Paper to be presented at the DRUID Academy Conference 2017 at University of Southern Denmark, Odense, Denmark on January 18-20, 2017

Business Models in Commercialising University Intellectual Property: The Causal and Effectual Reciprocation

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Abstract

Business Models in Commercialising University Intellectual Property: The Causal and Effectual Reciprocation Zurina Moktar1 & Chander Velu2 Institute for Manufacturing (IfM), Department of Engineering, University of Cambridge, 17 Charles Babbage Road, Cambridge, CB3 0FS, UK Enrolment and completion year: 2015-2019 Email: zm269@cam.ac.uk1, c.velu@eng.cam.ac.uk2 ABSTRACT State-of-the-art Prior studies have formalised the role of business models in bringing university intellectual property (IP) into the market. Extant entrepreneurial literature has also explored the causation and effectuation theory as two contrasting decision-making mechanisms valuable in explicating business logics. However, explanations on the business models evolution often lack the notion of causation and effectuation. Research gap Decision-making mechanisms in commercialising university IP that lead to the resultant business models appeared to be understudied. Therefore, the research question addressed in this paper is: How do causal and effectual processes affect business model development in commercialising university IP? Theoretical arguments This paper aims to investigate the causal and effectual processes that influence business model evolution in commercialising university IP. Causation is a goal driven process that focuses on selecting between means to create an effect, whereas, effectuation is an experimentation process that focuses on selecting between possible effects that can be created with the set of means. Method Using in depth case study method, this research empirically investigates the evolution of five university spin-off companies (USO), which received commercialisation assistance from the technology transfer office (TTO) in one of the UK top ranked universities. Results Research findings suggest that USO and TTO configured causal and effectual processes in specific ways throughout the course of commercialising university IP. The success of USO in commercialising such IP can be attributed to the non-predictive logic of effectual processes. All four USO began with effectual business model and gradually transition to causal business model when the technology had reached maturity stage. Rather than focusing on

competition, USO that dealt well with contingencies demonstrated the ability to experiment with strategies, form partnership, respond to resource constrains and allow justifiable change in goals over time. Research findings also demonstrate that causal business models are most effective in commercialising IP with higher technology readiness level within an existing market. References Amit, R., & Zott, C. (2012). Creating value through business model innovation. MIT Sloan Management Review, 53(3), 41. Berends, H., Jelinek, M., Reymen, I., & Stultiëns, R. (2014). Product innovation processes in small firms: Combining entrepreneurial effectuation and managerial causation. Journal of Product Innovation Management, 31(3), 616-635. Hindle, K., & Yencken, J. (2004). Public research commercialisation, entrepreneurship and new technology based firms: an integrated model. Technovation, 24(10), 793-803. Lubik, S., & Garnsey, E. (2016). Early business model evolution in science-based ventures: the case of advanced materials. Long range planning, 49(3), 393-408. Read, S., Dew, N., Sarasvathy, S. D., Song, M., & Wiltbank, R. (2009). Marketing under uncertainty: The logic of an effectual approach. Journal of Marketing, 73(3), 1-18. Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. Academy of management Review, 26(2), 243-263. Siegel, D. S., Veugelers, R., & Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: performance and policy implications. Oxford Review of Economic Policy, 23(4), 640-660. Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. Journal of engineering and technology management, 21(1), 115-142. Sitoh, M. K., Pan, S. L., & Yu, C. Y. (2014). Business models and tactics in new product creation: The interplay of effectuation and causation processes. IEEE Transactions on Engineering Management, 61(2), 213-224.

Jelcodes:L10,-

Paper submitted to:
DRUID Academy Conference 2017 *"Economics and Management of Innovation, Technology and Organizations"* 18-20 January 2017,
University of Southern Denmark, Odense, Denmark

Business Models in Commercialising University Intellectual Property (IP): Causal and Effectual Reciprocation

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Causal and effectual modes are two generic entrepreneurial decision-making mechanisms for new business development. Despite burgeoning empirical research based on this theory, the decision-making approach in commercialising university IP that leads to the resultant business models appears to be understudied. Explanations of the resultant business model lacks the notion of causation and effectuation. We address this issue by investigating the causal and effectual processes that influence business model development in commercialising university IP. Using an in-depth case study method, this research applies a causation and effectuation construct to rich data from commercialisation decisions at five university spin-off companies (USO). Research findings suggest that USO configured causal and effectual processes in specific ways throughout the course of commercialising university IP. Most USO began with effectual modes and gradually transitioned to causal mode when the technology had reached a mature stage. The success of USO in commercialising such IP can be attributed to the non-predictive logic of effectual processes in the face of technological and market uncertainty. Research findings also demonstrate that causal processes are most effective in commercialising IP with higher technology readiness levels within an existing market.

