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McAdam, M., Miller, K., & McAdam, R. (2021). A Micro Level Investigation of Stakeholder Motives on University Technology Transfer Business Models. *Studies in Higher Education*, 46(5), 951-964. Advance online publication. <https://doi.org/10.1080/03075079.2021.1896802>

[Link to publication record in Ulster University Research Portal](#)

Published in:
Studies in Higher Education

Publication Status:
Published online: 16/03/2021

DOI:
[10.1080/03075079.2021.1896802](https://doi.org/10.1080/03075079.2021.1896802)

Document Version
Author Accepted version

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A Micro Level Investigation of Stakeholder Motives on University Technology Transfer Business Models

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Abstract

Within this paper, we take a micro level perspective to explore how ecosystem stakeholder motives have impacted value creation and value capture processes within the University Technology Transfer (UTT) business model over time. To achieve this, we adopt a longitudinal qualitative methodology comprising of case study evidence of two differing bounded contexts of universities and their respective UTT stakeholder-based business models over an eight-year period. Our findings reveal, that in seeking to balance and align the value creation and capture processes needed to satisfy diverse stakeholders and achieve university mission, the importance of portfolio models within UTT business model design to ensure ongoing strategic alignment and sustainability.

Key words: Business Models; University Technology Transfer; Value creation and value capture; Longitudinal; Case Study

1.0 Introduction

Universities are now undergoing a period of sustained change driven by multifaceted external environmental factors (Cunningham et al., 2018; Morphew et al., 2018). This has led to the emergence of a ‘third mission’ where, beyond providing high quality education and excellence in research, universities are expected to contribute to the economic regional development (Guerrero et al., 2015). Achieving this new ‘third mission’ has seen the emergence of ‘entrepreneurial university’ models which emphasise university technology transfer (UTT) (Sanchez-Barrioluengo and Benneworth, 2019) as a way to create both economic and societal value.

To fully achieve an entrepreneurial ‘third mission’, universities need to demonstrate greater engagement with ecosystem stakeholders in order to ensure relevance and alignment of innovation with regional needs (Guerrero et al., 2015). Despite this, much remains unknown on how universities can effectively embed ecosystem stakeholders into their UTT processes, whereby each stakeholder has different motives and expectations with regards to this engagement (Miller et al. 2018). To explore this, we posit that business model representations are an appropriate means by which to explore the impact of university mission change and associated engagement with ecosystem stakeholders. In so doing, we respond to Foss and Saebi, (2017) who specifically call for research into how external stakeholders shape business models, where we suggest that a university context is appropriate to demonstrate the complexities involved in multi-stakeholder value creation and capture processes. Furthermore, Sjodin et al. (2020) highlight the challenges in aligning value creation and capture processes when dealing with diverse stakeholder relationships, however, we argue that this is even more complex in a university context where value creation and capture processes must also align with external and internal ecosystem stakeholders funding support mechanisms to ensure alignment with funding milestones and targets.

Unpacking the complexities involved in embedding ecosystem stakeholders into the UTT business model is of both theoretical and managerial importance, particularly at a time when universities are under increasing pressure to demonstrate their social and economic value (Audretsch et al., 2018). Consequently, this research addresses the following research question - what impact does ecosystem stakeholder motivations have on value creation and value capture processes at the micro level within the UTT business model over time?

In order to address this research question, two UK University case studies within the same UK region form the focus of our empirical investigation. Case University 1 is known as a research-intensive University which focuses on achieving world class research across a wide range of disciplines. It is a member of the Russell Group which is a group of 24 UK Universities who collectively produce over two thirds of the world leading research across all UK Universities (Russell Group 2021). Case University 2 is a former polytechnic which was established as a University in the 1990s and focuses on a broad remit of teaching, learning, academic enterprise and selected areas of research.

2. Our Theoretical Framing

2.1 Changing University landscape: An ecosystem stakeholder perspective

Recent changes in the university landscape such as increased competition, reduced public funding commensurate with increasing policy and societal pressures on universities to demonstrate their societal contributions (Sanchez-Barrioluengo et al., 2019), have resulted in an enhanced interest in the effective transfer or commercialisation of university knowledge and technology (Dolan et al., 2019). Universities which have placed precedence on these activities are often referred to as entrepreneurial universities, where their missions strive to balance economic and social value (Guerrero and Urbano, 2019; Miller et al., 2018). To achieve such

goals, universities face specific challenges including the need to develop appropriate policies, capabilities, culture, structures, strategies and processes consistent with an entrepreneurial approach (Cunningham and Miller, 2021). However, existing infrastructure is often formal and bureaucratic in nature (Guerrero and Urbano, 2019; Dolan et al., 2019); where traditional university governance relies on hierarchical structures and risk averse academic staff, who often have little entrepreneurial background or competency (Huynh et al., 2017). Unlike many forms of basic research in Universities, technology transfer and exchange requires collaboration between a wide range of ecosystem stakeholders internal and external to the university, whose motivations and methods of working may vary considerably (Miller et al., 2018). Such stakeholder interaction and cooperation challenges the rigidity of University–Industry boundaries in seeking value co-creation and capture in a more open and collaborative environment (Dooley and Gubbins, 2019).

