UNIVERSITY OF SOUTHAMPTON

FACULTY OF BUSINESS AND LAW

Southampton Business School

What Contribution does the Evolving Academic Entrepreneur/Technology Transfer Manager Relationship Make to the Absorptive Capacity of University Spin-outs?

by

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Thesis for the Degree of Doctor of Philosophy

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ABSTRACT

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WHAT CONTRIBUTION DOES THE EVOLVING ACADEMIC ENTREPRENEUR/TECHNOLOGY TRANSFER MANAGER RELATIONSHIP MAKE TO THE ABSORPTIVE CAPACITY OF UNIVERSITY SPIN-OUTS?

Dorrie Yi-Wen Chao

The aim of this study is to reduce the ambiguity of the university technology transfer (UTT) process by monitoring the interactions and the antecedent factors, including prior knowledge and experience, of the key stakeholders – University Technology Transfer Managers (TTMs) and Academic Entrepreneurs (AEs) – in the creation of university spin-out. This study develops a novel conceptual framework by using absorptive capacity (AC) to understand the determinants that constitute university spin-out AC, the role of TTMs and AEs and the impact of their collaborative and synergistic relationship upon different stages of the spin-out process. Based on the exploratory nature of this research, this study adopts a multiple case study methodology and qualitative approach to investigate relationship building and collaboration between university AEs and TTMs within the process of spin-out. The investigation was made up of thirteen case studies with twenty-six interviewees (thirteen TTMs and thirteen AEs, as pairs), from eleven universities across the UK. The research findings reveal that prior knowledge (consisting of experience, background, networks, personal attributes, and motivation) is of great value to both TTMs and AEs, as it shapes and highlights the complementary function of each of their roles in the spin-out process, and contributes to spin-out AC in various ways. Prior knowledge also helps TTMs and AEs to act as the cornerstone of university spin-out combinative capabilities (that is, shared language, connectedness, close communication, tighter interaction, and trust building), which facilitate the spin-out process and assist AC development as a whole through their synergistic effect. This study adds to the UTT and AC literature by addressing antecedent factors, explorative and exploitative learning, and areas for possible improvement of AE and TTM collaboration and of the spin-out process as a whole. It aims to provide a more explicit understanding of the process of UTT and the stakeholders involved, leading to better control and development of UTT related activity, and contributes both to present and future research and to policy making.

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DECLARATION OF AUTHORSHIP

I, Dorrie Yi-Wen Chao, declare that this thesis and the work presented in it are my own and have been generated by me as the result of my own original research.

What Contribution does the Evolving Academic Entrepreneur/Technology Transfer Manager Relationship Make to the Absorptive Capacity of University Spin-outs?

I confirm that:

1) This work was done wholly while in candidature for a research degree at this University;

2) Where I have consulted the published work of others, this is always clearly attributed;

3) Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;

4) I have acknowledged all main sources of help;

5) Where the thesis is based on work done all by myself.

Signed: ……

Date: ……

Acknowledgements

Completing this PhD has been the longest journey I have ever taken and the most challenging and rewarding experience of my life; it has included so many ups and downs, happiness and tears. Nevertheless, it has also dawned on me that I am the luckiest person, because I have had so much support and help along the way. I will always be grateful to those concerned.

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Definitions and Abbreviations

AC	Absorptive Capacity
AE	Academic Entrepreneur
CSO	Chief Scientific Officer
CTO	Chief Technology Officer
HEIF	The Higher Education Innovation Fund
IP	Intellectual Property
PAC	Potential Absorptive Capacity
RAC	Realised Absorptive Capacity
R&D	Research and Development
RO	Research Objective
RQ	Research Question
TTD	Technology Transfer Office Director
TTM	Technology Transfer Manager
TTO	Technology Transfer Office
UTT	University Technology Transfer

CHAPTER 1

Introduction and Overview

The aim of this chapter is to set up the key research question and the related research objectives to indicate the purpose of the study. The chapter starts, in Section 1.1, with a discussion of the background and theoretical lenses of previous research and of the research gaps. The research aim and research objectives that capture the research gaps addressed are presented in Section 1.2. The study then briefly introduces the methodology adopted and the research process in Section 1.3. The key points concerning the major contribution of this research are discussed in Section 1.4. The chapter concludes with an overview of the structure of the study in Section 1.5.

1.1 Theoretical Background and Lenses

Following the rapid growth of an innovation and knowledge-based economy, the importance of knowledge transfer for greater economic wealth creation has been acknowledged (DTI, 2003; Lambert, 2003; Lockett, 2006; Technopolis, 2006). To support the demands of radical innovation, the exploitation of various sources of knowledge and the efficiency of knowledge transfer have become key issues for sustainable innovation and economic development. Siegel et al. (2004) and Geuna and Muscio (2009) suggest that the best and most effective knowledge transfer takes the form of collaboration and communication between universities and businesses. Knowledge transfer is also a knowledge/information exchange and learning process amongst universities, businesses, and industry that can result in benefit to all parties (Lockett, 2006; Abreu et al., 2008).

Given the increasing numbers of patents issued to universities and businesses in most innovative countries since the mid-1980s (Lambert, 2003), the economic benefits and impact of the growth of scientific and technological knowledge

transfer between these parties has raised interest amongst many researchers and also amongst businesses and governments (Harmon et al., 1997; Brookes and Kelly, 2004; Shane, 2004). This has led to a research focus on the effects of government policy which encourages university technology creation, transfer and commercialisation (Mowery et al., 2001; Shane, 2004; Debackere and Veugelers, 2005). The strong research and innovation base of a university can support firms with the most up-to-date knowledge and, at the same time, reduce the risk, time, and cost incurred by firms in acquiring new knowledge. The notion of university technology transfer (UTT) has therefore developed into a range of different forms, such as patenting, licensing, and university spin-out company creation (Grimaldi et al., 2011; Siegel and Wright, 2015). Siegel et al. (2003) argue that UTT is an important mechanism for generating local technological spillovers as a source of return to the university and could also contribute to regional economic development (Siegel et al., 2003; NESTA, 2007; Iacobucci and Micozzi, 2014).

Lambert (2003) and Siegel et al. (2003) both indicate that most UTT involves licensing to industry, and developed as an approach between the 1980s and the mid-1990s. Since then, and following recognition of the potential of university commercialisation activity, government policy has strongly promoted business-university collaboration and entrepreneurship and the use of spin-outs as a source of employment creation (Gregorio and Shane, 2003; Lambert, 2003; O'Shea et al., 2005). Due to the accelerated growth of radical innovation, many newly exploited technologies, which require the assistance of professional scientists, cannot simply be transferred via licensing (Henderson, 1993; Audretsch, 1995; Franzoni and Lissoni, 2007). Therefore, it is argued that university spin-outs are the most viable solution for commercialising university-based technology, which may increase the probability of the success of technology transfer (Wright et al., 2004; Franzoni and Lissoni, 2007). Spin-out activities successfully expanded amongst universities (Lambert, 2003), and stimulated the entrepreneurial environment with academic innovative potential. The creation of university spin-outs allows and motivates university academics/scientists to be involved directly in the development and commercialisation of their research output which can ease and resolve the problems that might occur during the process of knowledge transfer and also potentially play a role in boosting economic and social activity (Etzkowitz et al.,

2000; Gregorio and Shane, 2003; Muscio, 2010; Audretsch et al., 2012; Algieri et al., 2013; Iacobucci and Micozzi, 2014; Visintin and Pittino, 2014).