Keywords: business model, IP commercialisation, causation and effectuation

1. Introduction

The commercialisation of university IP has become an increasingly important issue, partly driven by universities' motivation to maximise their returns on IP (Perkmann et al., 2013; Markman et al., 2008; Locket & Wright, 2005; Goldfarb & Henrekson, 2003). Likewise, IP commercialisation strategies such as licensing and spin-off establishments attract major attention within both the academic literature and the policy community (Lehoux et al., 2014; O'Shea et al., 2008; Rothaermel et al., 2007). In maximising IP returns through the commercialisation process, business model is one of the key constructs to create, capture and deliver value to customers (Chesbrough, 2007; Teece, 2010). Past research has sought to investigate the ability of business models to create, capture and deliver value from technology (Richardson, 2008; Nelson, 2006; Teece, 1988). However, empirically driven work to explicitly examine entrepreneurial decision-making process behind the established business model is notably lacking. Correspondingly, Zott et al. (2011) and Zott and Amit (2007) posit that research on business models appears to occur in isolated silos across various disciplines, without sufficient interactions among them. Therefore, despite its importance, decision-making mechanism process for the resultant business model seems to have been disregarded.

In a similar vein, extant entrepreneurial literature has explored the causation and effectuation theory as two contrasting decision-making mechanisms valuable in explicating business logics. However, explanations on the business models evolution often lack the notion of causation and effectuation. As a result, literature often fails to demonstrate the iterative process involving causation and effectuation modes before university IP is commercialised. Poor understanding on the decision-making process could result in a serious incapability to survive the crucial juncture of the commercialisation stage (Lubik & Garnsey, 2015; Sætre et al., 2006; Ndonzuau et al., 2002). This caveat highlights the missing link in the literature between entrepreneurial decision-making process and the resultant business model to commercialise university

IP. The urgent need to integrate these two streams of knowledge has now come into focus. Hence, this paper is an attempt to extend current literature by empirically advancing our understanding of how resultant business model come into place. This is achieved by investigating the entrepreneurial decision-making mechanism. Therefore, the research question addressed in this paper is: *How do causal and effectual processes affect business model development in commercialising university IP?*

2. Literature Summary

2.1 University Spin-Offs as IP Commercialisation Channel

Technological invention originates from several inceptions and university research constitutes a vital source. Most often, these technological inventions are protected legally through IP protection. In the general sense, the World Intellectual Property Organization (WIPO) defines IP as "creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce" (WIPO, 2008). The most common types of IP that a university draws upon are: patents, trade secrets and sometimes copyright. Depending on the type of IP and the country where the IP law is enacted, owners are granted certain exclusive rights over their inventions (Ryder & Madhavan, 2014). In the university context, IP, customarily governed by the University IP Rights Policy, can be considered as the outcome of research projects.

In order to commercialise IP resulting from university research, it is common for a university to establish a new company through a separation process and this new company is known as a USO. Together with the relevant intangible assets, the university transfers to the new legal entity the obligations and risks associated with the commercialisation of the IP (Pattnaik & Pandey, 2014). Indeed, Clarysse et al. (2011) and Vohora et al. (2004) also explain that USO creation involves the development of a separate project with the subsequent allocation of legal rights and responsibilities, risk management, and to some extent fundraising to attract investors for financial contributions. According to Pirnay and Surlemont (2003), a spin-off falls under many types of divisions, of which a USO is one specific category. Klofsten and Jones-Evans (2000) define a USO as "a new firm or organisation to exploit the results of the university research". According to Banal-Estañol and Macho-Stadler (2010), a USO is a firm that is in the earliest phase of a new entrepreneurial venture. Despite its infancy stage, a USO has long been known as a means for research institutions to commercialise their technology (Pattnaik & Pandey, 2014; Rothaermel et al., 2007).