Heuristic frameworks exploring the development of the University’s third mission includes the Quadruple Helix, where the university, societal users of innovation, industry and Government interact to ‘co-create’ innovations (Carayannis and Rakhmatullin, 2014) which have greater market relevance and benefit. In this context, ecosystem stakeholders’ motivations are encouraged to be more collaborative, based on the premise that collaboration between stakeholders leads to knowledge sharing and learning which can enhance the competency development of all involved. This is the core basis of government funders’ shift in prioritisation from rapid monetisation of innovation to a more open approach which encourages ecosystem stakeholders to share knowledge and expertise in order to co-create innovations of both economic and social value (Cunningham and Miller, 2021). Technology transfer office (TTO) staff and academics’ motivation to be more collaborative stems from it being a funding condition and a key part of achieving their third mission (Morphew et al., 2018). Furthermore, academics have both intrinsic and extrinsic motivations for engaging with industry (Perkmann et al., 2013); most notably it develops their market knowledge and competencies which can increase their market orientation and result in shorter times to market (Messina et al., 2020).

The value that industry end-users can glean from university collaboration is also widely acknowledged (Gretsch et al., 2019), especially with regards to gaining access to knowledge and skills which can enhance competitive advantage, but also due to industry and end user collaboration generating ‘value in use’ as opposed to only ‘value in exchange’ (McDonald et al., 2016). Consequently, industry and end users are motivated to collaborate to ensure innovations are more aligned to their needs during development processes (Morphew et al., 2018; Gretsch et al., 2019), and in so doing are more market orientated.

Whilst macro level policies, mechanisms and procedures exist to encourage ecosystem collaboration (Audretsch et al., 2018), at a micro level there is significant variance and ambiguity with regards to their operationalisation (Dooley and Gubbins, 2019; Cunningham and Menter, 2020). Cunningham and O’Reilly (2018) identify the need for greater understanding of technology transfer at the micro level where all stakeholders (and individual actors) and their interactions are more fully understood. This can be achieved through the lens of the UTT business model.

2.2 UTT business models: Value creation and value capture

Mission change within universities requires not only changes to structures, activities and processes, but also requires changes to behaviours and norms within the university, which is encapsulated by their business model (Miller, 2014). Following Amit and Zott (2012), we take both a process and activity based view of a business model to view the UTT business model as all the processes, and activities involved in commercialising technological knowledge which spans organisational boundaries to incorporate a range of stakeholders.

A business model is made up of value processes (Teece, 2010), where value needs to be created and captured for not only the organization but for all stakeholders who are either governance actors or who contribute to the functioning of the business model (Amit and Zott, 2012; Cunningham and Miller 2021). To understand value creation and value capture within a university context, we draw upon Sjodin et al. (2020) who suggest their relational and dyadic nature, where value may need to be exchanged and/ co-created with actors within a business model, which contrasts from a traditional provider centric or customer centric process (Chesbrough et al., 2018). Sjodin et al. (2020) define value capture as the process of generating value, which can be economic value or in the case of a university, social value. Furthermore, value capture is not only securing value whether economic or social, but also its distribution amongst participating stakeholders.

Engaging stakeholders in any business model can present significant challenges where balancing divergent goals can result in disharmony and strategic misalignment (McAdam et al., 2017). Sjodin et al. (2020) identify that stakeholder collaboration should be strategically connected to value creation and capture processes, where it is important that the value created for all stakeholders outweighs the costs involved in realizing the value. Saebi and Foss (2015) identify the need to more fully understand how organisations can manage value creation and value-capture processes across organisational boundaries. Indeed, despite a vast amount of research on UTT, albeit for a few notable exceptions (McAdam et al., 2017, 2016), there is a lack of micro level research which explores how UTT business models evolve their value creation and capture processes to meet changing strategic outcomes (Cunningham and Miller, 2021).