Since the 1990s, with the introduction of government policies to encourage and remove restrictions on the commercialisation of university-based knowledge and technology (such as the Bayh-Dole Act in the US in 1980), many universities have established technology transfer offices (TTOs) to act as intermediaries between university, business, and industry, to facilitate the process of UTT (Lambert, 2003; Siegel et al., 2003; Siegel et al., 2004; Markman et al., 2005a; Muscio, 2010), and to spill over university knowledge for the benefit of the public (Mowery, 2005; Wennberg et al., 2011). The importance of dialogue during the process of knowledge transfer has been mentioned above, and this can be extended to communication and networking (Lockett, 2006). The responsibilities and functions of TTOs and technology transfer managers (TTMs) have been discussed in many studies (Siegel et al., 2003; Siegel et al., 2004; Wright et al., 2004; Debackere and Veugelers, 2005; Muscio, 2010). The multiple functions of TTOs/TTMs can not only help to improve the efficiency and success of technology transfer from university to business and industry and also play an important role in economic development (Markman et al., 2005b; Muscio, 2010). However, the importance and quality of TTOs has also been questioned. Lambert (2003) argues that the quality of TTOs can vary significantly as a result of antecedent factors that relate to both the organisation and the individual. Therefore, their efficiency, performance, economic impact, and policy implications have also been widely discussed (e.g. Siegel et al., 2003; Siegel et al., 2007; Muscio, 2010; Algieri et al., 2013). Amongst the related research, however, there are relatively few studies which provide empirical evidence. The contribution of TTOs/TTMs to the UTT process remains a subject of debate in the literature (Muscio, 2010).

Previous studies point out that the university and TTO experience in university spin-out creation can be seen as the accumulation of heterogeneous knowledge, development of capabilities for establishing spin-out, and as beneficial to the improvement of spin-out creation in the present and future (Lockett and Wright, 2005; Markman et al., 2005a; O'Shea et al., 2005; Gómez et al., 2008). Siegel et al. (2003) and Siegel et al. (2004) built up a model of the UTT process based on licensing activity and pointed out the barriers to, and recommendations for,

improving the licensing process. However, they did not illustrate the impact of the barriers on the process. Meanwhile, these do not necessarily apply to other UTT activities such as those involved in spin-out. More empirical research into university spin-out activity, with practical evidence of the UTT process, is therefore required.

The process of creating spin-out activity involves the interaction of various parties, including TTMs, academic entrepreneurs (AEs), and venture capitalists or other entrepreneurs (Wright et al., 2007; Link et al., 2015). AEs and TTMs are identified as two main stakeholders who work together as a team on the UTT process from the beginning even before patenting or opportunity recognition. Although the current literature shows the individual roles of TTMs and academics within the UTT process (McAdam et al., 2009; McAdam et al., 2010), there is no empirical work which explains how they begin to work together, and more importantly, how their synergistic effect and relationship contributes to UTT. As previous studies have highlighted the importance of partnered parties (such as TTMs and AEs) having good social relationships or incorporating team/trust building activities for successful knowledge creation and to establish the basis for collaboration (Rynes et al., 2001; Van Den Bosch et al., 2003; Chen, 2004), this study aims to fill the gaps in current literature by looking into relationship building between TTMs and AEs.

In order to develop an in-depth understanding of the process of UTT, this study aims to investigate how the two key stakeholders – TTMs and AEs – begin their collaboration, build up their relationship, and then transfer the academic output into university spin-outs. The study therefore utilises the concept of absorptive capacity (AC) to look at how university spin-out nurtures the ability to acquire, assimilate, transform, and exploit knowledge through exploratory and exploitative learning processes (Lane and Lubatkin, 1998; Zahra and George, 2002), and develops a novel process model that aims to understand the key constituents of university spin-out AC and their impact upon AC accumulation. Previous research looks into the relationship between the roles that participate in the improvement of UTT, and shows that the AC development in which universities engage improves the commercialisation of UTT (Rothaermel and Thursby, 2005; McAdam et al., 2009). This study uses AC as the main research framework to articulate all that happens between TTMs and AEs within the process of UTT

from the beginning, based on the key determinants that constitute spin-out AC. In previous studies, the collaboration between TTMs and AEs has mainly been discussed only at the individual level and impact upon the development of spin-out AC as a whole also have not been fully discussed in the literature (e.g. McAdam et al., 2009; McAdam et al., 2010). Empirical evidence is required to analyse their complementary, collaborative, and synergistic relationship and the influence this has on university spin-out creation. Therefore, there is a need to investigate the actual contribution of TTMs and AEs to university spin-out, the development of explorative and exploitative learning processes for progressing spin-outs, and to appreciate how they overcome barriers and their impact upon the spin-out process.

1.2 Research Aim and Research Objectives

Based on the theoretical background and lenses, this study aims to reduce the ambiguity of the UTT process by monitoring the interactions and the antecedent factors, including prior knowledge and experience, of the key stakeholders – TTMs and AEs. In order to fill the research gaps identified from previous literature, this study therefore formulates a central research question (RQ) and two research objectives (RO1 and RO2).

RQ. How does the interaction between AEs and TTMs contribute to the development of AC within university spin-outs and how does this affect the commercialisation process?

RO1. What are the key determinants of university spin-out AC and how do they shape the role of TTMs and AEs in spin-out?

RO2. How does the role of TTMs and AEs and their collaboration impact upon different stages of the university spin-out process?

1.3 Methodology and Research Process

The ontology and epistemology enable this study to focus mainly on understanding social interactions, including the motivations and intentions which exist between two stakeholders; the TTM and AE (Saunders et al., 2007). This study therefore involves a number of semi-structured and open-ended interviews with stakeholders as the primary strategy for revealing the whole picture of interaction between TTMs and AEs; it aims to understand both the history (e.g. prior experience) and development of the process.

Having illustrated the research philosophy and paradigm of this investigation, the thesis moves on to recognise the exploratory nature of the study. In order to answer the research questions, it adopts a multiple case study methodology and qualitative approach to investigate the relationship building and collaboration between university AEs and TTMs within the process of university spin-out creation. The final study was made up of thirteen case studies with twenty-six participants, from eleven universities across the UK. It also included interviews with eight TTO Directors (TTDs)/Heads of commercialisation (some of the TTDs were also the TTMs responsible for the case studies), and three UTT experts who were the heads of knowledge/technology transfer associations or managers of major venture capital companies in the UK.

In response to the research question, the analysis first identifies the prior knowledge of TTMs and AEs that trigger or motivate their participation in UTT and their perceptions and expectations of each other's role in the university spin-out process. Second, it sets out to identify the combinative capabilities amalgamated by TTMs and AEs from their relationship building, communications, and trust building during the spin-out process. Third, based upon the previous two analyses, which provide a comprehensive understanding of the key determinants of university spin-out AC, the study aims to reveal the whole story of how TTMs and AEs work together in the spin-out process. Their impact upon the different dimensions of AC development is also discussed.

1.4 Contribution

The research makes a novel contribution by revealing the UTT context in depth and suggesting improvements to the process during which AEs, TTMs and spin-outs interact. The results of this study are expected to contribute to the UTT and AC literature.

The results propose a novel perspective on AC within the context of identifying the importance of prior knowledge and how it helps TTMs and AEs to establish combinative capabilities. The findings contribute to a better understanding of the spin-out process; from raising AE awareness, to TTMs and AEs working together and complementing and benefitting from each other's role in the process. A mutual trusting relationship between TTMs and AEs could also benefit AC development. This study provides a deeper understanding of the mechanisms through which AEs and TTMs work together in the university spin-out process. It identifies tensions and doubts and provides insights into how most of these could be dealt with by filling the knowledge gaps, managing AE expectations, and promoting effective communication and trust.

Most importantly, the findings of this study are expected to guide, improve, and make more effective the development of present and future university spin-outs, the roles of TTMs and AEs, their collaboration, and the function of the TTO.

1.5 Overview of Thesis Structure

This thesis consists of six chapters. The first provides a brief introduction and outline of the structure of this study. Chapter 2 presents the theoretical framework and reveals the research gaps which were identified through a review of the literature dealing with knowledge and technology transfer, UTT and AC. The chosen research objectives and methodology of the study are justified in Chapter 3. An in-depth data analysis and discussion are presented in Chapters 4 and 5. Chapter 4 identifies and defines the prior knowledge which motivates and shapes the roles TTMs and AEs play in the university spin-out process and also their perceptions and expectations of each other. In Chapter 5, the histories of the communication between the TTMs and AEs, and of their relationships and trust

building are presented. This chapter examines the collaborative and synergistic relationship between TTMs and AEs, and their contribution to different dimensions of spin-out AC development, from the viewpoint of both parties. In Chapter 6, the study reflects on the findings in terms of the research questions set in Chapter 3 and highlights the contribution of the study in relation to the research objective, current literature, and empirical research. The limitations of the study are pointed out and recommendations for further research and practitioner implementation are also presented.

