.414**	0.417**	1		
(4) Software	-0.018	-0.02	0.03	1	
(5) Biotech	0.175	0.016	0.184	-0.233*	1

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

H1b and H2, lack of financial capital creates this "change or die" ultimatum. The company needs to either close down the business or adapt by making changes that solves the problem. This further supports the importance of dynamic capabilities and their effect on survival.

Although Hannan and Freeman (1984) states that firms undergoing changes are more likely to be discontinued, our results suggest the opposite. We propose this may be due to low structural inertia present in the RBSOs in our sample, as they are young firms, and most often have few employees. Furthermore, in the analysis of H1b it was indicated that some of the business models, and hence changes in business model, are more cognitive than operational. A cognitive change in business model may represent a low degree of reorganization, hence supporting that RBSOs are less affected by structural inertia.

The results of testing H1a revealed that most of the activity changes were made from product to TM or consultancy. This is consistent with the findings from H2 where business model change seems to be dependent on poor financial situation. As TM and consultancy in general are less resource demanding than a product model, the RBSOs may have been forced to change because of insufficient financial capital to further pursue the product model. This is also consistent with the result that business model change is likely to be a positive sign in terms of survival, as it may be a result of a "change or die" situation. Hence, these consistencies provides strong arguments for assuming that most RBSOs change business model when they have to rather than when opportunities

arises.

6 Conclusions

The business models of RBSOs have barely been touched by scholars, but is nevertheless an important aspect of RBSOs, as we have shown in this study. Skarbø et al. (2014) identified and characterized drivers for choice of business models. In this study we have empirically analyzed one of these drivers, financial capital, and its effect on business model, as well as the effect of business model change on survival. This was conducted by using a mixed method approach.

Through a qualitative analysis of all RBSOs with changes from one activity based business model to another, we found that financial capital is a dominant driver for these transitions. Insufficient financial capital was found to provoke as well as constrain the available choices in most activity changes. All combinations of activity based changes were found in the sample, with most transitions from product to TM or consulting. However, although regarded as a common transition by similar studies, only one soft starter was found. We suggest that this may be the result from a mismatch between the founders "cognitive" business model (what they state in the annual report) and their operational business model.

The importance of insufficient financial capital as a driver for choice of business model was further supported by our quantitative analysis of the RBSOs in our sample. Specifically, a change in business model was found to be significantly more

Table 13: Summary of results from all hypothesis tests.

Hypothesis	Result	Comment
H1a: All combinations of activity based changes exists for RBSOs	Supported	Most changes were from product to TM or consulting
H1b: We expect to find financial drivers as a constrainer in changes from product to TM or consultancy, as an enabler from TM or consultancy to product and both enabler and constrainer between TM and consulting.	Not supported	Financial drivers as a constrainer in change from TM to product was not found.
H2: Changes in business model are dependent on financial situation	Supported	Supported for change after two years of insufficient financial capital.
H3: RBSOs that have changed their business model are less likely to be discontinued	Supported	RBSOs that change business model were 7 times more likely to survive

likely after a period of poor rather than satisfactory financial situation. Another finding from our quantitative study is that RBSOs in our sample that perform a change of their business model has lower likelihood of being discontinued. This aligns with what resource based view states as dynamic capabilities, which will be important for firm performance. We argue that many of the changes were made because the companies are facing a crossroad of either change or die operation. Combined with the findings that poor financial situation greatly influences change, we believe this represents an indication of RBSOs being more likely to change their business model because they are forced to rather than as a response to an opportunity.

Thus, through the results of testing our hypotheses we are able to answer our research question: *How does financial capital affect a change in business model and how does a change in business model influence the likelihood of failing for RBSOs?*

The framework for analyzing drivers for choice of business models proposed in Skarbø et al. (2014) has shown to be useful for both qualitative and quantitative analysis of business model changes. This indicates that drivers for choice and change of business model are valid for analyzing both decisions. In addition, the categorization of drivers has shown to be a useful tool for analyzing how and why RBSOs change their business model.

7 Limitations and further research

Although the historical data available for each RBSO in our sample is unique in many ways, it is not without limitations. The amount of information provided in the annual report was found to differ greatly among the firms. Also, the variable of business model change is based on our own perception (by using the definition of element and activity change) of what the company articulate as their business model in the annual report. This may cause a bias in accuracy of the variables between each firm.

As it is unknown to us in which extent the companies reported all changes, we suspect that smaller element changes were not identified. These changes may not be viewed by the firm as relevant for the annual report, but still be relevant for our research. In addition, the report is written by the board of directors, which may have a different perception of what activities and business model elements the firm pursue than what they do in reality.

The term business model has become a popular way of describing attributes of firms for both scholars and practitioners (Zott et al., 2011). However, there is a great variation in how it is defined. The generally accepted definition of describing how a firm creates, captures and delivers value allows for many different perceptions. This

may affect the relatedness, and should be kept in mind when comparing to other studies on business models.

Although firms that are discontinued undoubtedly are failures, the firms that exist but have no activity (living dead) can also be viewed as failures. As a result, firms that have changed their business model but not discontinued may still be failures in reality. Hence, the *living dead* phenomena is a highly interesting topic for a qualitatively study to better assess the effect of business model change of failure vs success. How many, what caused the state, and what activity that was conducted would contribute to better understanding of the RBSOs evolution.

Since all companies develop differently, is reason to believe that the companies have diverse reasons for changing their business model. 15 of 42 changes in business model were done while the companies had two subsequent years of sufficient financial situation and a more more comprehensive study of those would probably reveal the underlying cause of change. A further qualitative study of those RBSOs that has changed their business model would give a better perception of the underlying reasons why companies develop differently in an emergent environment.

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