



City Research Online

City, University of London Institutional Repository

Citation: Ziaee Bigdeli, A., Li, F. & Shi, X. (2016). Sustainability and scalability of university spinouts: A business model perspective. *R&D Management*, 46(3), pp. 504-518. doi: 10.1111/radm.12167

This is the accepted version of the paper.

This version of the publication may differ from the final published version.

Permanent repository link: <http://openaccess.city.ac.uk/13876/>

Link to published version: <http://dx.doi.org/10.1111/radm.12167>

Copyright and reuse: City Research Online aims to make research outputs of City, University of London available to a wider audience. Copyright and Moral Rights remain with the author(s) and/or copyright holders. URLs from City Research Online may be freely distributed and linked to.

City Research Online:

<http://openaccess.city.ac.uk/>

publications@city.ac.uk

Sustainability and Scalability of University Spinouts: A Business Model Perspective

Ali Ziaee Bigdeli*

Aston Business School, Aston University

A.Bigdeli@Aston.ac.uk

Feng Li

Cass Business School, City University London

Feng.Li.1@City.ac.uk

Xiaohui Shi

Portsmouth Business School, University of Portsmouth

xiaohui.shi@port.ac.uk

* Corresponding Author – Address: MB221, Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom, Telephone: +44 (0) 121 204 3384.

Abstract

Most previous studies of University Spinouts (USOs) have focused on what determines their formation from the perspectives of the entrepreneurs or of their parent universities. However, few studies have investigated how these entrepreneurial businesses actually grow and how their business models evolve in the process. This paper examines the evolution of university spinouts' business models over their different development phases. Using empirical evidence gathered from three comprehensive case studies, we explore how USOs' business models evolve over time, and the implications for the financial sustainability and operational scalability of these ventures. This paper extends existing research on the development of USOs, and highlights three themes for future research.

Keywords: University Spinout, Business Model, Sustainability, Scalability, Case Study.

1. Introduction

There has been growing interest among policymakers and academics in how publicly funded research projects might generate greater economic (and social) value (Bozeman et al., 2015). University Spinouts (USOs) are regarded as a crucial vehicle via which to commercialize intellectual properties, particularly those that cannot be easily patented (Sørheim et al., 2011). Although many USOs can be characterized as new high-tech start-ups, they face specific obstacles in competitive environments, in that most universities lack commercial resources, and academic entrepreneurs (AEs) often lack commercial experience (Vohora et al., 2004, Lehoux et al., 2014). These difficulties are further exacerbated by the fact that the creation of competences can be a very slow process in USOs, due to (1) the lack of clear decision-processes and the delays caused by differing university- and/or departmental-level line responsibilities (Rasmussen et al., 2014), and (2) less market knowledge compared with corporate spinout (Clarysse, et al., 2011). Furthermore, the growth of USOs is often held back by conflicts between the objectives of its key stakeholders, such as the senior management of the university, the academic entrepreneurs and the venture's management team (Miller et al., 2014).

There is a rapidly emerging research stream that focuses on the Business Models (BMs) of USOs (Chiesa and Piccaluga, 2002, Druilhe and Garnsey, 2004, Mustar et al., 2006). These studies have focused either on the activities the spinouts perform, the role of the founding entrepreneur, or on the characteristics of their markets, but have left some important aspects under-researched. First, in many cases, the development process is described via a single snapshot, and the transformation of USOs' business models through different phases of their growth and development has been largely ignored (Rasmussen, 2011). Therefore, as one of the key aims of this research, we argue that a more dynamic approach towards the business model concept in the USO context is required to understand how the core components of their BMs evolve over their development phases. (We discuss the reasons behind employing this dynamic approach in detail in Section 3.)

Second, although previous studies have examined the notions of formation and growth in the USO context (e.g. Vohora et al., 2004 and Mustar et al., 2006), there remains a gap in the literature about how USOs can actually reach a financially sustainable and operationally scalable phase. Ironically, despite being likely environments for the creation of high-tech

firms, universities and academic entrepreneurs are ill-suited to sustain the growth pace of new ventures due to potential conflicts of interest with their tradition roles of teaching and research. As a result, such spinouts take much longer to return their initial investments and to expand their operations to global scale – if, indeed, they ever do (PraxisUnico, 2012). We attempt to address this issue by investigating the ongoing dynamics of the interactions within and between the core components of USOs' business models as they proceed along their development paths.

This paper therefore aims to address the questions of how USOs' business models evolve, and how the interactions within and between their core business model components can ultimately result in sustainability and scalability. To address these questions, we draw on two theoretical frameworks: first we adopted the Development Process Framework - initially proposed by Vohora et al. (2004) - to explore and explain the formation and growth of USOs over five non-linear phases. Second, we build on Demil and Lecocq's (2010) RCOV framework in order to ground the concept of business model in a parsimonious and dynamic perspective. Based on empirical evidence gathered from three comprehensive case studies, we discuss how the core components of a USO's business model (considered via the RCOV framework) evolve, and the extent to which the interactions among its BM components can result in sustainability and scalability over its development phases (as proposed by the Development Process Framework).

2. Theoretical Background

2.1 The Development Process of University Spinouts

Smith et al., (1985) have argued that a firm's organizational development follows some specific phases, and that as those phases progress, so do its organizational characteristics, such as structure and strategies. Drawing on the USO Development Process Framework initially developed by Vohora et al. (2004), we divide the evolution of USOs into six phases, which are not necessarily linear (as shown in Figure 1).

-Figure 1-

Many university spinouts emerge from scientific research carried out in research centers and

academic schools, maybe over several years (Shane, 2004). This earliest spin-out phase is referred to as the research phase - also known as the “idea phase” (Clarysse and Moray, 2004) - where the academic entrepreneur starts to realize that the knowledge created in the university has the potential to be commercialized. Once that opportunity is identified and framed, academic engagement and commitment need to be secured before progressing to the pre-organization phase: as Bjørnåli and Gulbrandsen (2010) pointed out, it is during this transition that academic entrepreneurs evolve into the new venture’s board of management.

In the pre-organization phase, the USO’s management team started to develop and implement strategic business plans with the key objective of gathering the resources that will be required for the spin-out to take place, and eventually to succeed (Bjørnåli and Gulbrandsen, 2010). In general, start-ups face considerable challenges when attempting to raise capital during their early development phases, since investors prefer to see an operational business before investing capital (Townsend and Busenitz, 2014). Politis et al. (2012) emphasize the lack of ability to gain financial credibility as one of the key challenges in the early USO development phases, which mean investment providers (such as venture capital companies) often regard USOs as high-risk firms.

In the re-orientation phase (after the USOs manage to gain sufficient financial resources), the focus shifts to offering something of value to potential customers, so that the investors can see the firms will generate returns (Ndonzuau et al., 2002). During this phase, academic entrepreneurs and their partners often need to reorganize their resources, so as to further increase their financial credibility (Wright et al., 2012). Ambos and Birkinshaw (2010) discussed the necessity of re-configuring resources during the development life-cycle, as this can bring USOs significant competitive advantages, which will enable them to become standalone entities, or ones that can be attractive to incumbents as acquisitions. In the sustainable return phase, the founding team will need to ensure that they gain the ability to reconfigure their existing resources and capabilities using information and knowledge they have obtained during previous phases (Freitas et al., 2013).