CHAPTER 2

Literature Review

To build the theoretical foundation for this study, this chapter summarises the UTT related literature and identifies the research gaps. Section 2.1 begins with a critical review of the definitions and distinction between knowledge transfer and technology transfer. Whilst different, this thesis considers that they are in fact inseparable, because knowledge can be seen as a broader interpretation of technology, and technology transfer consists of the transfer of both explicit and tacit knowledge. The complexity of, and resources required for, the process of knowledge transfer are also identified. In Section 2.2, the importance of the role universities play in the process of knowledge and technology transfer emerges and the key stakeholders – AEs and TTOs – participating in and contributing to UTT are recognised. The function each stakeholder performs in the UTT process is also discussed. In order to provide a more comprehensive understanding of the UTT process, the present study explores how TTMs and AEs contribute to the establishment of university spin-out companies. In Section 2.3, this study therefore uses AC to investigate how TTMs and AEs contribute to UTT by developing a spin-out's ability to acquire, assimilate, transfer, and exploit knowledge for commercial ends (Cohen and Levinthal, 1990; Zahra and George, 2002). As the contribution of universities to AC at different levels in the process of knowledge transfer has previously been identified, this study adopts AC to construct the key theoretical framework and looks at: (i) the individual *prior knowledge* of TTMs and AEs; (ii) their *combinative capabilities*, which include their relationship building with one another through the communication tools of shared language, boundary spanning, and network building (with all individuals/contacts involved in the process), *internally*, within the university spin-out, and *externally*, with external actors; and finally (iii), at how these *determinants* impact upon the different stages of the development of university spin-out AC.

2.1 Knowledge Transfer and Technology Transfer

2.1.1 Knowledge Transfer

While the creation of knowledge has been seen as an important way for firms to establish their competitive advantage (Matusik and Hill, 1998; Osterloh and Frey, 2000), it is noted that knowledge transfer has become the basis of that competitive advantage (Argote and Ingram, 2000) and the key to the development of sustainable competitive advantage (Osterloh and Frey, 2000; Lubit, 2001). Lockett (2006: 5) considers knowledge transfer to be “an essential element of innovation which drives competitive advantage in increasingly knowledge-driven economies”.

Knowledge transfer has been discussed widely, mainly in organisational, business, and management science research. It has also been variously defined in different studies. For example, “Knowledge transfer in organizations is the process through which one unit (e.g., group, department, or division) is affected by the experience of another” (Argote and Ingram, 2000: 151); knowledge transfer is a process of transferring a certain ability from one source to another user (Garavelli et al., 2002); knowledge transfer is a process of “transferring good ideas, research results and skills between universities, other research organisations, business and the wider community to enable innovative new products and services to be developed” (UK OST, 2006); and knowledge transfer is a mechanism for exploiting and exploring tacit knowledge (both know-how and personal) and experience, and then converting it into explicit knowledge (Hughes et al., 2007; Abreu et al., 2008).

This research summarises definitions of knowledge transfer and discusses the similarities and differences between the above mentioned studies. First, knowledge transfer can happen within universities, organisations, businesses, and even the wider community. Second, knowledge transfer is a process or mechanism for transferring knowledge between one providing unit and one recipient unit. Third, the knowledge to be transferred is a certain ability which can be tacit or explicit, or can even be transferred from tacit to explicit during the

process. Finally, knowledge transfer enables innovative new knowledge to be developed. This study clarifies the main characteristics of the process, as follows.

First, the knowledge involved in the transfer process needs to be identified. It can be categorised into explicit knowledge and tacit knowledge. Explicit knowledge is something which can be easily discovered, transmitted, and shared in the form of words, numbers, models or manuals. Tacit knowledge is personal and broader than explicit knowledge but also includes more intangible factors, such as know-how, personal experience, culture, beliefs, and perspective (Howells, 1996; Van de Velde et al., 2007; Abreu et al., 2008). Once tacit knowledge has been codified and transformed, it becomes new explicit knowledge. It can be seen that tacit knowledge has potential in both knowledge exploitation and exploration; it can be used to refine existing knowledge, to explore the old certainties, and to research the application of knowledge to explore new possibilities (March, 1991; He and Wong, 2004). Tacit knowledge has also been recognised as an important component of technological innovation growth and creating competitive advantage (Howells, 1996; Pavitt, 2003). Howells (1996) states that the contribution of tacit knowledge has been acknowledged in terms of not only the development of innovation, but also the growth of economic performance. As a result, the knowledge involved in knowledge transfer activities can be explicit or tacit, and can take many forms, including know-how, research results, personal experiences, expertise and skills. The process of knowledge transfer enables firms to create new knowledge and also initiate competitive advantages within the knowledge driven economy (Lockett, 2006; RCUK, 2007).

During the process of knowledge transfer, knowledge will be transferred from the person who owns the knowledge to another who needs to acquire and use that knowledge. In Lockett's (2006) study, knowledge transfer is described as a dialogue, a two-way interaction, knowledge sharing, communication, or knowledge exchange. However, the transfer is difficult because, as Argote and Ingram (2000: 152) point out, "the state of the knowledge repositories affects the processes and outcomes of knowledge transfer". In order to accomplish a successful knowledge transfer, it must be possible to fit the knowledge which is transferred into the new context. People are considered to play the key role in the achievement of this goal (Argote and Ingram, 2000).

Argote and Ingram (2000: 164) argue that “people are capable of adapting knowledge from one context to another”. People with experience or skills can quickly learn, or be trained, to build up an understanding of the new knowledge, especially tacit knowledge (Matusik and Hill, 1998; Lubit, 2001; RCUK, 2007). It was also found that knowledge transfer is more effective when accompanied by the movement of personnel because “people are capable of adapting the tools and technology to the new context” (Argote and Ingram, 2000: 164). Moreover, such people are able to modify the knowledge of recipients and improve the performance of knowledge transfer through training and communication (Argote and Ingram, 2000). In addition, Lubit (2001: 169) suggests that when people work together in a group it provides a platform for sharing tacit knowledge, anecdotes, and experiences, and the “mixing of tacit knowledge often leads to new insights and innovations”. Accumulated experience can also facilitate the understanding and communication of new technology (Zander and Kogut, 1995).

The above review of the knowledge transfer literature exposes the complexity of the knowledge transfer process, based on the various natures of knowledge. People with experience and the ability to adapt knowledge are considered to be an important intermediary and facilitator in the process (Argote and Ingram, 2000). There are, however, relatively few studies which provide empirical evidence of the degree to which experience and ability are required or to what extent people can facilitate the process of knowledge transfer. Deeds (2001: 30) stressed that the intangible nature of knowledge and of capabilities, which are “usually difficult to observe, quantify, and measure”, might present difficulties for those conducting relevant research. Therefore, there is a need, in this research, to look into actual knowledge transfer activities and to see how the people involved contribute to the transfer process. The results are expected to contribute to a reduction in the ambiguity of knowledge transfer in general.

2.1.2 Technology Transfer

Bozeman (2000) concludes, from previous studies, that technology transfer can be defined in many different ways, depending on the research discipline and purpose. Many studies simply regard technology transfer as part of the process of knowledge transfer (Lockett, 2006; Abreu et al., 2008). This study presents a

review of the literature concerning knowledge and technology transfer (see the discussion above), and in the text which follows, attempts to explore their similarity and dissimilarity.