3. Research Methodology

A multi-grounded investigation was conducted of two differing bounded contexts of universities in order to seek both theory elaboration and theory building within an under-researched phenomenon (Yin, 2018). A multi-grounded approach acknowledges that prior theories inform current approaches but recognises the need to also let the data inductively generate insights and then ‘ground’ these within pre-existing theories (Goldkuhl and Cronholm, 2018). Additionally, we followed a longitudinal, comparative approach spanning which is deemed appropriate for exploratory business model research (Foss and Saebi, 2015). Table 1 provides an overview of each university.

[Insert Table 1 here]

4.1 Data Collection

The case studies were constructed over an eight-year period which allowed data to be captured over of a full Research Excellence Framework (REF) period and their preparations for a new REF period¹. Data collection consisted of semi-structured interviews and follow-up discussions to clarify and expand upon key themes emerging from the analysis phase. The interviews, averaging 50 minutes in duration, were conducted with purposeful heterogeneous stakeholders (Alvesson and Skoldberg, 2009) over five data collection points (2008, 2010, 2012, 2014 and

¹ The REF was first carried out in 2014, replacing the previous Research Assessment Exercise. The REF aims to provide an expert review of UK universities research outputs and impact in order to provide accountability for public investment, facilitate benchmarking, helped determine reputation and aids the allocation of funding for research (UKRI, 2020). Changes were made to REF requirements in 2014 requiring an assessment of the wider impact of research, alongside an assessment of the quality of research outputs and the vitality of the research environment was introduced (Watermayer, 2016). This necessitated universities to engage more with industry, end users and government and so demonstrate societal impact (Smith et al., 2011) in order to submit examples of impact as impact case studies, as well as traditional publications.

2017). A total of 104 interviews were conducted with 36 diverse stakeholders comprising principal investigators, business liaison staff, TTO staff, innovation users and government stakeholders. A semi-structured interview guide was followed whereby each respondent was asked a series of questions regarding the development of their respective university UTT processes, challenges encountered with UTT commercialisation processes and external stakeholder engagement in UTT. The interviews were transcribed verbatim. In addition, secondary documentation served as a means of triangulation, thus counteracting any anomalies, preferential hindsight or retrospective memory bias that may have arisen during the interviewing process (Yin, 2018). Table 2 presents the profile of interviewees and documents analysed.

[Insert Table 2 here]

4.2. Data Analysis

Data analysis comprised of multiple stages. First, all data was compiled into a comprehensive database and textual data was then imported into NVivo. Then a process of open inductive coding (Miles and Huberman, 1994) was carried out independently by two members of the research team. This resulted in 64 open codes spanning across the data collection points. Next, theoretical coding was conducted to ‘ground’ the inductive codes within current theory (Goldkuhl and Cronholm, 2018). An iterative and reflexive process to data analysis was followed (Yin, 2018), which resulted in two overarching themes relevant to our underpinning research question. Table 3 outlines the data structure which was subsequently used to structure our findings.

[Insert Table 3 here]

5.0 Findings

In contextualising our findings, we first refer to the structural changes made to the business model design in both cases, whereby they attempted to facilitate processes which were more supportive to facilitating university engagement with external ecosystem stakeholders. This is then followed by a detailed discussion of the core ecosystem stakeholder motives and how they resulted in strategic challenges in aligning value creation and value capture processes and activities within the UTT business model. We illustrate our narrative with power quotes (Pratt, 2009). More comprehensive proof quotes are outlined in the supplementary materials.

5.1 Structural business model design changes to facilitate greater ecosystem stakeholder engagement

During the first data collection point in 2008, although the requisite for more collaborative approaches was recognised, it was not until 2010 that both case universities experienced significant restructuring of their TTOs, with the aim of strategically aligning traditional research, enterprise and commercialisation activities. In both cases, this restructuring resulted in the creation of new job roles which focused on impact and industry engagement, recruitment of staff with industry expertise and was accompanied by new industry engagement strategies. These new strategies were embedded into wider strategic plans within both universities (e.g. 2011-2015 and 2016-2020) which reflected a changing mission where priorities such as ‘impact’ and ‘meeting societal needs’ were emphasised. The strategic research and enterprise staff in both universities (RES1 and RES2) identified that this restructuring coincided with research council and government funding changes which were reflected in the

changing requirements of the REF where universities were required in 2014 for the first time, to submit impact case studies alongside high-quality research outputs such as journal publications. As noted by Case 2's strategic TTO manager "*Impact and engagement from industry must now be thought about from the very start of a research project, at the proposal stage*" (TTO3).