Nevertheless, reaching this point (i.e. the sustainable return phase) does not mean USOs have the capability to scale up their operations: scalability being defined as the extent to which they have the potential to serve larger numbers of customers and use technologies,

equipment, and centralized facilities to decrease costs (Zhao et al., 2013). This phase is conceived as a recurrent loop - that is, when the USO becomes financially sustainable, it may start to scale its operations up to produce more products/services and serve more customers. After each scaling-up, the firms need to be sustainable at that scalability point before embarking on further growth. In order to reach this phase (i.e. the scalability loop phase), the business model should be in a constant state of evolution to ensure first, that it integrates the resources it has in place so it has the capability to develop products to meet commercial needs (Sirmon et al. 2011) and second, that it is flexible in face of three main factors: its market(s), its customers and its competitors.

2.2 Business Model Evolution in University Spinouts

The academic literature on the BM concept is a rich and heterogeneous corpus which embraces several different approaches to the business model concept, from looking at it from an entrepreneurial perspective (e.g. Kim and Mauborgne, 2000, Baden-Fuller and Morgan, 2010), to viewing it as a tool to represent the way companies capture and create value (e.g. Mahadevan, 2000, Casadesus-Masanell and Ricart, 2010, Amit and Zott, 2012). In general, however, the concept is employed to represent the state of a firm or an industry at a specific moment. Hence, research tends not to take a dynamic perspective to understand how firms' business models evolve over time (Pereira Da Costa and Levie 2014) - so "*the relationship between business model and time is little discussed (...) it is a snapshot and description at a specific moment in time*" (Osterwalder et al., 2005: p.15). Previous studies which take this "*static perspective*" focus on identifying and describing the main components of a firm's business model, including its resources and capabilities, value network, collaboration, and customers (e.g. Osterwalder, 2004, Johnson et al., 2008). In contrast, those that offer a "*dynamic perspective*" use the business model as a tool to address the transformation and evolution of an organization, or the business model itself, over time, focusing on the interactions among the core BM components of the specific organization under study (e.g. Casadesus-Masanell and Ricart 2010, Schilke 2014, Moyon and Lecocq 2014).

The main weakness of the static perspective is that it assumes that the same elements are (and will remain) equally central or core to all types of firms and organizations (Siggelkow, 2002). However, the formation and growth of a university spinout is rarely based just on the formal configuration of key BM components. During the early phases of a USO's development, the

entrepreneurs involved are often not clear about what their final product/service will be, which limits their ability to articulate coherent value propositions or identify appropriate customer segments. In order to reconcile these two approaches, we use the RCOV framework to facilitate the analysis of USOs' business model evolution at various phases of their development. The RCOV framework was initially inspired by the Penrosian view of the firm (Penrose 1960), which constitutes a parsimonious and dynamic approach to the business model notion (Demil and Lecocq, 2010). Based on this view, a given firm's business model is an outline of the ongoing interactions between of its core business components.

The basic assumption of the framework is that a firm's growth results from the interaction between its Resources and Competencies (RC) to propose novel value propositions to the market, its Organization structure (O), and its Value proposition (V), as expressed in the products and/or services it supplies. Note that the three core components each encompass several different aspects – such as various kinds of resources and different types of partners within the value network - so the structure and volume of the firm's revenues and costs is an outcome of the choices it makes relative to these three components and how they interact.

The evolution of USOs' business models result from the ongoing dynamics stemming from the interactions *between* the core components, which result in transformations in their cost structures and/or revenue streams. These evolutions can be initiated internally or externally, and typically involve new resources (e.g. obtaining new research fund/grant), improvements in the USO's competence and new resources that can lead to such improvements (e.g. bringing in professional business staff to the firm), the reengineering of its organizational structure and processes (e.g. changes in the USO's executive board) and/or the re-defining of its value propositions (e.g. providing new services or collaborating with other research centers). In some cases, changes in USOs' business models occur when their performance starts to decline, and the hope is that business model transformations may both improve operational processes and also constitute positive signals about the firm's sustainability. However, previous research has not empirically investigated the questions of when, how and why USOs' business models evolve to reach sustainability and scalability.

3. Methodology

Given the nature of our research question, we adopted a multiple case study approach to

uncover the evolution of business models through their development phases and their routes to sustainability and scalability. The multiple case study approach supports a “*replication*” logic (Yin, 2003), in which empirical analyses can be seen as a series of independent experiments that confirm or disconfirm conceptual insights as they emerge. Case studies also provide a meaningful methodological approach, particularly when existing perspectives seem insufficient due to there being little empirical evidence or theoretical development (Santos and Eisenhardt, 2005).

3.1 Selection of Case Studies

We selected three USOs, which had secured substantial external funding from the National Health Service (NHS) and/or from private equity firms. The selection of the case studies was partly dictated by opportunities to gain quality access to the senior managements of these organizations. We conducted a comprehensive case study of USO_A over a 24 month period, which was supplemented by comprehensive case studies of two other USOs (USO_B and USO_C) over 18 months, all of which have been spun out from the same leading UK university which - in partnership with local government - is dedicating to establishing a new industrial base in the specific field of healthcare and medical science through launching spinouts and attracting inward investment (Goddard et al., 2012).

Although all three cases aimed to commercialize technological innovations and provide sustainable returns to their equity investors, they had been formed under different frameworks used by the university’s TTO, mainly distinguished by the levels of support the office provided. We selected USOs that received different level of support as case studies deliberately to analyze how different formation methods influenced the evolutions of their business model, and their subsequent routes towards sustainability and scalability. Finally, all the cases had arrived at the sustainable return phase of development, allowing greater insights into the paths they followed in arriving there. Table 1 gives summary descriptions of the three case study firms, which we gave the codes names USO_A, USO_B and USO_C for confidentiality reasons.

-Table 1-

3.2 Data Collection Approach

The empirical research is based on several different sources: (a) semi-structured interviews, (b) observation of the on-going operations within the firms, (c) informal follow-ups through meetings and e-mails, and (d) archival data (mainly business plans, annual reports and company internal material). We triangulated the data that was gathered through different sources to mitigate bias and subjective judgments. For instance, we cross-checked the interviewee's discussion on the on-going operations with our observations and the reports presented to the parent university.

First, as the main form of data collection, we conducted 12 in-depth semi-structured face-to-face interviews; (a) 3 with the founders of each USO, (b) 6 with senior members of staff including the CEOs, operations managers, or senior project managers, and (c) 3 with senior representatives from the TTO, including the Head of Venturing and Incubator Manager. Only the three founders of the USOs had senior academic position (mainly in clinical studies) in the University, and the other interviewees had business/management background. The interview questions consisted of three main parts. First (in addition to questions about the dynamics of their markets) the founders were asked to describe and assess the organizational development phase in which their firm was currently operating. Second, we invited them to discuss how the key components of the firm's business model had been defined and evolved during the spinout's different development phases. Third, we asked them to evaluate their relationships with the university's TTO and its impact on their business model evolution. To gain that office's perspective, we asked three of its senior managers to explain the frameworks the university had used to support the academic entrepreneurs in establishing their spinouts. The interviews lasted about 2-3 hours, were tape-recorded, and transcripts prepared soon afterwards. These interviews were spread out over the studies' observation periods so as to understand and cross-check how the firms' business models and their key components evolved over the various phases.