The word ‘technology’ is often misleading because it is frequently connected with the application of scientific knowledge (Zander and Kogut, 1995). Knowledge is considered to be much broader than technology (Gopalakrishnan and Santoro, 2004) and some argue that technology is just a form of knowledge (Garud and Nayyar, 1994). When a technology transfer activity occurs, usually a specific technology will be transferred and commercially exploited. However, when a knowledge transfer activity occurs, the knowledge is not only scientific or technological (Abreu et al., 2008), but can include physical, or social/behavioural theories and principles, mathematical modelling, philosophy, politics, and organisational skills (Tornatzky and Fleischer, 1990; Abreu et al., 2008). Some knowledge is not even understandable or ready to use and commercialise. Therefore, while knowledge transfer has to go through a pre-transfer stage to codify and identify the knowledge needed, technology transfer usually starts directly with the transfer of a tangible and precise technology to business. It has been found that explicit knowledge which is embedded in technology can be transferred more easily and in a less costly manner (Zander and Kogut, 1995; Argote and Ingram, 2000). Tacit knowledge, however, is more difficult for the competitor to imitate (Zander and Kogut, 1995; Osterloh and Frey, 2000), and more importantly it is a crucial source from which firms can create sustainable competitive advantage (Osterloh and Frey, 2000; Lubit, 2001).

Gopalakrishnan and Santoro (2004: 67) state that “knowledge transfer and technology transfers are dynamic processes where organizations need to initiate, assimilate and institutionalize the transferred knowledge or technology”. On one hand, it seems that the process of knowledge transfer requires more time or resources than technology transfer, but such investment can be worthwhile because of its potential to create overall competitive advantage for firms. On the other hand, technology transfer activity can efficiently and professionally help firms to achieve their goals in an innovation and knowledge driven economy. Zander and Kogut (1995) argue that technology transfer is not solely associated with the application of scientific knowledge. They present a case study which demonstrates “the principles by which individual skill and competence are gained

and used, and by which work among people is organized and coordinated" (Zander and Kogut, 1995: 77). Successful technology transfer allows the recipient unit to acquire new knowledge or capabilities (in design, operation and maintenance, marketing, finance, production, human resource management, etc.) which can be utilised and commercially exploited in the marketplace (Zander and Kogut, 1995). People with skill and competence, and the synergistic working relationship, are therefore again of value to the process of technology transfer. This is consistent with the research gap addressed in Section 2.1.1 of this study. To sum up, technology transfer is not just about transferring 'explicit knowledge', but involves the transfer of various forms of 'tacit knowledge', especially through the medium of people. Knowledge transfer and technology transfer are different, but work hand-in-hand; one could not work without the other.

Since the main focus of this research is technology transfer within universities, this study adopts a broader and more general definition of the term technology transfer. Here it is considered to be the technology (with/without the tacit knowledge) that can be commercialised from a university to another organisation or setting. As Bozeman (2000: 628) points out, most work on technology transfer considers "technology as an entity, not a study and certainly not any specific applied science". This study considers the entity itself to be a particular product, idea, service, or concept which emanates from the science and technology research output of the university (science, maths, engineering, etc.) and creates intellectual property (IP) that can be commercially exploited. People who are involved and contribute to technology transfer within a university context are also, therefore, crucial and will be discussed in the next section. Most university-business collaboration engages in both knowledge and technology transfer activities (Lambert, 2003; Gopalakrishnan and Santoro, 2004). Abreu et al. (2008), however, find that current university-business collaborations focus too heavily on technology transfer. It is suggested that government should also consider the various impacts of knowledge exchange between university and business on the economy and on business performance, and should introduce wider policies to encourage university-business collaboration (Abreu et al., 2008).

2.2 University Technology Transfer

2.2.1 The Role of Universities in UTT

In this turbulent and rapidly changing knowledge-based economy, firms increasingly have to speed up the development, commercialisation and even globalisation of innovation to create the competitive advantages which will enable them to survive or grow. Thus, reducing the time needed for development and commercialisation and also making the innovation process, and achievement of first mover advantage, more effective have become key issues which innovating firms and entrepreneurs have to manage (Link et al., 2015). The important role universities play in contributing to such processes has therefore drawn considerable attention from researchers in the past few decades (Rasmussen and Wright, 2015).

Since the 'Big Science' projects launched by the US in World War II, universities in America have received federal funding to develop research capacities devoted to industrial science and military technology (Franzoni and Lissoni, 2007; NESTA, 2007). The director of the US Office of Scientific Research and Development, Vannevar Bush (1945), recommended the continued encouragement of university efforts towards wartime science and research in peacetime. Universities, therefore, continually conduct basic research with funding from government, and some of the research results are also used commercially by industry (NESTA, 2007). The notion of UTT has developed into different forms such as patenting, licensing, and university spin-out company creation in the US, as well as expanding to many other countries in the world (Grimaldi et al., 2011; Siegel and Wright, 2015).

In 1980, the Bayh-Dole Act in the US gave the universities ownership of any IP generated with government funding and eliminated restrictions on licensing (Etzkowitz et al., 2000; Poyago-Theotoky et al., 2002; Lambert, 2003; Siegel et al., 2003; NESTA, 2007). Although patents were common within US universities prior to the Bayh-Dole Act (Franzoni and Lissoni, 2007), few universities recognised the importance and commercial potential of technology transfer (Mowery et al., 2001). However, it is agreed that the Bayh-Dole Act only had a

small effect on UTT, and that the rapid increase in university technology commercialisation was affected by the shift in IP laws and government policy towards funding academic research (Henderson et al., 1998; Mowery et al., 2001; Mowery and Ziedonis, 2002). This highlights the importance to universities of having appropriate incentive schemes in place to secure academics' willingness to cooperate in licensing or spin-out with adequate shares in royalties or equity (Link et al., 2015). Lambert (2003) points out that licensing played a leading role in most technology transfer activities before the mid-1990s. However, there has been considerable growth in university spin-outs since the early 1990s; indeed, the creation of university spin-out companies has become one of the most popular technology transfer activities (Franklin et al., 2007). Established firms today face increasing numbers of barriers when attempting to bring new technologies to market, and universities have come to regard themselves as a solution to technology transfer through their creation of high-tech university spin-outs (Franklin et al., 2001; O'Shea et al., 2005).

Following the rapidly increasing numbers of patents issued to universities and businesses in most innovative countries since the mid-1980s (Lambert, 2003; Siegel et al., 2004; Link et al., 2015), the economic benefits and impact of the growth of scientific and technological knowledge transfer between these parties has been of interest to many researchers, businesses, and governments (Harmon et al., 1997; Brookes and Kelly, 2004; Shane, 2004; Link et al., 2015). This has led to a research focus on the effects of government policy which encourages university technology creation, transfer, commercialisation, and venture creation not just in America but across many countries in the world (Mowery et al., 2001; Shane, 2004; Debackere and Veugelers, 2005; Wright et al., 2007; Rasmussen and Wright, 2015). The strong research and innovation base of a university can support firms with the most up-to-date knowledge and, at the same time, reduce the risk, time, and cost incurred by businesses in acquiring new knowledge. In addition, UTT is vital to regional economic development (Siegel et al., 2003; NESTA, 2007; Iacobucci and Micozzi, 2014). Siegel et al. (2003) argue that UTT is an important mechanism for generating local technological spillovers as a source of return to the university. Universities can efficiently transfer technology to meet the needs of local businesses and industry, and at the same time build up competitive strength for the region

(NESTA, 2007). Moreover, Link et al. (2015: 2) point out that UTT related activities “can result in additional revenue for the university, [and] employment opportunities for university-based researchers and graduate students”.