As a matter of fact, USO creation strategy is closely aligned with its intention to bring IP-protected technology into the market. Bringing latent and IP-protected technology into the market is a complex process. Due to this, the exploitation of university research results via the creation of USO appears to be an under-developed option to create wealth from the commercialisation of research (Shane, 2004; Etzkowitz, 2003; Siegel et al., 2003). In this sense, USO creation should ideally blend with its business-model development. Pioneering studies argue that transitioning new technology into the market requires more than scientific knowledge; it also needs to be sustained by a business model (Lubik & Garnsey, 2015; Chesbrough, 2007). The next section presents literature on the clarification of business model in commercialising IP protected technology.

2.2 Business Models in Commercialising IP Protected Technology

The business-model concept emerged with the Internet boom of the late 1990s, and it has been gathering momentum ever since (Osterwalder et al., 2005; Morris et al., 2005). Today, the term 'business model' is prevalent both in business study and management study (Zott et al., 2011; Teece, 2010; Baden-Fuller & Morgan, 2010). Interest in this topic has mainly been reinvigorated by the benefits a business model offers in enhancing competitive advantage, which has been demonstrated by both academics and practitioners (Mason & Mouzas, 2012; Shafer et al., 2005; Morris et al., 2005). Despite its rapid proliferation, the business-model concept still lacks a uniform definition (Lubik & Garnsey, 2015; Zott et al., 2011). Likewise, Hedman and Kalling (2003) argue that a business model is frequently defined according to its intended use, causing insufficient grounding in theory. In light of this, Shafer et al. (2005) maintain that a business-model definition should be simple enough to be easily understood, communicated and remembered. The definition the authors offer is: "a business model is a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network."

Due to its infancy stage, business-model literature polarises largely in silos across various disciplines. Nevertheless, one phenomenon of interest that can be seen growing is the role of business models to unlock the value embedded in technology (e.g. Lubik & Garnsey, 2015; Lehoux et al., 2014; Baden-Fuller & Haefliger, 2013; Zott et al., 2011; Esslinger, 2011; Baden-Fuller & Morgan, 2010; Calia et al., 2007). The innovation literature has also extended our understanding about how the business model can be operationalised as a means of profiting from innovation (e.g. Teece, 2007, 1988; Chesbrough et al., 2003). In sum, business model is mainly seen as a mechanism that connects a firm's technology to customer needs and to other resources of the firm (Teece, 2010).

Lubik and Garnsey (2015) and Lehoux et al. (2014) argue that business models not only entail consequences for technological innovations, but can also be shaped by them prior to commercialising a technology. This area of study is particularly important because bringing new technology into the market is not a straightforward task. Rather, it is complicated and non-linear, so much so, the decision-making mechanism behind the business model establishment is equivalently important to be understood. Otherwise, the multifaceted challenges encapsulating commercialisation stage (owing to the uncertain technology value and target market) will fail (Anderson & Tushman, 1991). Despite this, there appeared to be a limited body of work upholding the need to understand the decision-making mechanism prior to establishing a business model to commercialise university IP. The next section discuses causation and effectuation theory as potential explanations to entrepreneurial decision-making mechanism in commercialising university IP.

2.3 Causation and Effectuation Theory

This study builds upon the causation and effectuation theory as the underlying explanation towards the decision-making mechanism prior to business model establishment (in commercialising university IP). Causation and effectuation theory distinguishes two contrasting entrepreneurial logics; causation processes take a particular effect as given and focus on selecting between means to create that effect, while effectuation processes take a set of means as given and focus on selecting between possible effects that can be created with that set of means (Sarasvathy, 2001; 2009). Causation rests in the logic of prediction based on the premise that "to the extent we can predict the future, we can control it". Oppositely, effectuation rests in the logic of control based on the premise that "to the extend we can control the future, we do not need to predict it" (Sarasvathy, 2009). Despite the clear segregation between these two approaches, causation is not superior over effectuation and vice versa (Sitoh et al., 2014; Sarasvathy, 2001; 2009). In fact, both processes can coexist, overlap and intertwined with one another. Therefore, both processes can be configured in specific ways (Sitoh et al., 2014).