The collaborative effect of such changes was a greater emphasis on processes which connected academics with industry and end users. This was reflected in flexible technology disclosure processes in both universities from 2014 onwards, whereby academics were encouraged to engage with stakeholders from the beginning of the commercialisation process, which was in contrast to strict processes reported in both universities in 2008 and 2010 which required non-disclosure agreements before academics discussed their technologies with industry. However, it was only at the last data collection point (2017) that both universities implemented focused strategies to motivate and support academics engagement with industry through the development of training courses and workshops. Furthermore, in 2017, the majority of the PIs interviewed stressed that given that research funding proposals now required industry engagement and pathways to impact, they were much more motivated to develop networks with organisations and to think about the commercial potential of their research from the outset.

5.2 Motivations, mechanisms and competency development

The findings unravelled that each ecosystem stakeholder had varying and often conflicting motivations driving their engagement in co-creational innovation processes with the case universities. The findings also underscored the mechanisms which each stakeholder used to engage with the case universities and the subsequent competencies they developed as a result of their engagement with other ecosystem stakeholders. Table 4 provides a comprehensive overview of the findings, which are summarised below.

5.2.1 Government stakeholder motivations and mechanisms. Over the different data collection points, the government stakeholders expressed their motivations for more co-creational innovation between ecosystem stakeholders during the UTT processes within both cases. This aligned with wider national strategies for innovation (e.g. the HM Government 2017 Industrial Strategy and Sainsbury, 2007 review). Funding mechanisms such as Technology Assist, Proof of Concept and Small Business Research Initiative (SBRI) stipulated industry and end user engagement and as such were identified across the ecosystem stakeholder groups as key in facilitating their co-creational collaborations. However, it was identified by the TTOs in both cases (TCM2 and TCM1) that the performance measurements associated with funding did not change in line with these strategies encouraging collaboration. Indeed, the government stakeholders (GOV 2, GOVM, GOVS) confirmed the need to capture tangible outcomes of public spending which was often in the form of revenue and job creation. Across the different data collection points, PIs expressed their frustrations with working with the local government agency to fund prototype development- "*They are all about the metrics and this has to be within a specific time period. Whilst I understand they are providing the funding, technology development does not always follow their predefined time scales*" (Case 2, PI8). If the opportunity arose for an academic to commercialise their research without engagement with industry and end users (e.g. closed innovation), this was also supported by government. Consequently, whilst government stakeholders were formally seen to be encouraging open and collaborative innovation which creates value and competency development with diverse Quadruple Helix stakeholders (Guerrero et al., 2015), they also had their own set performance measurements to achieve. This resulted in strategic challenges and ambiguity within the UTT business model, where both cases tried to encourage open and co-creational innovation

development but also facilitate a closed innovation process in order to capitalise on an early resultant opportunity.

5.2.2 TTO stakeholder motivations and mechanisms. As expected, the motivations of TTO stakeholders (i.e. the University TTO managers and commercialisation executives for each faculty) to engage in more collaboratively UTT mirrored government stakeholders' motivations over the eight-year period. All of the UTT managers and commercialisation executives in both cases recognised that the ideal would be a fully collaborative innovation model where all academics engaged with government, industry and end users in a co-creational manner however, it was evident that this would be difficult to achieve when faced with other internal objectives and reduced funding. Indeed, a research and enterprise strategic staff member RES1 identified that changes to regional university funding structures between 2010 to 2015 occasioned a reduction of 24% of each case university's funding, which resulted in a need to focus on other forms of income through UTT and the capturing of value quickly to meet internal income targets. TTO managers in both cases (TCM1 and TCM3) identified their preference for patenting and licencing technology, where value could be captured more quickly, resulting in a closed innovation process, where value would only be created for a more limited number of stakeholders rather than pursuing the new venture creation route in the form of spin-off companies which could create and capture value for a larger number of stakeholders. However, there was acknowledgment that the most appropriate route was dependant on the technology and the motives of the academic, "*It is complicated, it depends on the technology but we have had a significant rise in the number of licences we have been engaged in recent years* (Case 1 TTO Manager, TTO1). This preferred strategy, aimed at capturing value at the earliest UTT stage was less risky than the pursuit of new venture creation strategy but it did not fully align with the overall University mission to engage more collaboratively with ecosystem stakeholders.