In 1985, the UK government first gave universities ownership of IP developed with the aid of government funds, and allowed the transfer of that property to the private sector (Etzkowitz et al., 2000). In 1997, it acknowledged the importance of driving its strong science and technology base into the innovation and knowledge-based economy considering this to be a positive step in innovation policy-making. The relationship between university and industry has, thus, been changing (DTI, 2003). In 2000, the UK government recognised the important role of the universities in increasing social and economic returns and established many initiatives to encourage knowledge and technology transfer activities (BVCA, 2005). The Higher Education Innovation Fund (HEIF) was introduced in England in 1999, and then established by the government in 2001 as a third stream of funding, supporting the commercialisation of knowledge and technology transfer using, amongst other things, licensing, university spin-outs, collaboration between university and industry, and entrepreneurial training and teaching (Lambert, 2003; Franklin et al., 2007; HCSTC, 2013). The House of Commons Science and Technology Committee’s (HCSTC) (2013: 172) report for 2013 shows that “HEIF is being maintained at £150 million per annum for 2011–15, and is being reformed to increase the rewards for universities that are most effective in business engagement”. In 2003, the government recognised the importance of knowledge transfer and implemented the recommendations of the Review of Business-University Collaboration, published by Richard Lambert, to develop model agreements for voluntary use by industry and the universities (Lambert, 2003; NESTA, 2007). It can, therefore, be seen that the UK government’s innovation policy engages in the development of knowledge and technology transfer (NESTA, 2007). The supportive attitude continues in the latest HCSTC report (2013: 3), which states that, “the future success of the UK economy has been linked to the success of translating a world class science base to generate new businesses with the consequent generation of UK jobs and wealth.”

Siegel et al. (2004) and Geuna and Muscio (2009) suggest that the most effective knowledge transfer takes the form of collaboration and communication between

universities and business/industry. Some studies indicate that knowledge transfer is also a knowledge/information exchange and learning process amongst universities, businesses, and industry, and that they may all benefit from the outcome of knowledge transfer (Lockett, 2006; Abreu et al., 2008). When tacit knowledge has been codified and transformed into explicit and specific knowledge, it requires protection in the form of IP regulation. Universities therefore usually patent their precise knowledge from science, technology, and innovation research output before proceeding with a variety of technology transfer routes such as licensing and spin-outs (Lambert, 2003; Link et al., 2015). These UTT activities, which involve the commercialisation of university IP, are referred to as academic entrepreneurship (Grimaldi et al., 2011; Siegel and Wright, 2015). With their highly innovative and exploitative potential and scientifically experienced AEs, universities have become active key players in the scientific knowledge market (Audretsch, 2000; Debackere and Veugelers, 2005). Due to the changing role of universities, the competition between them, and the need to raise revenue or generate funds to pursue academic entrepreneurship, recent research has indicated that academics may face a new phenomenon – pressure to link their research output more closely with economic needs and commercialisation (Martin, 2012; Siegel and Wright, 2015). Not all university academics/scientists are happy or comfortable with the commercialisation of their research output, or willing to deal with such pressure, but research shows that their negative attitudes toward commercial engagement have been gradually softened (Etzkowitz, 2002; Jain et al., 2009).

The enactment of the Bayh-Dole Act in 1980 not only caused a rapid growth in licensing and numbers of patents issued to US universities, and influenced the relevant regulation in many countries worldwide; it also led increasing numbers of universities to establish TTOs to exploit, manage, and facilitate the commercialisation of UTTs (Henderson et al., 1998; Poyago-Theotoky et al., 2002; Shane, 2004; Franzoni and Lissoni, 2007; Link et al., 2015). Thus, since the 1990s, with the introduction of government policies to encourage the commercialisation of university-based knowledge and technology, TTOs also act as intermediaries between universities, business, and industry, to facilitate the process of UTT (Lambert, 2003; Siegel et al., 2003; Siegel et al., 2004; Markman et al., 2005a; Muscio, 2010; Link et al., 2015). In addition to this, they spill over

university knowledge for the benefit of the public (Mowery, 2005; Wennberg et al., 2011), and have an important impact upon the economy and on policy making (Siegel and Wright, 2015). The importance of dialogue during the process of knowledge transfer has been mentioned above, and this can be extended to communication and networking (Lockett, 2006).

Franzoni and Lissoni (2007: 24) find that the decision whether to transfer technology through licensing or spin-outs mainly "depends on the technological regime and the appropriability of the innovation". Many researchers support this argument, as patents with higher appropriability regimes that involve a higher degree of tacit knowledge and a stronger science base are more likely to be licenced to their original inventor. Spin-out creation is therefore necessary for AEs to manage the patents with their uncodified knowledge (Shane, 2002; Franzoni and Lissoni, 2007). However, the decision could also be made based upon the anticipated financial returns, on the university's stance, and on "their desire to generate economic/knowledge spillovers to the community" (Link et al., 2015: 8). It is also important to consider whether the technology matches the university's objectives and strategies for commercialisation and whether the TTO has sufficient or appropriate resources, capabilities, and competencies to proceed with the chosen UTT activity, particularly when dealing with university spin-outs (Clarysse et al., 2005; Link et al., 2015).

Siegel et al. (2003) and Siegel et al. (2004) used a qualitative approach to look into the actual 'production process' of UTT (see Figure 1), the barriers and improvements to the process (see Table 1 and more discussion in Sections 2.2.3 and 2.2.4), and the significance of networks and relationships. They assessed the impact of environmental and institutional factors and of organisational practice on the productivity of TTOs by interviewing three main UTT stakeholders: university academics/scientists, TTO directors, and firm managers/entrepreneurs. They built up a model of the UTT process based on licensing activity and pointed out the barriers to, and made recommendations for, improving the process, although they did not illustrate the impact of the barriers on the process. However, these do not necessarily apply to other UTT activities such as those involved in spin-outs. More empirical research into other UTT related activities such as university spin-out activity, with practical evidence of the UTT process, is required.

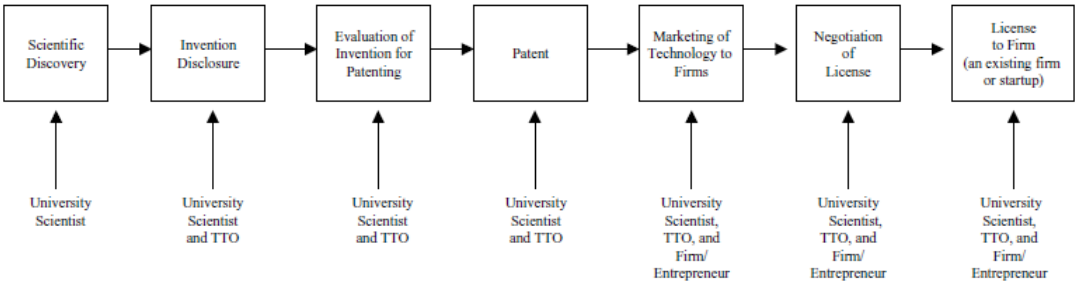

Figure 1 How Technology is Transferred from a University to a Firm or Entrepreneur (A Theoretical Model)

Source: Siegel et al. (2004)

Table 1 The Barriers and Suggested Improvements to the UTT process

Barriers	Suggested improvements
1. Lack of understanding regarding university corporate, or scientific norms and environments 2. Insufficient rewards for university researchers 3. Bureaucracy and inflexibility of university administrators 4. Insufficient resources devoted to technology transfer by universities 5. Poor marketing/technical/negotiation skills of TTOs 6. University too aggressive in exercising IP rights 7. Faculty members/administrators have unrealistic expectations regarding the value of their technologies 8. 'Public domain' mentality of universities	1. Universities and industry should devote more effort to developing better mutual understanding 2. Modify reward systems to reward technology transfer activities 3. Universities need to provide more education to overcome informational and cultural barriers 4. Universities should devote additional resources to technology transfer 5. Universities should be less aggressive in exercising IP rights 6. Increase formal and informal networking between scientists and practitioners 7. Universities need greater technical expertise and marketing skills in the TTO

Source: Siegel et al. (2003) and Siegel et al. (2004)

2.2.2 University Spin-out Companies

Since 1990, the interest in entrepreneurial universities has grown. Spin-out activities successfully expanded amongst universities, and stimulated the entrepreneurial environment with academic innovative potential (Lambert, 2003; Shane, 2004). Wright et al. (2006: 481) noted that "the creation of university spin-out companies that create wealth is a major policy objective of governments and universities". Also since early 1990, however, and following recognition of the potential of university commercialisation activity, with government policy strongly promoting business-university collaboration and using spin-outs as the source of employment creation, the balance of technology transfer has shifted too far towards university spin-outs (Gregorio and Shane, 2003; Lambert, 2003; O'Shea et al., 2005). Due to the rapid growth of radical innovation, many newly exploited technologies, which require the assistance of AEs, cannot simply be transferred via licensing (Henderson, 1993; Audretsch, 1995; Franzoni and Lissoni, 2007). Therefore, it is argued that university spin-outs are the most viable solution to commercialising university-based technology, which may increase the probability of the success of technology transfer (Wright et al., 2004; Franzoni and Lissoni, 2007).