Causation and effectuation concept has attracted attention in the entrepreneurship research field since it was first coined by Saravsvathy (2001) (e.g. Sitoh et al., 2014; Berends et al., 2014; Maine et al., 2012; Chandler et al., 2011). However, Berends et al. (2014) argue that there have been limited studies investigating this theory in the real-life setting. To relate, causation and effectuation notion in business model to commercialise university IP is notably scare. It is well understood that university IP commercialisation is a journey stern with pitfalls. University IP is commercialised often in the face of uncertainty and most of the time the market is unknown ex ante (Read et al., 2009). Hence, USO often deduces business models without being able to thoroughly rationalise or articulate it (Sitoh et al., 2014). This underscores the importance to explore the causation and effectuation mechanism deeper as the theoretical lens to understand business model establishment.

3. Method

A cross-sectional, in-depth case study method was employed to allow rich contextual insight and in-depth understanding of how business model is established in five USO (Yin, 2013; Eisenhardt, 1989).

Case selection. This research selects IP commercialisation cases in a UK top ranked public research university with an established Technology Transfer Offices (TTO). The university selected is deemed to have a strong technology-transfer profile and is located in a high-technology cluster. All five USO exploit and commercialise technologies resulting from physical science research. Four USO are commercialising technologies for the cleantech industry while the other one is commercialising technology for the medical device industry. While most criteria advantageously provide a similar context and reduce rival explanations, the ability to select different industries could potentially intensifies research external validity (Yin, 2013).

Data collection. Primary data were collected through visits, conversations and semi-structured interviews over a five-month period, n=26. Interviewees consisted of USO academic founders, USO case managers from the TTO, USO CEO (or equivalent position) and other stakeholders involved in the commercialisation of university IP. Decisions about which participants to interview in each round were informed by an on-going analysis, which aimed to gain additional perspectives on the existing data (Rasmussen et al., 2011). Since the interview method relied heavily on the interpretation of data from the research participants, data triangulation was incorporated by including several other sources, such as annual reports, strategy plans, policy papers and web pages.

Data analysis. In order to build a theory from the interview findings, the data were analysed in such a way as to answer the research questions meaningfully (Eisenhardt, 1989). The analysis process anticipates rich text-based raw data that require a deep level of interpretation. With regard to this, a Template Analysis was employed to guide the analysis of the study (Symon & Cassell, 2012). Template analysis is a method of organising qualitative data, from textual format to hierarchical themes, led by building relations between the emerging themes (Brooks & King, 2012).

4. Findings

4.1 Case companies

Table 1 presents the case companies and their transitions from patented technologies to the resultant business models.

USO (year founded)	Patented technology	Application	Technology development	Resultant business model
Company A (2010)	Photovoltaic device and fabricating method	New technology to produce plastic solar cell modules	Exploit the technology to develop third generation solar cells based on printed plastic	Launched another spin off while developing the technology further. The new spin-off commercialises and manufactures pay-as-you-go solar power for Sub Saharan Africa's market
Company B (2006)	Microwave induced pyrolysis reactor and method	New technology to break down organic material in the absence of oxygen	Exploit the technology to develop reactor that can recycle plastic aluminium laminates	Commercialises customised, industrial-scale reactor for waste handlers, local authorities, fast moving consumer goods (FMCG) brands and consumers in the UK
Company C (2005)	Magnetic cooling method	New technology to generate low carbon cooling products	Exploit the technology to manufacture more efficient cooling appliances	Still developing the technology further for domestic and commercial appliances market
Company D (2006)	A passive ventilation stack	New technology to provide low energy ventilation system	Exploit the technology to develop low energy ventilation system for buildings	Commercialises and installs low energy ventilation system for buildings throughout the UK
Company E (2005)	Oxygen generation apparatus and method	New technology to generate humidified oxygen at above atmosphere pressure	Exploit the technology to develop medical device that promotes better wound healing process	Commercialises and manufactures medical device that promotes better wound healing process for patients in UK, Canada and US

Table 1. USO transition from patented IP to the resultant business model

Company A- Company A was founded in 2010 as a USO following the discovery of organic photovoltaic (OPV) device and method of fabricating. For the past six years, there has been series of commercialisation strategy changes which can be seen in two dimensions 1) how the company spends the resources in order to build a business model 2) being engineering led to being customer pulled. Company A knows fundamentally that they are going to be manufacturing OPV, what has changed was the emphasis from internally looking at improving a technology to meet their own goals to being one where it needs the customer to tell Company A what they want. In 2010 the newly appointed CEO decided not to wait for the technology to reach maturity stage and thought of commercialising whatever the company had. One of the academics confirmed the feasibility to commercialise a pay-as-you go solar box using standard silicon panel instead of OPV. When OPV is ready, it will then get substituted. In 2011 and while still developing OPV further, Company A launched another spin-off company as a new way to deliver off-grid solar power in Sub Saharan Africa. This provided a key route to market for Company A into high volume off-grid applications.