The TTOs within both cases identified that despite government and industry stakeholders claiming that they wanted to co-create innovations collaboratively, there was a preference to capture value as quickly as possible - "*Given the option, most opt to licence as they see it as a less risky and time intensive option which can generate good returns*" (TTM3). Thus, it was stressed by both cases' TTO managers (TCM3 and TCM1) that the ideal solution for the TTOs was to have a portfolio of business models (Sabatier et al., 2010; Amit and Zott, 2012), with differing value creation and capture mechanisms suitable for the divergent motives of different ecosystem stakeholders; whether that was performing well in the REF, short-term revenue gain or encouraging co-creational collaboration with industry and wider society from technology disclosure to new venture creation. Indeed, by the last data collection point in 2017, there was a business model portfolio evident within both cases, which was contextually dependent, where each technology disclosure was treated on a case by case basis. In such cases, TTO commercialisation executives liaised with the academics in the early stages of the UTT process to agree the value creation and value capture processes and associated stakeholders which would be aligned with the technology. Case 2 commercialisation executive identified that their portfolio was aimed at creating and capturing value in diverse ways: "*not all technologies can be patented or protected and in the past we would have let the academic pursue this on their own but we have many routes to market now which recognises the diversity of disclosures some of which may be interdisciplinary... or not easily protected in the traditional way*" (Case 2, TCE4). By trying to encourage both concurrent co-creational value creation with ecosystem stakeholders along with allowing some technologies to pursue more closed processes, where value is only created and captured for a limited number of stakeholders, led to ambiguity in the business model design.

5.2.3. Academic stakeholder motivations and mechanisms: Whilst many of the PIs reported at all of the data collection points that they were enthusiastic to engage with industry, a large majority identified their willingness to capture value as soon as possible so that they could focus on their own research agendas and promotion ambitions (See Table 4). As one academic explained *“I would love to engage more with industry but it’s a trade-off. It requires a lot of time and investment of resources with no guarantee of a return. Whilst I can tell my head of school of all the engagement activities I have been involved in, if I do not have 4-star publications, I will not get promoted”* (Case 1 PI4). Whilst it was possible to get promoted through the academic enterprise route, this was less common and was only introduced as a measure on internal appraisal forms in 2017 in Case 1. Case 2, a more teaching-based university always had two promotion routes, namely research (value capture) and academic enterprise (value creation and capture); thus bestowing more legitimacy on engagement with industry stakeholders. However, Case 2’s PIs had higher teaching and administration loads, which negatively impacted on their ability and willingness to engage with industry. Indeed, academics across both cases identified common barriers impacting their motivation to engage with industry, such as lack of market skills and access to networks, time and resource limitations, opportunity costs associated with developing relationships with industry and research translational issues. On the whole, the PIs felt that the TTOs could do more to help them engage in co-creational innovation.

5.2.4 End user stakeholder motivations:

At the start of the research period, there was limited end user engagement, where both universities predominantly had a strategy of technology push, with the exception of some serial academic entrepreneurs who regularly consulted with potential users based on prior developed relationships. Whilst end users were engaged during mechanisms such as Proof of Concept programmes and government funded networking programmes, this was often more in a market research capacity rather than end users being motivated to participate in the co-creation of technology development. However, from 2014 onwards, in line with external government and funding drivers motivating universities to increase their engagement with society (as previously discussed), collaborative programmes and mechanisms emerged which funded user driven problems and co-creational innovation where end users were recognised as participant and influencing stakeholders in the UTT process rather than as passive recipients of technology based outcomes (e.g. SBRI, technology development assist programmes, see Table 4). This increased the motivation of end user engagement with universities at earlier stages of the UTT process. Additionally, both case universities opened up their processes to embed end users within research and impact steering committees to enhance their processes and mechanisms for facilitating and encouraging end user engagement during UTT.

5.2.5 Industry stakeholder motivations and mechanisms: The motivations of industry did not appear to change to any significant degree across the eight-year period (See Table 4). Whilst industry was keen to get involved with universities to co-create value and avail of knowledge and skills, their predominant focus was on capturing value as early as possible. However, IS2 and IS3 mentioned that bureaucratic university structures, IP issues and collaborations with academics who lacked market orientation and business skills meant that the time they needed to devote to co-creational innovation did sometimes outweigh what they could afford, thus reducing the potential benefits to be accrued from these types of collaborations. Case 1 identified a preference of industry to avail of expertise via patents rather than fully participating in co-creational innovation. However, there were examples of good co-creational practices in both cases from the 2014 data collection point onwards. Industry Stakeholder 2 (from Case 2) had been working with an academic (PI10) from the early stages of UTT, where they frequently

exchanged knowledge and expertise which lead to changes in the technology in order to make it more market orientated and also the establishment of a potential stream of customers.