University spin-out companies are variously defined in previous research. Narrowly, a spin-out is a company that relies on the exploitation of IP generated by university research (Gregorio and Shane, 2003; BVCA, 2005). However, recent studies have proven that some university spin-outs have been founded even though their AEs failed to disclose the relevant IP to the university administrator (Fini et al., 2010; Aldridge and Audretsch, 2011). Rasmussen and Wright (2015: 783), considering the role a university can play in a start-up, therefore define university spin-outs as "new ventures initiated within a university setting and based on technology derived from university research" (Rasmussen and Borch, 2010).

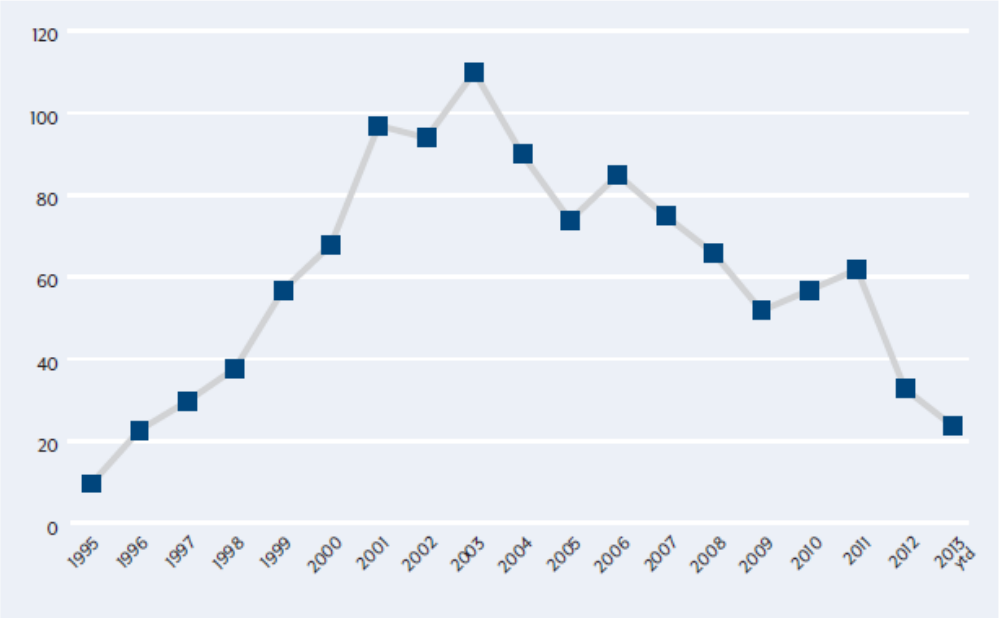

Figure 2 New University Spin-outs Created in each Academic Year in the UK

Source: PraxisUnico, (2013: 8)

Due to the difficulties of finding funding for university spin-outs, especially in the early stages of development, the number dropped significantly after 2003 and this decline continued until 2013 (see Figure 2, PraxisUnico, 2013). However, UK universities in general convert more of their research than do US universities into spin-out companies (Franklin et al., 2007). Data from the PraxisUnico Spinouts UK Survey Annual Report (2013) indicates that there were 800 active university spin-out companies in the UK in 2013. In addition, Abreu et al. (2009) point out that universities within the Russell Group, which have research grant income and in-house capability, have much higher rates of activity than any other pre- and post-1992 universities with which to make their contribution to the economy, mainly by technology transfer and collaboration with large businesses. Fewer, however, "cite spin-out companies than might be expected" (NESTA, 2010: 2). Similarly, in America, while some universities, such as Massachusetts Institute of Technology (MIT) and Stanford, are highly successful at creating high-growth ventures, still the majority of US universities produce very few spin-outs (Mustar et al., 2008; Rasmussen and Wright, 2015). Rasmussen and Wright (2015: 785) stress that "Despite the potential benefits from promoting spin-offs and the strong

attention from policy makers, it seems that many universities struggle to become effective supporters of spin-offs."

A university's entrepreneurial culture can have a critical impact upon the success of its start-up creations (Link et al., 2015; Siegel and Wright; 2015). The university's resources and capabilities, and the competencies associated with the individuals involved in the founding UTT team can also influence the development and success of a spin-out (Link et al., 2015; Rasmussen and Wright, 2015). However, Rasmussen and Wright (2015) point out that although some researchers have tried to identify why some universities perform better, there is no clear pattern to indicate how historical success leads to the future success of university spin-out creation.

Van de Velde et al. (2007: 14) note that "in terms of knowledge transfer, it is clear that the transfer of tacit knowledge is both difficult to manage and to control". The complex process of tacit knowledge transfer can be very costly and time consuming, particularly for small and medium enterprises. Government therefore plays an important role in encouraging and speeding up collaboration between highly skilled knowledge providers and those firms which need to acquire new knowledge (Lambert, 2003; Abreu et al., 2008). The creation of university spin-outs allows and motivates university academics/scientists to be involved directly in the development and commercialisation of their research output, which can ease and resolve the problems that might occur during the process of knowledge transfer and also play a potential role in boosting economic and social activity (Etzkowitz et al., 2000; Gregorio and Shane, 2003; Muscio, 2010; Audretsch et al., 2012; Algieri et al., 2013; Iacobucci and Micozzi, 2014; Visintin and Pittino, 2014).

In the past decade, research into university spin-outs has mainly focussed on their entrepreneurial orientation, competencies, and performance (Clarysse and Moray, 2004; Siegel et al., 2007). Despite the popularity of university spin-out creation prior to the year 2003, there are only a few studies which look at the spin-out process and the individuals involved in assisting that process (McAdam et al., 2009; McAdam et al., 2010). The process of creating spin-out activity involves the interaction of various parties, including TTMs, AEs, and venture capitalists or other entrepreneurs (Wright et al., 2007; Link et al., 2015). AEs and

TTMs are identified as two main stakeholders who work together as a team on the UTT process from the beginning even before patenting or opportunity recognition. Wright et al. (2007) address the individual's role as human capital which includes the stock of knowledge and skills which play a part in the complex entrepreneurial process (Becker, 1964). Wright et al. (2007) indicate that individuals with higher levels of human capital (in the form of education and experience) are more productive in high-tech entrepreneurial companies and industry. The importance and contribution of people with knowledge and skill in the UTT process has again been proven here.

During the spin-out process, AEs are considered to play a technical role as chief technology officers (CTOs), whilst the university should develop a network to allow them to access other human capital such as commercial or marketing skills (Lockett et al., 2005). It is crucial that the individuals within the founding team of a university spin-out have relevant prior commercial experience, and applied technological experience, but evidence indicates that, in practice, not many teams have this (Colombo and Piva, 2008; Link et al., 2015). Studies show that experience can contribute to the strengthening of interactions between academic and non-academic members of the founding team (Siegel et al., 2003; Wennberg et al., 2011; Visintin and Pittino, 2014). University spin-outs usually develop through the dynamic interaction of many different individuals in the founding team, with different competencies throughout the spin-out process (Clarysse and Moray, 2004; Rasmussen and Wright, 2015). The support and contribution of the individual members involved in the venturing process is difficult to identify and remains vague, but it is certain that all these people can play a critical role at some stage in a spin-out (Rasmussen et al., 2011; Rasmussen and Wright, 2015). This thesis attempts to address this variety by analysing the contributions made by individuals within the spin-out process. Sections 2.2.3 and 2.2.4 therefore begin to look at individual levels, illustrating TTM and academic perspectives with regard to university spin-out, commercialisation, and UTT, and their individual/collaborative contribution to the process.