"Because without the idea there wouldn't be the opportunity. That's very true. However, without the money and skillset to commercialise it, there wouldn't be opportunity either. It's getting both sides to appreciate the value that brings to it." – CEO

Company B- Company B was established in 2006 as a USO after the discovery of microwave induced pyrolysis method. Today, this company aims to commercialise customised, industrial-scale reactor for waste handlers, local authorities, FMCG brands and consumers. However, at the point of writing, no reactor has been successfully sold. Waste handling industry has been very uncertain and company B business model has changed five to eight times in the last ten years. These changes were very specific to the case of this company due to the industry it is in. In 2007 the industry was suffering and the company fought very hard to survive. In 2010, Company B built a showcase plant and secured significant investment from a syndicate of investors. After multiple changes in the business model, Company B decided to go back to what has been proposed as the business model when the company was first founded.

"…the market had changed, the niche had changed, the situation had changed. For example, if our company was in the situation where it is now, in the technology development route from A to B (commercialisation), we are now in B, being today where we are, if the commodity prices today is what they were in 2008, I would have sold 5 plants by now." – Managing Director and Chief Technology Officer

"It was actually very funny because last Monday my board decided to go for (business model), it was approved on Monday, to resemble more what I have put in the original plan in 2006…after three or four different changes." – Managing Director and Chief Technology Officer

Company C- Company C was founded in 2005 as a USO. This was after the discovery of a new cooling technology that use advanced metal alloys and magnetic fields to drive a novel cooling cycle. The technology is aimed to be exploited in smaller domestic and commercial appliances where conventional gas based cooling technology is less efficient (rather than large industrial scale plants). Although the technology appeared to be most readily exploited, company C still work to create potential market for this technology. Nevertheless, Company C still continuously receives significant collaborative R&D funding from the European Union, Carbon Trust and the Technology Strategy Board. At the point of writing, Company C is still developing the technology further.

"You need to position your new technology as the opportunity to create new markets. Eventually you are going to displace the old technology but you will never win trying to fight against them. So always try to find the correct path avoiding confrontational."- CEO

Company D- Company D was formed as USO in 2006 following the discovery and development of the proprietary low energy e-stack mixing ventilation system as part of a major research programme. After the prototyping period circa 2007, Company D managed to commercialise its product. In 2012, Company D set up a partnership with American and Canadian companies. The idea is to have these companies to sell product designed by Company D. Those companies will then pay royalty to Company D. The business went very slowly. After a year, the outsourcing sales model appeared to be not profitable and the CEO decided to put an end to the agreement. Nevertheless, Company D has been relatively successful in commercialising and installing their product in buildings throughout the UK.

"*When you set up a company and put together a business plan, the one thing you can be absolutely confident of in a business is that the business will not do exactly what it says in the business plan. The forecasts that we made early on were too optimistic. That was, obviously, a disappointment for investors if you don't meet your targets. We have to go ask for more money when the company didn't grow as strongly as it was originally planned."* -CEO

Company E- Founded in 2005, Company E was established after the discovery of method to generate oxygen at above atmosphere pressure. The technology was then exploited and emerged as a wound healing device which has been sold not just in the UK but also countries like the US and Canada. After the change of leadership, Company E executed changes in two areas1) product improvements that lead to cost improvements. i.e. revisiting product engineering to make the device cheaper and review feedback from the market 2) outscore the manufacturing process i.e. very critical in growing a technology business especially in an area where human resource in such manufacturing is scare.

"I've put in a lot of changes now. We are going to outsource our manufacturing. Where using a third-party manufacture…It's a major shift in getting product security supply. Really critical thing for growing tech business. To be in the position that when you hit a ramp in sales, there is supply." – Chairman

4.2 Causal and effectual processes demonstrated by case companies

After investigating commercialisation decisions in five USO across 102 total events, it is determined that most USO began with effectual modes and gradually transitioned to causal modes when the technology had reached a maturity stage. These companies experiment with marketing strategies under various circumstances. The success of USO in

commercialising such IP can be attributed to the non-predictive logic of effectual processes in the face of technological and market uncertainty. Further qualitative analyses also confirmed that causal processes are most effective in commercialising IP with higher technology readiness levels within an existing market. However, in one case (Company B), an assessment of a qualitative interview demonstrated that initially, this company began with a causation mode, transitioned to effectuation mode, and then shifted back to a spectrum between effectuation and causation. Table 2 and 3 present the casual and effectual processes demonstrated by the case companies in there commercialisation stages.