6.0 Discussion and conclusions

Limited research to date has provided a micro level exploration on how dynamic interchanges between ecosystem stakeholders has led to changes within the UTT business model. We contribute to this gap in understanding, through our longitudinal insights which unravelled how ecosystem stakeholders' divergent motives impacted the value creation and value capture processes within the UTT business model. In so doing, we make a number of contributions. First, we provide novel micro level nuanced insights into the challenges universities face in embedding stakeholders into their UTT business model to achieve their third mission. As evidenced in our findings and in Table 4, whilst both universities underscored the importance of engaging in co-creational innovation with industry and end users, this was strategically challenging when many ecosystem stakeholders (e.g. TTO, industry, PIs) showed a preference for capturing value quickly, often through licences. Government stakeholders, also demonstrated a preference for returns from public funding in a timely manner instead of pursuing more riskier long-term co-creational collaboration strategies, which could be argued to lead to value realisation for a larger number of stakeholders, despite recent changes to their funding structures which demanded more collaborative innovation.

Second, we contribute new insights into complex multi-stakeholder-based business models and in particular the need for UTT business models to be able to balance open value co-creational processes in tandem with more closed approaches. We demonstrate this through portfolio models within the UTT business model design, which provide flexibility in order to develop different variations of value creation and value capture processes and activities dependent upon the combination of ecosystem stakeholders involved in a project and their respective motives. Although research on portfolio business models is scarce (Sabatier et al. 2010), particularly in a UTT context, it does caution that portfolio models can cause strategic challenges when they occur simultaneously and are not mutually exclusive (Amit and Zott, 2012; Chesbrough et al 2018). Our findings illustrate that both cases faced resourcing challenges in operationalising a portfolio approach and ambiguity over which strategic goals to pursue – whether to meet internal and external funding targets or to strive for co-creational activities, which both require different activities and processes. Related to this, we provide new insights into the need for dual competencies across all internal and external ecosystem stakeholders in order to operationalise portfolio models. We identify how these competencies can be cumulatively developed through learning and collaboration with ecosystem stakeholders over time, where value can be accrued holistically across stakeholder groups. As demonstrated in Table 4, each of the stakeholders developed and demonstrated residual organisational and technical competencies through their experiences and learning from ecosystem engagement and collaboration. Indeed, at the end of the data collection period, stakeholders were able to rapidly realign their competencies and supporting mechanisms to suit the open and closed portfolio variants within the hybrid business model. Therefore, these findings further extend knowledge on the complexities of multi-stakeholder engagement in business models (Sjodin et al. 2020).

Third, we advance knowledge on the entrepreneurial university by suggesting that portfolio approaches could be effective mechanisms to support traditional closed approaches to commercialisation to protect basic science research whilst still striving towards a collaborative entrepreneurial mission which would satisfy government and wider societal demands to engage in greater value creation with ecosystem stakeholders (Guerrero et al., 2015).

Finally, we make a contribution to policy and practice by illustrating the challenges associated with transitioning to a collaborative UTT business model to achieve third mission, particularly when funding mechanisms encourage value capture as early as possible to

demonstrate returns on public funding. Our findings thus illustrate the need for performance mechanisms and funding goals to acknowledge wider longer-term value which can be accrued from co-creational value creation processes, in the form of residual competency development, which may lead to more innovative technologies in the future. Our findings on the varying and changing motivations of ecosystem stakeholders will also be of benefit to TTO managers and university strategic staff by providing evidence to support their decision making and UTT resource allocation into portfolio models for UTT.

Despite challenges related to the complexity of representing the richness of a longitudinal data set, this approach facilitated a holistic visualisation of stakeholder motives and UTT business model changes over time which is suitable for a theory building exploratory approach. Future research could explore in more detail the strategic mechanisms universities use to manage and balance portfolio business models and the range of value creation and capture mechanisms within these to satisfy both stakeholder motives and power/resource dependencies would enrich the area of UTT business models. Furthermore, it was evident that achievement of mission change ultimately depends upon academic entrepreneurs' willingness and ability to engage with diverse stakeholders, therefore future research could explore the micro level challenges academics face within such a context from a range of theoretical lenses such as absorptive capacity, dynamic managerial capabilities and role identity theory. Moreover, future studies should look at how university technology transfer business models and the determinants of their value creation and capture activities differ across different national contexts.