Second, the initial interviews were supplemented by observation of the ongoing process of the USOs' development. Being actively engaged (e.g. as participant observers) with the spinouts – from July 2011 to June 2013 with USO_A, and from January 2012 to June 2013 in the other two cases - gave us rich insights into their organizational dynamics, decision-making processes, growth patterns, and deep understanding of the development of their business strategies and the evolution of their business models. We also carried out several

follow-up interviews (with the same senior members), and business meetings and telephone conversations to obtain updated information about the firms' operational processes. Interviewing these key people involved in the USOs' development patterns enabled the researchers to cross check their interpretations of events and gain a range of different perspectives from the university, the academic entrepreneur and the firm. Finally, we collected and analyzed other documents, such as the firms' business plans, published press articles, and the rules and regulations within which they had to operate.

3.3 Data Analysis Approach

The data analysis was conducted in three main steps based on the guidance suggested by Miles and Huberman (1994). The first step of the analysis (data reduction) focused on coding the interview manuscripts and archival data. This step was conducted by three independent researchers, in which the operational processes, organizational development phases, and changes in the firm's business models over time were identified and assessed through content analysis of the transcripts. The data display (mapping) was then developed manually in the form of tables from the findings, which demonstrated the changes of the key components of the business models against the organizational development phases (Tables 2, 3, and 4). The analysis of the data summarized in these three tables facilitated a cross-case analysis to identify the differences and similarities among the cases (Eisenhardt and Graebner, 2007), and later summarized in Table 5.

Subsequently, in the second step, the researchers examined and cross-checked the observations data (e.g. informal meetings, notes, recordings, etc.). This facilitated the emergence of important patterns (Straus and Corbin, 1998) regarding the key decisions made by the AEs or senior managers. A circular relationship between data collection, analysis, and discussion has been required in the data analysis approach proposed by Miles and Huberman (1994). Therefore, as the third step, several iterations between the sources of data (i.e. interviews and observations) and their analyses were carried out. This, particularly, enabled the researchers to classify and examine the AE's key decision(s) during each of the development stages that impacts the changes of the key components of the business models.

4. Findings

This section presents the findings from each of the three cases at their individual level. A general description of the cases is presented in Table 1. Further, we provide an overview of

how the USOs business models evolve in different organizational stage (Tables 2-4) and then summarize the cross-case analysis that emerged from the interplay between the two main sources of empirical cases (Table 5).

4.1. Case Study 1: USO_A

As a result of some excellent outcomes from these experiments in the first two phases on the venture's development, the founder of USO_A realized the need to design and develop a package consisting of a game controller together with a serious game to improve the rehabilitation of both children and adults. In the pre-organization phase, the firm secured a major external resource - a research grant awarded for the design and development of several assisted living related products. In regards to its organizational composition, the USO's executive team decided that the firm should act as a video game publisher. The firm defined its key value proposition as the rehabilitation package (application and controller) which was to be designed in-house. On the one hand, USO_A had many years of medical expertise and experience in healthcare and medical studies; on the other, it had developed networks with partners who were video games industry experts, who would actually devise programs that would be applicable to rehabilitation treatments.

There was a key ambiguity in defining the organizational structure. The decision to just be a publisher tended to fragment the organizational structure. The standard structure of companies involved in video games development involves a middleware supplier who supplies the facilitating software; a game producer who has the studios and appropriate skills to design games; and finally a publisher who is the key player in game industry networks, and supplies the finance to support the game development and handles commercialization and marketing activities. But, in fact, there were no middleware firms in this field capable of providing software to facilitate USO_A's game programming efforts.

Improvements in the AE's knowledge and competences, and the board's decision as to the firm's structure resulted in the evolution of its value proposition, and the acquisition of additional external resources during its re-orientation phase. During the opportunity framing phase, the firm defined a key extra element to its initial value proposition, which concerned gathering medical information from patients as they played the games. This approach also allowed the USO to improve both the game controllers and the games themselves, drastically

improving the physiotherapy and rehabilitation processes. The academic entrepreneur told us:

“... We believe that this opportunity adds a great value to our rehab packages and assists us in improving the efficiency and effectiveness of our product ...”

By presenting the effectiveness for patients of gathering medical information during their rehabilitation process, USO_A managed to secure more than £2m over several major funding rounds during the firm's re-orientation phase, enabling it to start large-scale commercialization of the rehabilitation packages. In this phase, the company decided to first go to market using an approach in which users/patients self-purchased the game/controller package from health product retailers. Obtaining relevant regulatory approvals was holding the company back, as professional institutions (e.g. the NHS and General Practitioners (GPs)) could not purchase the product before it had passed the relevant regulations. As the academic entrepreneur noted:

“... The rules and regulations are killing healthcare start-ups - especially when they have a product or service to be commercialized. Many such companies die out before they can even start selling anything ...”

In the re-orientation phase, when the organizational structure issue had been decided (i.e. to be a game publisher), the academic entrepreneur decided to team up with other academics to set up two more new companies; one as the middleware provider and the other the game producer. The academic entrepreneur believes that the firm's new internal and external network structure of the firm will bring success to the entire chain, and assist USO_A in drawing further new resources together in the form of specialized partners from the video game industry. He argues that this change in the firm's organizational structure, and the access to novel resources it involves, represents its path through the scalability loop. Table 2 summarizes the changes in the key components of USO_A's business model during the venture's development phases.

-Table 2-

4.2 Case Study 2: USO_B

Table 3 demonstrates the changes in the components of USO_B's business model. In the first two phases of its development, USO_B's operations were mainly research-focused and carried out by the academic entrepreneur and his University colleagues. USO_B experienced significant changes when developing its initial business model. The main transformation of the venture's key business model components occurred in the pre-organization phase, when the board decided to bring in professional business executives to develop a new business model. Although the company retained its key value proposition, it was re-defined as genetic testing via advanced medical platforms, as the quickest and most economical testing approach. After it had demonstrated a strong business model, and met other organizational and technological requirements, the NHS Trust agreed to fund the company to the tune of £700k. But as the firm's budget was too low to employ an experienced professional business team, the TTO itself became involved in running USO_B's day to day business operations. As the TTO's head reported:

“... I was brought in just to check the business plan, working alongside the clinicians from the Trust to develop the business model. After this, the university asked me to find a potential CEO for the company - but because the budget was limited they asked me to do the job for a short time – and after nearly 5 years I'm still here ...”

USO_B was formed by the two institutional shareholders (i.e. the University and the Trust) to exploit a university IP (the initial genetic testing platforms). After its pre-organization phase, the firm was no longer managed by the academics, but by someone from the University TTO with commercial experience and skills. Thus the changes in its organization structure in the pre-organization phase brought fresh resources into the firm and radically modified its value proposition. In the re-orientation phase, it identified two key revenue streams. The first was a R&D consultancy in which the USO got paid for carrying out research projects for the University and/or The Trust, and the second focused on genetic testing for hereditary diseases (mainly different types of cancers). A further income stream was subsequently added to the firm's portfolio, while R&D collaborations with other institutions were also considered as a potential income stream. According to the founder:

“...Another value stream is going to be personalized medicine - where you tailor a drug regimen to person's genetic makeup – which we think will be a very lucrative

business. This is a whole growth area in medicine ... it's very new for us and we are in on the ground floor now ...”