2.2.3 Technology Transfer Offices and Technology Transfer Managers

Macho-Stadler et al. (2007: 485) mention that “a TTO can be interpreted as a technology seller pooling inventions from several research labs within a university”. The responsibilities and functions of TTOs have been widely discussed in many studies and these are summarised below:

1) Encouraging university academics and scientists to disclose their innovations and research results (Siegel et al., 2003).

2) Playing a role as guardians who safeguard, manage and protect university IP resulting from university research (Siegel et al., 2003; Siegel et al., 2004; Link et al., 2015).

3) TTOs work closely with university academics and scientists, and are therefore in a good position to explore opportunities which may have striking commercial potential for university scientific and technological innovations (Siegel et al., 2003; Wright et al., 2004).

4) TTOs facilitate the commercialisation of university IP through licensing or spin-outs (Siegel et al., 2004; Muscio, 2010).

5) TTOs link university innovations and industry, as well as matching university academic scientists and businesses more effectively (Siegel et al., 2003; Debackere and Veugelers, 2005; Muscio, 2010; Siegel and Wright, 2015).

6) The role of the TTM has also been recognised as important in the process of UTT, serving as a bridge between customers (entrepreneurs/firms) and suppliers of innovation (university scientists) (Siegel et al., 2004; Link et al., 2015).

7) Supporting entrepreneurial skills development for academics, faculty, and students (Siegel and Wright, 2015).

Not only do the multiple functions of TTOs help to improve the efficiency and success of technology transfer from university to business and industry; they also

play an important role in economic development (Markman et al., 2005b; Muscio, 2010). However, the importance and quality of TTOs has been questioned. As mentioned in Section 2.2.2, Siegel et al. (2003) and Siegel et al. (2004) point out the barriers which exist between TTOs and other stakeholders in the UTT process, and make suggestions for improvement (see Table 1 on page 13).

Macho-Stadler et al. (2007: 497) show that the size of the TTO may be critical to its ability to maintain its good reputation; it should be prepared to shelve some projects and to deliver the good ones, "thus raising the buyer's beliefs in expected quality, which will result in fewer but more valuable inventions being sold at higher prices". The intermediary role of TTOs could lower the cost of the search for potential buyers and reduce the uncertainty problem (Hoppe and Ozdenoren, 2005; Hellmann, 2007; Link et al., 2015).

Lambert (2003) argues that the quality of TTOs, as a result of antecedent factors that relate to both the organisation and the individual, can vary greatly. Therefore, the efficiency, performance, economic impact, and policy implications of TTOs have also been widely discussed in many studies (e.g. Siegel et al., 2003; Lockett et al., 2005; Siegel et al., 2007; Muscio, 2010; Algieri et al., 2013; Siegel and Wright, 2015). Amongst the related research, however, there are relatively few studies which provide empirical evidence. There are also still many debates in the recent literature on the contribution of TTOs to the UTT process (Muscio, 2010).

Previous studies show that university and TTO experience of UTT related activities consists of an accumulation of heterogeneous knowledge, and of the capabilities which they have developed for establishing spin-outs; these are considered to be beneficial to the improvement of spin-out creation in the present and future (Lockett and Wright, 2005; Markman et al., 2005a; O'Shea et al., 2005; Gómez et al., 2008; Link et al., 2015). TTMs can learn by succeeding, experimenting, and failing, and by sharing their knowledge and experience across the TTO (Debackere and Veugelers, 2005; Weckowska, 2015). Weckowska (2015: 73) further investigates the learning process in the development of TTM ability and argues that there is a need to ensure "continuity of relations (e.g. by reducing staff turn-over), allowing staff to make decisions about work practices on the basis of their learning, and encouraging them to

develop and maintain networks of contacts with their peers in other TTOs". Previous research points out that spin-out formation, the university's expenditure on IP protection, and the business development capabilities of TTOs are positively correlated (Lockett and Wright, 2005; Link et al., 2015). It is suggested that previous spin-out success might depend upon the commercial capabilities of TTMs, therefore universities should devote more attention to the recruitment, training, and development of TTMs with broader commercial skills. Moreover, in order to achieve an effective UTT, universities need to attract and retain TTMs with appropriate skills to support the commercialisation. Traditionally, TTMs are required to have a strong legal background, but the skills they now need have extended to include "opportunity recognition and exploitation and other commercialisation and entrepreneurial skills" (Link et al., 2015: 31).

Muscio (2010) argues that TTMs without academic backgrounds can still make a notable contribution to UTT, as long as they understand and have the respect of AEs, and have the relevant business/commercial backgrounds and experience to establish their credibility, to improve the effectiveness of TTO and UTT activity, and to work cooperatively with both AEs and industrialists. Furthermore, TTMs require special skills or experience (for example, IP law, technical, communication, marketing, and administrative) in order to facilitate the UTT process and to help bridge the cultural gap between university and industry (Markman et al., 2005b; Sloman, 2007; Muscio, 2010). Siegel et al. (2003) and Siegel et al. (2004) suggest that TTMs also need greater marketing/negotiation skills and technical expertise to improve the UTT process. Lockett and Wright (2005) stress the importance of the knowledge accumulated from those skills and experience in developing capabilities (especially for university spin-out) which are beyond the skills required for licensing. Iacobucci and Micozzi (2014) consider that people with entrepreneurial experience have a stronger predisposition to participate in start-ups, and that such experience can impact upon university spin-outs in the long run.

It is acknowledged that the multiple functions of TTOs fulfil this role and provide all the necessary human capital AEs need from the spin-out process, including the encouragement of innovation disclosure, safeguarding of university IP, exploration of opportunities with commercial potential, and facilitation of the commercialisation of university IP, amongst others (Siegel et al., 2003; Siegel et

al., 2004; Wright et al., 2004). Although O'Shea et al. (2005) point out a positive correlation between the number of TTMs within the TTO and spin-out creation, Gómez et al. (2008) argue that the number of TTMs is much less important than their expertise. Nevertheless, there is a lack of empirical evidence about how TTMs enact such roles and the background (knowledge, skill, or experience) they require to support the UTT process, especially during the creation of a spin-out.

2.2.4 Academic Entrepreneurs

Technology transfer activities connect highly educated and qualified staff to business and industry (Carayannis et al., 1998). Highly skilled people are considered a dominant, essential factor in the complete and efficient transfer of knowledge to the user. As discussed, universities are well placed in the process of knowledge transfer. They potentially possess elevated levels of innovative knowledge embodied within a highly educated workforce (DTI, 2003). Universities are not only able to put their research results into practice and create wealth through the commercialisation of knowledge (O'Shea et al., 2005; RCUK, 2007), but their academics are enabled to conduct better experiments because of their interaction with industrial scientists (Poyago-Theotoky et al., 2002). Moreover, universities provide academics who are not only optimally placed to release the commercial potential of research, but more importantly are capable of handling the whole process of knowledge transfer, by codifying important tacit knowledge, solving specific problems which may occur, and then successfully transferring knowledge (DTI, 2003; Fontana et al., 2005; Lockett, 2006; Kitson et al., 2009). University academics and scientists working with TTMs, therefore, have the expertise to unlock a development and the knowledge necessary for commercialisation and management of high level radical innovative technology. At the end of the knowledge transfer process, they can also ensure that firms possess identical knowledge to that which was identified by the source (Garavelli et al., 2002). Their ability to manage both tacit and explicit knowledge allows the firms efficiently to obtain sustainable competitive advantage. However, the process by which they are involved in transferring technology, along with both explicit and tacit knowledge, remains vague and requires further empirical investigation.