USO	**Effectual process demonstrated at the ideation and technology development stage**	**Causal process demonstrated when the product enters commercialisation stage**
Company A	• Selected the most commercially viable application for printed plastic solar cell • Made creative use of partly developed technology to spin off another company • Shifted priority to the existing business over product innovation • Leveraged access to funding by merging with a USO from another university • Relied on customer feedback to feed R&D	• Entered solar energy market with a goal to manufacture OPV • Selected solar energy market based on expected return • Launched another spin-off within an existing market while developing the technology further
Company C	• Selected the most commercially viable application for magnetic cooling technology • Determined potential goal and type of market to be exploited based on access to resources • Partnered and collaborated with other corporate companies to fund R&D	• Entered the cleantech market while still developing the technology further • Selected cleantech market based on expected return
Company D	• Selected the most commercially viable application for low energy ventilation technology • Executed market probing • Tried unsuccessfully to execute outsourcing sales model with American and Canadian companies • Scoped innovation to be realised with available resources • Partnered with the parent university in natural ventilation research • Hit early buy in when new regulation on school ventilation was introduced • Outsourced manufacturing	• Entered the clenteach market with a goal to commercialise and install low energy ventilation system in buildings throughout the UK • Selected cleantech market based on expected return
Company E	• Selected the most commercially viable application for oxygen generation technology • Tried unsuccessfully to employ the razor-blade business model i.e. free consumables, charge device • Formed alliance with NHS to support research and access funding • Relied on customer feedback to feed R&D • Outsourced manufacturing	• Entered medical device market with a goal to commercialise oxygen generator device that promote better and faster wound healing process • Selected medical device market based on expected return

Table 2. Effectuation-causation transition

USO	Causal process demonstrated at the ideation stage	Effectual process demonstrated at the technology development stage	Causal process demonstrated when the product enters commercialisation stage
Company B	• Conducted early market research • Identified goal to commercialise microwaved induced pyrolysis technology as one way to recycle plastic aluminium laminate • Selected recycling market based on expected return and industry climate	• Responded to the uncertainty in waste handling industry • Changed business model based on the commodity price and other externalities • Formed alliance with FMCG companies • Executed market probing	• Entered waste handling market with a goal to commercialise customised reactor for waste handlers, local authorities, FMCG brands and consumers • Built showcase plant to strengthen business case

Table 3. Causation-effectuation-causation transition

5. Discussion

Based on the findings, our analysis is discussed in the following two parts, 1) we discuss the causal and effectual reciprocation on the journey to IP commercialisation, 2) we examine how causal and effectual processes influence the resultant business model.

In all five USO, a combination of causal and effectual processes can be clearly identified at three commercialisation stages, that is, ideation stage, technology development stage, and commercialisation stage. In Company A, C, D, and E, technologies are commercialised based on effectual logic in the ideation and technology development stage (see Table 2). These companies dealt with contingencies such as market non-existence, longer time taken to market, and limited access to funding. Most of the decisions made at these two stages were highly influenced by internal and external factors. All USO took advantage of their internal capabilities to augment their strategy development to better support the IP commercialisation process. Invigorating internal capabilities means a USO continuously strengthens its individual, organisational, and institutional capabilities (O'Shea et al., 2008; Landry et al., 2006). Nevertheless, externalities prohibit and in some cases help USO to modify their propositions based on the market climate, in order to move forward to the commercialisation stage. External factors are factors which a USO has limited control over but could directly influence how a resultant business model is ingrained, for example, access to venture capital, industry structure, and type of market entered.

We also find that in the beginning of business activities, Company A, C, D, and E are more effectual because they just entered the earliest phase of entrepreneurial venture, thus, tend to be resource poor. In acquiring the most needed resources, these companies demonstrated creativity in exploiting available resources by re-scoping innovation to be realised within existing means. Company A, C, D, and E are also keen to form alliances and partnerships in order to access funding, expert support, reputation, and brand affiliation. Nevertheless, once the business grows, decision-making becomes inevitably more causation driven. The whole phenomena observed are in parallel with Read and Sarasvathy's (2005) and Sarasvathy's (2001) findings. Company A, C, D and E represent effectuation-causation transition in commercialising university IP.