-Table 3-

4.2. Case Study 3: USO_C

Table 4 reports the way in which the key components of USO_C's business model evolved over the firm's development phases. Similar to the other two USOs, the operations of USO_C in the first two stages of development involved initial research on brain activities. The pre-organization phase was the point when the firm called in the University TTO for more rigorous help and, with the support of the team's business experts, the company secured its first investment (£90k) from Northstar Equity Investors. The company's management team started to consider three main value proposition possibilities (a) selling software to drug companies, (b) engaging with those companies to 'de-risk' their drug development processes using the approach they had discovered (i.e., operating as a consulting service), or (c) following more traditional bio-tech models, by duplicating the number of drug candidates in the discovery process. Although the first approach promised to be quite successful, the firm's founder and his colleagues were not convinced it was the most suitable business strategy for securing company growth. The company then started to focus on the consultancy approach: as the AE noted:

“ ... We did a number of these consultancy projects, e.g. for Cambridge Laboratories. You could grow your business model like that - in fact lots of American companies follow that approach where they get paid for their scientific consultation. But I still think it puts a very low cap on your expectations and your company's potential growth ...”

As in the previous cases, a significant evolution in the firm's business model occurred during the re-orientation phase, when the founder realized that very few drug companies were actually running drug discovery programs. As a result, USO_C decided to focus on a novel value proposition that focused on what a drug discovery platform can actually do, and what it can yield. In view of this new value proposition, USO_C's organization was restructured and

new resources were brought into the firm. First, it entered into several collaboration/partnership agreements with large drug development companies, and in 2008 USO_C gained a new £50m investment from one of the world's biggest hedge fund firms to significantly scale up its operations. These significant and successful changes in the firm's business model pushed USO_C to expand its operations further. In order to focus more fully on this platform, the firm moved all its discovery functions and the scientists dealing with them to one of world's biggest network biology centers for located in Oxford. In interview, the AE reported:

“... We are now working with our partners in phase I drugs development, examining whether the drug candidates can survive in the other phases. This will give us not £100k but £10m. If we can get into the other phases, we are talking about a much larger chunk of money. So, if the candidate can survive in phase 2, you will get much more than you could get through a consulting service or by selling software packages...”

USO_C reshaped its value proposition, with a new discovery team working on a specialized network pharmacology platform. The senior project manager stated:

“... We have learnt that the only way to really monetize the value more quickly is to put our discovery platform under other peoples' cash mountains. One way to do that is to collaborate on discovery processes with larger companies in such a way that we get some share of the downstream value...”

-Table 4-

The analysis of the case studies summarized in Table 2-4 facilitated the identification of similar patterns within the venture's different organizational stages, and how their business models change against these stages. Hence, Table 5 summarizes these key findings.

-Table 5-

5. Discussions

Our empirical data revealed that USOs' business model evolution became most evident during the transition from the pre-organization to the sustainability return and scalability loop phases. These significant changes in the USO's business model occurred as the result of one or a set of decisions which, although they were usually made voluntarily, were influenced by a range of internal or external factors. Based on content analyses of the observations data and later cross-checking with interview data, we classified these decisions into three common themes: *Organizational structure consolidation* during the pre-organization phase, *innovative value composition* in the re-orientation phase, and *value network extension* during the sustainability and scalability loop phases. We refer to each of the development phases below to explain how the USOs' core business model components evolved in response to voluntary and/or involuntary decisions during their company growth.

5.1 Research phase

The USOs we studied were each set up to address different objectives, and each adopted different organizational support structures, and their academic founders focused on understanding different aspects of their disciplines and how they could commercialize their knowledge and ideas, hence their business models were often not formally defined. This echoes Iacobucci and Micozzi's (2014) findings that university spinouts are formed at very early phases of their technology development cycles, and so often lack clearly defined business models. For instance, the academic team that established USO_B later started to take existing gene-testing technology from the lab and to research into its potential for novel applications across different industries. Similarly, the academic scientists behind USO_C carried out their research and experiments on brain activities - despite having only very small funds - in order to test whether the results could be applied in the pharmaceutical industry. So this phase can be regarded as the starting point for defining the USOs' core business model components, when AEs' improving competence in commercialization led them to outline their firms' organizational structures and potential value proposition(s) more fully.

5.2 Opportunity Framing Phase

In the opportunity framing phase, the USOs' business model structures remained unclear as the tangible or intangible assets had not yet been packaged for commercialization. It should

be noted that none of the three academic entrepreneurs established their firms primarily to generate wealth, but rather to fulfil their goals to commercialize the ideas or technologies they developed in their research, so that they would have greater impact in their specific industries. But, in terms of how their technological discoveries could be best commercialized to address the relevant markets via appropriate business models, their paths remained unclear (Lehoux et al., 2014). In this phase, the academic entrepreneurs recognized that their experiments had potential commercial applications in a number of market segments, but did not yet have clear ideas as to how to structure their business models or define their customers, suppliers, and distributors.

5.3 Pre-organizational Phase

Our empirical findings demonstrate that the principal changes in the case USOs' business models emerged in this phase, when improvements in the AEs' competence in commercialization and addressing venture credibility issues triggered decisions about *organizational structure consolidation*. This aligns with Rasmussen et al.'s (2014) arguments that business models begin to be formed as entrepreneurs' knowledge about resources and potential opportunities improves. In all three case studies, the AEs realized that, in order to enhance their firms' financial stability and operational resources, their organizational structures needed to be better developed via support from the university's TTO, whose role, therefore, became more significant in this phase.

Note that, although the USOs were all spun out from the same parent university, the TTO used three different frameworks to support their formation, which can be categorized as low-level (in the case of USO_A), medium-level (for USO_C) and high-level (for USO_B). We argue that these frameworks affected the evolution of their business models enormously, especially in their pre-organizational phases. In USO_A, for instance, the TTO's low-level support resulted in formation of a weak executive board, which meant the firm found it difficult to define its position in the market appropriately. In the USO_B and USO_C cases, the impact of the TTO's supporting frameworks was less noticeable in the path to sustainability, either because these spinouts received more support in shaping their business models, or because they acted to reduce the role the University played in their organization.

Although they cannot be generalized, the empirical findings from our case studies show that a

medium-level support from the parent university TTO is likely to have the most positive influence on the spinouts paths to sustainability and scalability. Such support gives the academic entrepreneurs more autonomy to evolve the components of their business model as they learn and improve their knowledge about their resources and the markets they aim to serve (Treibich et al., 2013). In contrast, the low- and high-level support frameworks make the academic entrepreneurs dependent on university support even after their early development phases. Nevertheless, the changes in the USOs' organization structures through maintaining their cooperation with the TTO resulted in them securing new sources of funding.

5.4 Re-orientation Phase

Securing their first major research grants during the previous phase enabled our case USOs to develop sophisticated and customer-oriented value propositions. For instance, USO_A started to focus on gaining information from users to enable it to offer more effective solutions; USO_B developed three new platforms to accelerate the of its genetic testing processes; and USO_C made two novel data resources available to drug development companies for their more advanced processes. In all three cases, these changes in their value propositions resulted in modifications in their organization structures. For instance, USO_A brought in several academics from another department who had extensive game industry experience to form two new firms to provide middleware and design and produce games, while USO_B brought in more medical experts to improve its platforms to deliver faster and better quality genetic testing services. In this connection, Cassar (2014) has discussed that acquiring industry experience gives new ventures advantages that allow them to capture novel opportunities and gain information about business environments that may not be accessible from other sources.