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Table 1: Profile of Case Universities

	Case 1	Case 2
Focus	Research led and research-intensive Russell Group university, where excellence in research is seen as a lead driver to all other areas within the university	Emphasis on exclusivity based on a broad teaching and learning provision with an applied academic enterprise agenda supported by applied research in specific STEM fields.
Academic staff pathways	Career progression and rewards and recognition are based on REF criteria	Academic staff are encouraged to major on two of the three career path

	<p>which has a large emphasis on research-based publications. Academic enterprise is viewed as an additional activity alongside teaching and learning</p>	<p>routes: academic enterprise, research and teaching and learning. Those involved in academic enterprise are encouraged to be involved in a wide range of funding activities (knowledge transfer partnerships, technology commercialisation, innovation vouchers etc.)</p>
Student numbers	Circa 25,000	Circa 25,000
Camps	Single Campus	Multi-campus (n=4)
Undergraduate fees – set by government	£3575	£3575
Non-student fee funding	<p>Primary emphasis on Research Council funding with a secondary emphasis on EU funding</p>	<p>Emphasis on applied funding from academic enterprise and applied research activities. Funding also sought from Research Councils in specific STEM disciplines.</p>

Table 2: Data Collection Waves and Sources

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Interviewee	Case	Data Collection Waves				
		2008	2010	2012	2014	2017
Principal Investigator (PI1)	1	x	x	x	x	x
Principal Investigator (PI2)	1	x			x	
Principal Investigator(PI3)	1	x	x	x	x	x
Principal Investigator(PI4)	1	x	x	x	x	
Principal Investigator(PI5)	1	x		x	x	
Principal Investigator(PI6)	1					x
Principal Investigator(PI7)	2	x		x		
Principal Investigator(PI8)	2	x	x	x	x	
Principal Investigator(PI9)	2	x	x	x	x	x
Principal Investigator(PI10)	2	x	x	x	x	x
Principal Investigator(PI11)	2	x		x	x	
Technology Commercialisation Executive (TCE1)	1	x				
Technology Commercialisation Executive (TCE2)	1	x	x			
Technology Commercialisation Manager(TCM1)	1	x		x	x	
Technology Commercialisation Manager(TCM2)	1					x
Technology Commercialisation Executive (TCE3)	2	x			x	x
Technology Commercialisation Executive (TCE4)	2	x	x			
Technology Commercialisation Executive (TCE5)	2	x				
Technology Commercialisation Manager(TCM3)	2	x		x	x	
Technology Commercialisation Manager(TCM4)	2					x
Business Liaison Staff Member(BL1)	1	x	x		x	x
Business Liaison Staff Member(BL2)	1	x			x	

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Business Liaison Staff Member(BL3)	2	x	x	x	x	x
Business Liaison Staff Member(BL4)	2					x
Research and Enterprise Strategic Staff Member(RES1)	1	x			x	x
Research and Enterprise Strategic Staff Member(RES2)	2	x		x	x	x
Innovation User(IU1)	1	x		x	x	
Innovation User(IU2)	1	x	x		x	
Innovation User(IU3)	1					x
Innovation User(IU4)	2	x	x		x	
Industry Stakeholder (IS1)	1	x		x	x	
Industry Stakeholder (IS2)	1		x		x	x
Industry Stakeholder (IS3)	2		x			x
Industry Stakeholder (IS4)	2		x	x		x
Government Commercialisation Executive(Gov1)	1&2	x		x	x	
Government Commercialisation Executive(Gov2)	1&2	x			x	x
Government Commercialisation Executive(Gov3)	1&2	x	x		x	
Government Managerial Staff Member(GovM)	1&2	x	x		x	x
Government Strategic Staff Member(GovS)	1&2	x		x	x	
Archival Data	2010	2012	2014	2017		
TTO Documents	x	x	x	x		
Social Media (including Website, Twitter, Facebook and Instagram)	x	x	x	x		
Government Documents	x	x	x	x		
Innovation Strategy Documents	x	x	x	x		
Press Releases	x	x	x	x		

Table 3: Data Structure

Creating Provisional Categories and first Order Codes	Theoretical Categories (2nd order themes)	Aggregate Theoretical Dimensions
Statements about restructuring (AB); research and enterprise centres (AB); government funding (AB); changing requirements of the REF (AB); knowledge sharing (Ab); flexible technology disclosure processes (AB); the norms and culture relating to research activities (Ab); Research intensive vs teaching focused (Ab).	Restructuring, Mission Change and strategies University Context	Transitioning business model design
Statements about Technology Assist, Proof of Concept and Small Business Research Initiative (SBRI) programmes (aB); performance measurements (aB); performance metrics (aB).	Government Stakeholder Motivations and Mechanisms	Motivations and Mechanisms of Quadruple Helix Stakeholders
Statements about changes to regional university funding structures (AB); focus on other forms of income through UTT (ab); patenting and licencing technology Vs new venture creation (Ab); cognate vs non-cognate subjects (Ab); portfolio business models (Ab).	TTO Stakeholder Motivations and Mechanisms	
Statements about promotional criteria (Ab); teaching vs research (Ab); teaching and administration loads (Ab); lack of market skills (Ab); access to networks (Ab); time and resource limitations (Ab); opportunity costs; cognate vs non-cognate subjects (Ab).	Academic Stakeholder Motivations and Mechanisms	
Statements about Proof of Concept programmes and government funded networking programmes (aB); increased engagement with society (aB); collaborative programmes and mechanisms; societal value (ab); user driven problems and co-creational innovation (ab); end users as participant and influencing stakeholders (ab).	End User Stakeholder Motivations	
Statements about capturing value quickly (Ab); academic-industry relationships (AB); bureaucratic university structures (Ab); IP issues (Ab); conflict vs collaboration (Ab).	Industry Stakeholder Motivations and Mechanisms	