Unlike other USO, Company B started off with causation, transitioned to effectuation, and shifted back to causation when the technology had reached the maturity stage (see Table 3). However, the value proposition did not change throughout the commercialisation process. As suggested by Sarasvathy (2001), causation and effectuation can overlap, coexist, and intertwine over different contexts of decisions. Two potential explanations why Company B started off with causal processes instead of effectual are 1) the company is led by a novice entrepreneur with limited entrepreneurial skills 2) the value proposition was set up far too early that the company strove to achieve the goal when the technology was still immature. Realising the need to change its business model, Company B then experimented with other marketing strategies and dealt with contingencies in a more effectual manner. After the technology was formally established, the market was created, and the showcase plant was built, only then did the company transition back to the causal processes. Company B resembles a reciprocation of entrepreneurial decision-making process.

The way commercialisation decisions are made influences the resultant business model in all five companies. The combination of effectual and causal principles leverages the way USO identify value proposition, create the value, capture the value, and reach its network. The next section discusses how causal and effectual approaches influence constructs in the resultant business models. Firstly, the value proposition accords with the USO strategy towards competitive advantage, that is, the advantage over competitors is achieved by offering new technological solutions and/or

offering greater value to the customers. Specifically, the value proposition focuses on the monetary worth a USO aims to rationalise to its customers (why the customer would pay for the product or service they offer). Unlike known technology, new technology is always harder to be commercialised because the market segment is not well-established and sometimes needs to be created first. In this sense, value proposition needs to be pragmatically aligned with effectual processes to experiment with different offerings in order to exploit the first-mover advantage (Markides & Sosa, 2013). Operating a business under resource constraints forces a USO to exercise effectual decisions (MacCormack & Verganti, 2003; Ettlie & Rubenstein, 1987).

Secondly, value creation deals mainly with the USO resource and capabilities necessary to deliver the value it proposed earlier. In this regard, value creation encompasses all the activities that could enable a USO to create, produce, sell, and deliver its product or service to the customers. Hence, value is usually created thorough several effectual processes such as forming an alliance, partnership, and collaboration. Richardson (2008) argues that value can only be created with value proposition in mind because this process confers competitive advantage. In creating sustainable value, a USO needs to extensively define its value chain in order to distribute and/or bring the product or service to the market and, most importantly, devise complementary processes to ensure the product or service can get to the market, and stay there (Chesbrough, 2003). Thirdly, value capture envisages USO revenue and profit generation. This includes all the financial aspects such as the means of acquiring monetary return in exchange for its product or service, costs, and margins. Logically, value can only be captured after it is proposed and created (Richardson, 2008). In the USO context, the commercialisation of IP can be considered as the process of translating research findings into tangible commercial commodities, thus providing leverage in commercial markets. In this regard, USO captures value in the new technology predominantly through causal modes after the market is selected based on the expected return. At this point, the USO tends to exploit known markets using well-established knowledge through causal process. Finally, value network revolves around the way a USO enables transactions through coordination and collaboration among parties which commonly include customers, suppliers, partners, distribution channels, and coalitions. This area of discourse involves both effectual and causal processes to create new markets and form alliances and collaborative strategies.

6. Conclusion

Entrepreneurial decision making mechanisms rest in process-based phenomena, making it suitable to develop process-based explanations of IP commercialisation in USO. Based on the case study presented, we have demonstrated the link between causal and effectual processes to the resultant business model. This is critical in explaining how entrepreneurial decision-making processes are made in USO and most importantly indicates how USO adapt under technological and market uncertainty. Our findings also add insight into the causal and effectual reciprocation, which advances our understanding on the interplay between these processes. In summary, a USO configures causal and effectual processes in specific ways throughout the course of commercialising university IP. Most USO began with effectual modes and gradually transitioned to causal modes when the technology had reached the maturity stage. Causal processes, however, are most effective in commercialising IP with higher technology readiness levels within an existing market. To augment normative implications, more research needs to be conducted to gain deeper understanding of entrepreneurial decision-making mechanisms to commercialise university IP in different industries. This will help strengthen the theoretical grounding for research on business model dynamics and entrepreneurial decision-making logic.

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