It can be argued that the academic entrepreneurs realized that their business model designs had the potential eventually to deliver large scale sustainable returns. So they focused on re-defining their value propositions and rearranging their organization structures, which increased their chances of obtaining greater financial resources. Thus, innovative value composition impacted two core components of the USOs' business models. In the first place, their organizational dimensions were transformed when they realized they needed more professional staff and more effective delivery channels (Visintin and Pittino, 2014). Second, both their ability to demonstrate customer-oriented products and services, and the greater

credibility resulting from their transformed structures, enabled the ventures to acquire novel resources and competencies, i.e. specifically, more extensive external investment.

5.5 Sustainable Return Phase and Scalability Loop

All three firms studied in this research, although at different scale, have reached financially sustainable phases, and USO_C especially has started to scale up its operations. The USOs started to expand the scope of their activities, creating what we can call a *value network extension* (Zhao et al., 2013) by collaborating with other firms (inside and/or outside the same industry). For instance, USO_A realized that it could address two very different customer segments; one that could be targeted by collaborating with large health retailers, while the other by giving users the opportunity to download games via the Internet. In the USO_B case, after the initial genetic testing platforms brought the firm sustainable returns, the company started to scale its operations up by offering the results to new customers in other parts of the NHS. Changes in USO_C's business model enabled the firm not only to become sustainable by generating value from its existing technological platforms, but also to respond to new commercial opportunities by entering new market segments and collaborating with multinational drug companies.

The decisions to extending their value networks resulted in major transformations in the USOs' business models, because they influenced all three core components. Essentially, these changes impacted on their organizational structures, as they went on to develop several partnerships beyond their company boundaries. The firms' value propositions also changed radically, as they no longer focused on single product or service lines, but rather diversified their offers to cover new market segments (Lehoux et al., 2014). Generating greater value by serving larger market segments, and by working in partnership with larger industry players, resulted in major transformations of the USOs' resources, which gave them access to wider combinations of infrastructures and competences. Figure 2 summarizes how different components of the USOs' business models changed over their last three development phases.

-Figure 2-

6. Conclusion, Contributions and Future Directions

This paper has attempted to answer to the questions of how USOs business models evolve,

and how the interactions between and within their core business model components can lead them to financial sustainability and operational scalability. To answer these questions, we have outlined a multi-phased development model for USOs, and employed empirical evidence gathered from three comprehensive case. Our empirical examination of these university spinouts' development paths across several levels of analysis emphasizes that, in the early phases of their development, USOs are unclear about their business models and the complex relationships between their key components. Hence they cannot follow the traditional ladder to growth (Osterwalder and Pigneur 2011), in which the value proposition is first defined, followed by characterizing the customer segment, and classifying the key resources, activities and other key business model components.

More specifically, the USOs do not establish their business models in their research and opportunity framing phases. The three key BM components only begin to take shape during the pre-organization phase, as a result of the consolidation of their organization structures. However, the notion of their value proposition is still unclear, due to uncertainty about the commercial potential of their technologies, and the availability of sufficient funding (Politis et al., 2012). The first commercial types of (customer-oriented) business models are generated in the re-orientation phase, during which the direction of the basic BM three components moves towards potential market considerations, and when professional people join the team, formal structures of supply chains and distribution channels surface, and the USOs begin to have a fairly clear understanding of their cost structures and value streams. When they reach the point of earning an appropriate level of returns, they start to extend their value networks, and their business models shift towards more collaboration-oriented models, in which key partners come into play. It is in this phase that the USOs realize the fact that to continue their sustainability in the industry is subject to first having the organizational flexibility to constantly revise their business models, and, second, to making collaborations with key industry players. After achieving these two steps, USOs should be capable of scaling up their operations into more production lines, and serving more customers in national and international markets.

This research contributes to research on the development of USOs in several ways. First, it extends the conceptual framework proposed by Vohora et al. (2004) by demonstrating that the sustainability phase should not be considered as the final phase of development, since

reaching this point does not mean that ventures can actually scale their operations up. Hence, we add the scalability loop phase, in which illustrates how, once USOs have become financially sustainable, they may start to expand their operations (again), marketing more products/services and serving more customers. Second, by adding the RCOV framework (Demil and Lecocq, 2010) to emphasize a dynamic perspective towards business model concept, this study provides a more comprehensive framework for university spinout processes that takes into account how BMs change during these ventures' development phases. We clarify that, as well as describing the configurations of business model elements (in a static view), the way in which business models evolve over time (taking a dynamic view) must be taken into consideration and examined. Hence, we explained how business models evolve through phases of development until operational scalability is reached. Using a business model perspective to address the topic of organization change and evolution is consistent with the concerns of both practitioners and academics (Moyon and Lecocq, 2014)

This research also contributes to the literature on the business model concept, since very few previous studies have explored business model transformation over multiple phases of organizational development; and those that have touched on this issue have tended to take a 'before/after' view of the process of business model evolution (see for instance Sosna et al., 2010). Our study also explicitly addresses the concerns of academic entrepreneurs seeking to commercialize scientific innovations and ideas by establishing a USO backed by their parent universities and venture capital investors. Our examinations of the evolution of the key components of USOs' business models shows that academic entrepreneurs should pay constant attention to the arrangement of their resources to move through the phases, to generate new value propositions and to modify their organization structures.

We suggest that three types of future studies are required. First, research should systematically compare the similarities and differences between university spinouts and other types of start-ups, which could be carried out using empirical data gathered from selected start-ups that are in similar industries or that provide similar product/services. Second, the effectiveness of the different models university TTOs employ to help USOs reach sustainability and scalability need to be examined. Third, the circumstances in which business model evolution might put the USO into a critical phase where the founder(s) might consider implementing an exit strategy require further analysis.