“A,” evidence from 4+ stakeholder groups; ‘a,’ evidence from 2+ stakeholder groups
 ‘B,’ evidence from 4+ archival types; ‘b,’ evidence from 2+ archival types.

Archival Types (change Table 2)

- TTO=TTO documents
- SM=social media (including Website, Twitter, Facebook and Instagram)
- GD= government documents,
- IST=Innovation Strategy Documents
- PR= press release

Table 4: Changing Dynamics of Quadruple Helix Stakeholders during the UTT process

Stakeholder	Type of Value Motive	Motivation	Funding mechanism supporting collaboration	Residual competency development through collaboration
Government	Value Creation	To increase co-creational value creation in the innovation ecosystem to generate innovations with greater economic and social value using funding mechanisms.	The technology development assist programmes, Proof of Concept schemes, SBRI, funded IP development, patents and specific spinout formation support, market skills and identification programmes, further technology development assist programmes.	Technology market development competencies, funding allocation based on market and technology appraisal, identifying markets for technology skill sets, ability to form value creating teams and engage stakeholders to work together.
	Value Capture	The opportunity arises for more immediate commercialisation of technology being developed from universities, hence motivated to capture value using appropriate mechanisms with disregard of the need for co-creation.		
TTO/ Academic Stakeholder	Value creation	Increase commercialisation success by forming and developing technology development networks (national and international) to acquire and assimilate multiple sources of knowledge to drive value creation.	Funded network programmes e.g. Proof of Concept, SBRI. Acquisition by larger company, funded IP development, licensing, spinouts, Patents and specific Spinout formation support, market skills and identification programmes, further technology development assist programmes, Proof of Concept schemes Stage 2, SBRI Stage 2.	Network facilitation and leadership, funding scanning, identifying technology skill sets, market development, funding allocation based on market and technology appraisal, identifying markets for technology skill sets, licensing expertise, acquisition expertise, IP expertise, patent expertise, spinout formation expertise, ability to form value creating teams and stakeholders.
	Value capture	Opportunity arises for more immediate commercialisation of technology being developed, hence motivated to value capture using appropriate mechanisms.		
User Stakeholder	Value creation	To become part of the value creation process to increase individual user/company absorptive capacity developing potential for later value capture; early stage involvement with potential value creation at all stages, spill-over opportunities, competitive advantage.	Technology network participation and knowledge exchange; part of funded network using funded network programmes e.g. Proof of Concept, SBRI, part of technology platform in developing and technologies; using parallel technology skills sets, technology development assist programmes, Proof of Concept schemes (Stage 1), SBRI (Stage 1), Proof of Concept schemes Stage 2, SBRI Stage 2.	Value capture awareness capability, network leverage for value capture and commercialisation; market development for technology competencies, funding allocation based on market and technology appraisal, identifying markets for technology skill sets and groupings, licensing expertise, acquisition expertise, IP expertise, patent expertise, spinout formation expertise, market development for technology competencies, funding allocation based on market and technology appraisal, identifying markets for technology skill sets.
	Value Capture	Opportunity arises for more immediate commercialisation of technology being developed, hence motivated to value capture using appropriate mechanisms. To be part of the value capture network with specific income stream identified through co-opetition (i.e.		

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		both as collaborator and as competitor in specific knowledge spill over from value creation).		
Industry/ Venture Capital Stakeholders	Value creation	Increase specific technology value creation in the UTT through network and individual funding for potential value capture at a later stage. Opportunity for more technology spin off, spill over development from main technology being commercialised, hence motivated to increase value creation for further technology development using appropriate mechanisms.	Direct funding of networks for technology development as agreed part of assist programmes, Proof of Concept schemes, SBRI.	Network and individual funding allocation capability, identifying technology skill sets, ability to form value creating teams and stakeholders through direct funding, acquisition and merger expertise; licensing expertise, go to market decision making competencies.
	Value capture	Opportunity arises for more immediate commercialisation of technology being developed. Increase value capture in specific products and services to provide sustainable revenue streams.		