9. References

- Ambos, T.C. and Birkinshaw, J. (2010) "How do new ventures evolve? An inductive study of archetype changes in science-based ventures", *Organization Science*, vol. 21, no. 6, pp. 1125-1140.
- Amit, R. and Zott, C., (2012). Creating value through business model innovation. *MIT Sloan Management Review*, vol 53.
- Baden-Fuller, C. and Morgan, M.S. (2010), "Business models as models", *Long Range Planning*, vol. 43 nos 2/3, pp. 156-71.
- Bjørnåli, E.S. and Gulbrandsen, M. (2010) "Exploring board formation and evolution of board composition in academic spin-offs", *The journal of Technology Transfer*, vol. 35, no. 1, pp. 92-112.
- Bozeman, B., Rimes, H., and Youtie, J. (2015). The evolving state-of-the-art in technology transfer research: Revisiting the contingent effectiveness model. *Research Policy*, vol. 44, no. 1, pp. 34-49.
- Casadesus-Masanell, R. and Ricart, J.E. (2010) "From strategy to business models and onto tactics", *Long range planning*, vol. 43, no. 2, pp. 195-215.
- Cassar, G. (2014). Industry and startup experience on entrepreneur forecast performance in new firms. *Journal of Business Venturing*, vol. 29, no. 1, pp. 137-151.
- Chiesa, V. and Piccaluga, A. (2002) "Exploitation and diffusion of public research: the case of academic spin off companies in Italy", *R&D Management*, vol. 30, no. 4, pp. 329-340.
- Clarysse, B. and Moray, N. (2004) "A process study of entrepreneurial team formation: the case of a research-based spin-off", *Journal of Business Venturing*, vol. 19, no. 1, pp. 55-79.
- Clarysse, B., Wright, M., and Van de Velde, E. (2011). Entrepreneurial Origin, Technological Knowledge, and the Growth of Spin-Off Companies. *Journal of Management Studies*, vol. 48, no.6, pp. 1420-1442.
- Demil, B. and Lecocq, X. (2010) "Business model evolution: in search of dynamic consistency", *Long range planning*, vol. 43, no. 2, pp. 227-246.
- Druilhe, C. and Garnsey, E. (2004) "Do academic spin-outs differ and does it matter?", *The Journal of Technology Transfer*, vol. 29, no. 3, pp. 269-285.
- Eisenhardt, K.M. and Graebner, M.E. (2007) Theory building from cases: opportunities and challenges. *Academy of Management Journal*, 50, 25–32.
- Freitas, J. S., Gonçalves, C. A., Cheng, L. C., and Muniz, R. M. (2013). Structuration aspects in academic spin-off emergence: A roadmap-based analysis. *Technological Forecasting and Social Change*, vol. 80, no, 6, pp. 1162-1178.
- Goddard, J., Robertson, D., Vallance, P., 2012. Universities, Technology and Innovation Centres and regional development: the case of the North-East of England. *Cambridge Journal of Economics* vol. 36, pp. 609-627.
- Iacobucci, D., and Micozzi, A. (2014). How to evaluate the impact of academic spin-offs on local development: an empirical analysis of the Italian case. *The Journal of Technology Transfer*, pp. 1-19.
- Johnson, M.W., Christensen, C.M. and Kagermann, H. (2008) "Reinventing your business model", *Harvard business review*, vol. 86, no. 12, pp. 57-68.
- Kim, W.C. and Mauborgne, R. (2000) "Knowing a winning business idea when you see one", *Harvard business review*, vol. 78, no. 5, pp. 129-138.
- Lehoux, P., Daudelin, G., Williams-Jones, B., Denis, J. L., and Longo, C. (2014). How do business model and health technology design influence each other? Insights from a longitudinal case study of three academic spin-offs. *Research Policy*, vol. 43, no. 6, pp. 1025-1038.

- Lockett, A. and Wright, M. (2005) "Resources, capabilities, risk capital and the creation of university spin-out companies", *Research Policy*, vol. 34, no. 7, pp. 1043-1057.
- Mahadevan, B. (2000) "Business models for Internet-based e-commerce", *California management review*, vol. 42, no. 4, pp. 55-69.
- Miles, M.B. and Huberman, A.M. (1994) *Qualitative data analysis: An expanded sourcebook*, Sage Publications, Incorporated.
- Miller, K., McAdam, M., and McAdam, R. (2014) The changing university business model: a stakeholder perspective. *R&D Management*, 44(3), 265-287.
- Moyon, E., and Lecocq, X. (2014) "Rethinking Business Models in Creative Industries: The Case of the French Record Industry", *International Studies of Management & Organization*, vol. 44, no. 2, pp. 83-101.
- Mustar, P., Renault, M., Colombo, M.G., Piva, E., Fontes, M., Lockett, A., Wright, M., Clarysse, B. and Moray, N. (2006) "Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy", *Research policy*, vol. 35, no. 2, pp. 289-308.
- Mustar, P., Wright, M. and Clarysse, B. (2008) "University spin-off firms: lessons from ten years of experience in Europe", *Science and Public Policy*, vol. 35, no. 2, pp. 67-80.
- Ndonzuau, F. N., Pirnay, F., and Surlemont, B. (2002). A stage model of academic spin-off creation. *Technovation*, 22(5), 281-289.
- Osterwalder, A. (2004) "The Business Model Ontology: a proposition in a design science approach", *Institut d'Informatique et Organisation. Lausanne, Switzerland, University of Lausanne, Ecole des Hautes Etudes Commerciales HEC*, vol. 173.
- Osterwalder, A., Pigneur, Y., and Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the association for Information Systems*, vol. 16, no. 1.
- Osterwalder, A., Pigneur, Y., (2011). *Business Model Generation: A handbook for visionaries, game changers and challengers*, John Wiley & Sons
- Penrose, E.T. (1960) "The growth of the firm—a case study: the Hercules Powder Company", *Business History Review*, vol. 34, no. 01, pp. 1-23.
- Pereira Da Costa, Antonio Sergio and Levie, Jonathan (2014) *Effectual and causal behaviors, business model change, and performance of early-stage firms*. In: *Academy of Management Conference*
- Politis, D., Gabriellson, J., and Shveykina, O. (2012). Early-stage finance and the role of external entrepreneurs in the commercialization of university-generated knowledge. *Venture Capital*, vol. 14, no.2, pp 175-198.
- PraxisUnico (2012) *Spinouts UK Survey*, Edinburgh.
- Rasmussen, E. (2011) "Understanding academic entrepreneurship: Exploring the emergence of university spin-off ventures using process theories", *International Small Business Journal*, vol. 29, no. 5, pp. 448-471.
- Rasmussen, E., Mosey, S., and Wright, M. (2014). The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures. *Research Policy*, vol. 43, no, pp. 92-106.
- Santos, F. M., and Eisenhardt, K. M. (2005). Organizational boundaries and theories of organization. *Organization Science*, vol. 16, no. 5, pp 491-508.
- Schilke, O. (2014). On the contingent value of dynamic capabilities for competitive advantage: The nonlinear moderating effect of environmental dynamism. *Strategic Management Journal*, 35(2), 179-203.
- Siggelkow, N. (2002). Evolution toward fit. *Administrative Science Quarterly*, vol. 47, no. 1, pp. 125-159.
- Shane, S.A. (2004) *Academic entrepreneurship: University spinoffs and wealth creation*, Edward Elgar Publishing.

- Sirmon, D.G., Hitt, M.A., Ireland, R.D. and Gilbert, B.A. (2011) "Resource Orchestration to Create Competitive Advantage Breadth, Depth, and Life Cycle Effects", *Journal of Management*, vol. 37, no. 5, pp. 1390-1412.
- Smith, K.G., Mitchell, T.R. and Summer, C.E. (1985) "Top level management priorities in different stages of the organizational life cycle." *Academy of management Journal*, vol. 28, no. 4, pp. 799-820.
- Straus, A. and Corbin, J. (1998) *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 2nd ed. Thousand Oaks, CA: Sage Publications.
- Sørheim, R., Widding, L.Ø, Oust, M. and Madsen, Ø (2011) "Funding of university spin-off companies: a conceptual approach to financing challenges", *Journal of Small Business and Enterprise Development*, vol. 18, no. 1, pp. 58-73.
- Townsend, D. M., and Busenitz, L. W. (2014). Turning water into wine? Exploring the role of dynamic capabilities in early-stage capitalization processes. *Journal of Business Venturing*. (In Press)
- Treibich, T., Konrad, K., and Truffer, B. (2013). A dynamic view on interactions between academic spin-offs and their parent organizations. *Technovation*, vol. 33, no. 12, pp. 450-462.
- Visintin, F., and Pittino, D. (2014). Founding team composition and early performance of university—Based spin-off companies. *Technovation*, vol. 34, no. 1, pp. 31-43.
- Vohora, A., Wright, M. and Lockett, A. (2004) "Critical junctures in the development of university high-tech spinout companies", *Research Policy*, vol. 33, no. 1, pp. 147-175.
- Wright, M., Clarysse, B. and Mosey, S. (2012) "Strategic entrepreneurship, resource orchestration and growing spin-offs from universities", *Technology Analysis & Strategic Management*, vol. 24, no. 9, pp. 911-927.
- Wright, M., Lockett, A., Clarysse, B. and Binks, M. (2006) "University spin-out companies and venture capital", *Research Policy*, vol. 35, no. 4, pp. 481-501.
- Yin, R.K. (2003) *Case Study Research: Design and Methods*, Sage Publications, London.
- Zhao, Y. L., Song, M., and Storm, G. L. (2013) "Founding Team Capabilities and New Venture Performance: The Mediating Role of Strategic Positional Advantages", *Entrepreneurship Theory and Practice*, 37(4), 789-814.

	<i>USO_A</i>	<i>USO_B</i>	<i>USO_C</i>
<i>Background/ Business Nature</i>	Founded in 2010 in partnership with the University and the UK's NHS Trust. The firm specializes in the design and development of Assistive Living Technologies and Services (ALTS), such as computer-based applications for assisted living purposes.	Established in 2008 through a partnership between the NHS Foundation Trust and the University to focus on focusing on developing, validating and delivering molecular diagnostics using the latest sequencing and genotyping technologies.	Established in 2001 through the collaboration with the University TTO to focus on Systems biology drug discovery through patented platforms.
<i>Initial Founder / Current CEO</i>	Academic Entrepreneur / Academic Entrepreneur	Academic Entrepreneur / Professional Business Person	Academic Entrepreneur / Academic Entrepreneur
<i>Founder Background</i>	Professor of neuroscience with extensive knowledge and experience in after stroke rehabilitation methods	Leading professor in clinical genetics and a medical consultant with over 20 years of experience.	Senior academic in clinical studies focusing on brain activities and how different novel drugs can cure the damages-sections of the brain.
<i>Main Shareholders</i>	University and NHS Foundation Trust	University and NHS Foundation Trust	Venture Capital Firm, Academic Entrepreneur and University
<i>Phase of Development (2013)</i>	Sustainable Return	Sustainable Return	Sustainable Return Phase – entered into Scalability Loop
<i>Formation Framework</i>	Low- level Support	High- level Support	Medium- level Support
<i>Major Initial Funding / Size / Turnover (2013)</i>	£250K / 6 employees / Not Disclosed	£700K / 12 employees / ~ £1m (2013)	£90K / 20 employees / ~ £9m (2013)

Table 1. Overview of the Case Studies

	<i>Research Phase</i>	<i>Opportunity Framing Phase</i>	<i>Pre-organization Phase</i>	<i>Re-orientation Phase</i>	<i>Sustainable Return Phase & Scalability Loop</i>
<i>Resources & Competencies</i>	Medical academics expert in identifying innovative ways to improve the rehabilitation process.	Bringing in a few software and hardware developers as well as business experts to prepare a business plan.	Securing the first major research grant (worth £250K) to design applications for rehabilitation.	Securing a £2.1m research grants to design and develop the entire rehabilitation package in-house.	Employing more IT experts to develop a novel algorithm to collect patients' information in a more systematic and efficient way.
<i>Organization Structure</i>	The academic entrepreneur and a few academic colleagues pursue their interests in using technological innovations for assistive living purposes.	Representatives from the NHS and University joined the executive board.	Business experts from the TTO recommended firm should stay just as a game publisher. No formal conclusions regarding suppliers or distributors.	Forming two other firms as middleware and game producers. Initiating negotiations with large healthcare suppliers. .	Starting collaboration with large health and medical care retailers in order to reach self-purchasing market.
<i>Value Proposition</i>	Knowledge of identifying the areas in which computer-based applications can improve the efficiency and effectiveness of rehabilitation.	Applications that could be used on PC, laptop and other platforms to assist physiotherapy.	Rehabilitation package designed in-house with support of software and hardware developers.	Medical information gathered via the package to improve the process of rehabilitation, and the package itself.	Offering more personalized assisted living technologies and services on self-purchased market.

Table 2. The Evolution of USO_A's Business Model during its Development Phases

	<i>Research Phase</i>	<i>Opportunity Framing Phase</i>	<i>Pre-organization Phase</i>	<i>Re-orientation Phase</i>	<i>Sustainable Return Phase & Scalability Loop</i>
<i>Resources & Competencies</i>	Professor of Clinical Genetics focused on applying latest sequencing technology in molecular diagnostics.	Knowledge and skills gained through in-depth experiments on genetic testing using new technological platforms.	Securing the first major research fund (approx. £700K) by illustrating the efficiency of the new method.	Entering several collaborations with major labs and drug companies to improve testing platforms.	Although the business is profitable, plans have been prepared to improve and increase the numbers of medical experts involved.
<i>Organization Structure</i>	The academic entrepreneur as the main founder, with support from some academic colleagues.	Four staff (2 seconded from the University and 2 from the NHS Trust) joined the company to prepare formal business plans.	Bringing in another 12 professionals to maintain the platforms already developed, and to design and develop new platform(s).	Strategic decisions to (a) focus more on personalized medicine testing services (b) get support from the NHS to improve the platforms.	No plan has yet been prepared to reform the organizational structure.
<i>Value Proposition</i>	Knowledge of bringing new technological innovations into genetic testing experiments.	Innovative genetic testing platforms that could decrease process times and improve the accuracy of the results.	Offering a molecular diagnostic service using the latest generation sequencing technology and services for human genome capture.	Three new platforms to accelerate the genetic testing process, and become more focused on personalized medicine.	New testing platforms that can run more genetic tests at the same time with lower maintenance costs.

Table 3. The Evolution of USO_B's Business Model during its Development Phases

	<i>Research Phase</i>	<i>Opportunity Framing Phase</i>	<i>Pre-organization Phase</i>	<i>Re-orientation Phase</i>	<i>Sustainable Return Phase & Scalability Loop</i>
<i>Resources & Competencies</i>	Small grants that enabled the academic entrepreneur and his colleagues to carry out preliminary research on brains activities.	Knowledge gained through the small granted projects.	Securing £90k from Northstar Equity Investors. Suggestion to fill in IPO and become a public firm.	Going public and joining London's Stock Exchange, which raised £1.3m.	Raised £50m to advance lead cancer drug and exploit network pharmacology platform.
<i>Organization Structure</i>	Research-focused activities and experiments by the academic entrepreneur and his colleagues in the University's labs.	No external employees – still just the academic entrepreneur focusing on selling bio-tech software to drug companies.	Bringing in professional business staff from TTO, engaging with drug companies to de-risk the drug development processes.	Focusing more on partnership/collaboration agreement to get involved in drug development processes with big drug companies.	Discovery functions and the scientists dealing with them moved to one of the world's biggest centers for network biology in Oxford.
<i>Value Proposition</i>	The knowledge and experience gained through a network system analysis to identify drugs that are both safe and effective.	Published results of the experiments in top medical journals, preliminary discovery platforms and computers.	Clinical assets including several sophisticated discovery platforms, enabling firm to enter the drug development process.	The two very large data resources; one focused on protein interacts, the other which includes 15m unique compounds containing 2.6m unique proteins.	Results of phase I of drug discovery; examining whether the candidate can survive in other phases.

Table 4. The Evolution of USO_C's Business Models during its Development Phases in

	<i>Research Phase</i>	<i>Opportunity Framing Phase</i>	<i>Pre-organization Phase</i>	<i>Re-orientation Phase</i>	<i>Sustainable Return Phase & Scalability Loop</i>
<i>Resources & Competencies</i>	No specific resources. Primary knowledge of the academic entrepreneur in the field.	Knowledge and skills gained through in-depth experiments / knowledge about potential opportunities. Still no funding.	The first research grant to carry out more in-depth and advanced experiments.	Several large research grants. – Professional and skilled employees on board.	Combination of infrastructure and competencies through partnership. Become public to raise more cash.
<i>Organization Structure</i>	No Formal structure. The AE as the only person who undertook the initiative to commercialize.	No Formal structure. Negotiation with the University to bring in professionals to form the executive board.	Formal executive board /constituted Business experts and professionals brought on board. No formal strategies regarding suppliers and distributors.	Defining position in the industry - Characterizing the distribution channel(s) and supply chain management.	Enters into collaboration with other USOs or private companies to share the risk and profits.
<i>Value Proposition</i>	No tangible product/service in this stage.	Still no customer-oriented product/service at this stage. Initial results of the experiments.	The intellectual property as the preliminary value proposition.	More personalized products/services based on customers' requirements.	Diversity in products/ services that can serve new market segments/ international markets.

Table 5. The Business Model Evolutions during USOs' Development Phases

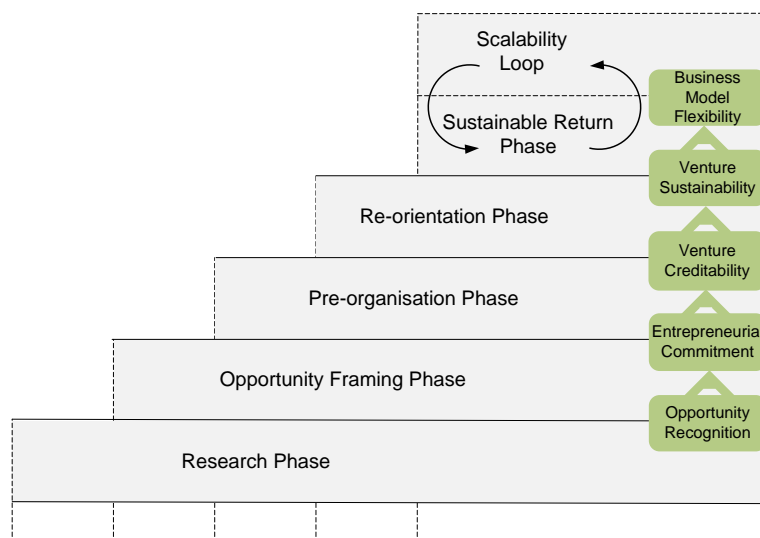


Figure 1. The Development Process of University Spinouts (Adapted from Vohora et al. 2004)

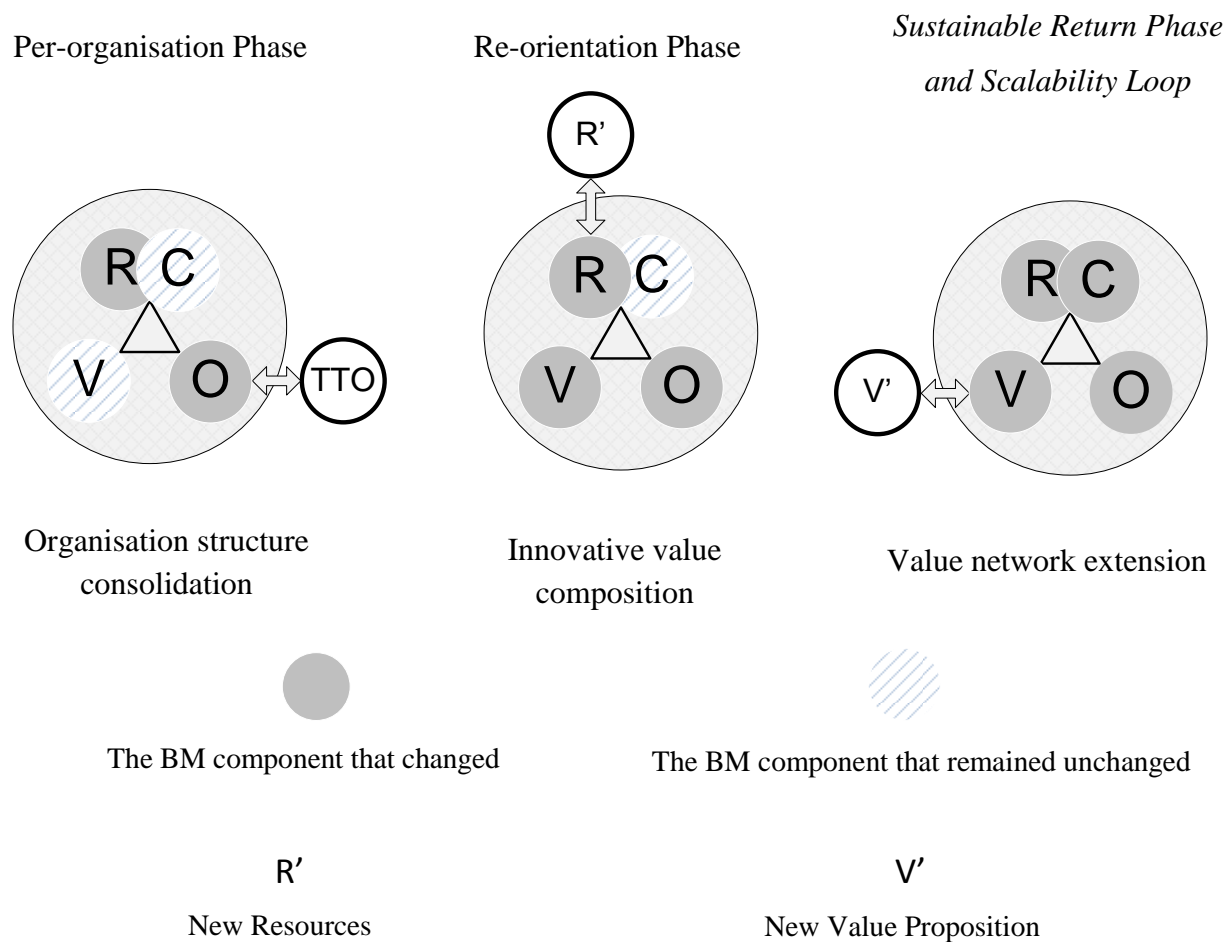


Figure 2. Changes in Key USO Business Model Components