Academics have also recognised that universities play a key role in increasing the competitiveness of business (Abreu et al., 2009), as well as in supporting the development of university entrepreneurial competency (Rasmussen and Wright, 2015). Participation in UTT related activities can enhance academics' visibility amongst their peers, extend their social network, and help them to establish stronger academic connections, whilst also bringing financial rewards/grants to support their research (Link et al., 2015). Following the emergence of a UTT activity, university academics and scientists become involved directly and actively in licensing as technical consultants or as AEs in the formation of university spin-outs (Samson and Gurdon, 1993; Franzoni and Lissoni, 2007; Link et al., 2015). Markman et al. (2005b) indicate the positive impacts of university academics' and scientists' active participation and collaboration with TTOs on the speed of the commercialisation of UTT and on revenues, whilst Jensen and Thursby (2001) suggest that faculty involvement in UTT could increase the likelihood that academics will participate in related activities. The incentives for faculty or academic involvement could come from the royalties entailed in UTT activities. As university spin-out creation may generate greater financial returns for universities than licencing, AEs might request better financial rewards for their work, as an incentive for making more effort (Macho-Stadler et al., 2008; Link et al., 2015). University programmes, courses, and seminars which support university spin-out creation may also motivate and be of value to these potential entrepreneurs. This remains rare, however, and entrepreneurial education for university academics should be actively promoted by universities (Gómez et al., 2002; Gómez et al., 2008; Prodan and Drnovsek, 2010). Furthermore, Rasmussen and Wright (2015: 794) claim that academic "scientific excellence and industry experience is important for the creation of business opportunities, and prior entrepreneurial experience and external networks important for exploiting the opportunity". However, due to AE general lack of industrial and entrepreneurial experience, access to external resources and social capital or networks can be crucial and may influence the creation or performance of a university spin-out (Siegel and Wright, 2015).

Even though university academics are an essential component of UTT, their attitude and willingness to engage in UTT activities in practice requires further investigation. First, they still consider their position in the university primarily to

be one of teaching and research (Lockett, 2006; McAdam et al., 2009). They also have doubts and concerns that the degree of their participation in commercialising university technology may force them to abandon their research and teaching and may involve them in strenuous efforts to meet the needs of industry (Lockett, 2006; Abreu et al., 2009; Toole and Czarnitzki, 2010). However, the results of a study by Abreu et al. (2009) have shown that the interactions of academics with external organisations, or even with wider society, actually strengthen teaching and research activities. The positive correlation between university spin-out activities and research productivity and quality have also been confirmed (Gregorio and Shane, 2003; Rasmussen and Wright, 2015). Second, their commitment to the UTT process is not well recognised and rewarded (Cockburn and Henderson, 1998; Siegel et al., 2003; Siegel et al., 2004; McAdam et al., 2009). Third, AEs and TTMs may need more appropriate communication skills or networks for dealing with each other, and an essential ability to acquire the resources needed for commercialisation within the UTT process (Venkataraman et al., 1992; Franklin et al., 2001). Fourth, Muscio (2010) points out that young departmental directors are more likely to trust TTO activities than those with greater experience who may have difficulty accepting UTT and the need to collaborate with TTOs.

Academics' freedom to become engaged in UTT activities "is of fundamental importance to the future wellbeing of society" (Abreu et al., 2009: 41). Whilst academics traditionally disclose their innovations for the benefit of the public good, Shane (2004) and Markman et al. (2005a) point out that the trend towards UTT may cause them to focus on the commercial potential and financial returns of applied rather than basic research. Siegel et al. (2004) and Siegel et al. (2007), mention that many AEs in the US do not disclose their research output to their universities and consider that involvement with TTOs might slow down the commercialisation process, either because the TTOs tend to prioritise the safeguarding of researcher interests and the maximisation of university returns, or they want to protect the researchers and the environment that generates innovations (Link et al., 2015). There are also problems within the knowledge transfer process with regard to information asymmetry, whereby information concerning the value/quality of an invention is not equally available to both industry and academia. For example, academics may not be able to assess the

commercial opportunities of their inventions or may even hold unrealistic expectations about the value of their research output (Siegel et al., 2003; Siegel et al., 2004). As the literature indicates, it is one of the duties of TTOs to assist academics with such problems (Link et al., 2015). Siegel et al. (2003) and Siegel et al. (2004) suggest that universities should provide more relevant education to overcome this informational barrier and also encourage more formal and informal networking between academics/scientists and practitioners.

2.3 Absorptive Capacity

Traditional research and development (R&D) and internal knowledge/technology transfer within organisations have been replaced by outside sources of knowledge and external technology transfer (Cohen and Levinthal, 1990; Cockburn and Henderson, 1998), which accelerates the development of scientific knowledge with a related reduction in costs compared to those for internal R&D (Siegel et al., 2004). The ability to explore and exploit such external knowledge has therefore come to our attention, it is considered to be significant in the innovation process, and is recognised as a firm's AC (Cohen and Levinthal, 1990). The importance of AC has emerged in the past few decades and it has been widely noted and applied in various research fields, including those of knowledge/technology transfer (Chen, 2004; McAdam et al., 2009; McAdam et al., 2010), organisational research (Lane and Lubatkin, 1998; Van Den Bosch et al., 1999; Jansen et al., 2005), entrepreneurship (Deeds, 2001), and innovation performance (Tsai, 2001; Fosfuri and Tribó, 2008).

2.3.1 Overview of Absorptive Capacity

Cohen and Levinthal (1990: 128) established the theoretical framework of AC and defined it as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends", which is the most commonly utilised definition across all the AC related research.

Zahra and George (2002) reconceptualised AC (see Figure 3), based on the diverse definitions developed from different research fields, "as a set of

organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability" (Zahra and George, 2002: 186). They argued that the acquisitive and assimilative capacity of a firm is its 'potential absorptive capacity' (PAC) and its transforming and exploiting capacity is its 'realized absorptive capacity' (RAC). Importantly, they, also argued that PAC and RAC are two complementary elements in building sustainable competitive advantage (Zahra and George, 2002).

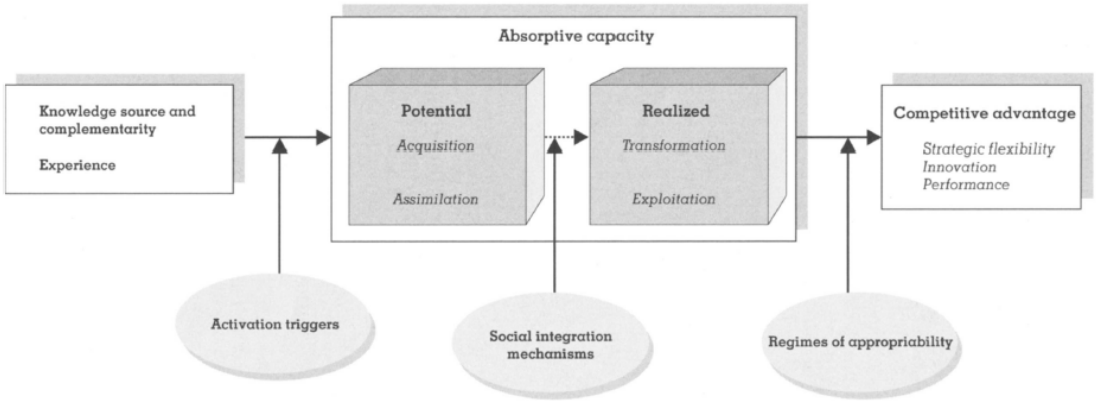

Figure 3 A Model of Absorptive Capacity

Source: Adapted from Zahra and George (2002: 192)

Lane and Lubatkin (1998) began to look at the process of acquiring outside knowledge to facilitate interorganisational learning. Lane et al. (2002: 856) then addressed a more detailed process-oriented definition for AC as "a firm's ability to utilize externally held knowledge through three sequential processes" of exploratory, transformative, and exploitative learning (see Figure 4). Exploratory learning involves recognising and understanding new external knowledge, and exploitative learning focusses on applying the newly acquired and assimilated knowledge to commercial ends. These two processes are similar to Zahra and George's (2002) concepts of PAC and RAC. The process of transformative learning consists of assimilating new external knowledge and also serves as the bridge which enables newly acquired knowledge and existing knowledge to be combined (Lane et al., 2002).

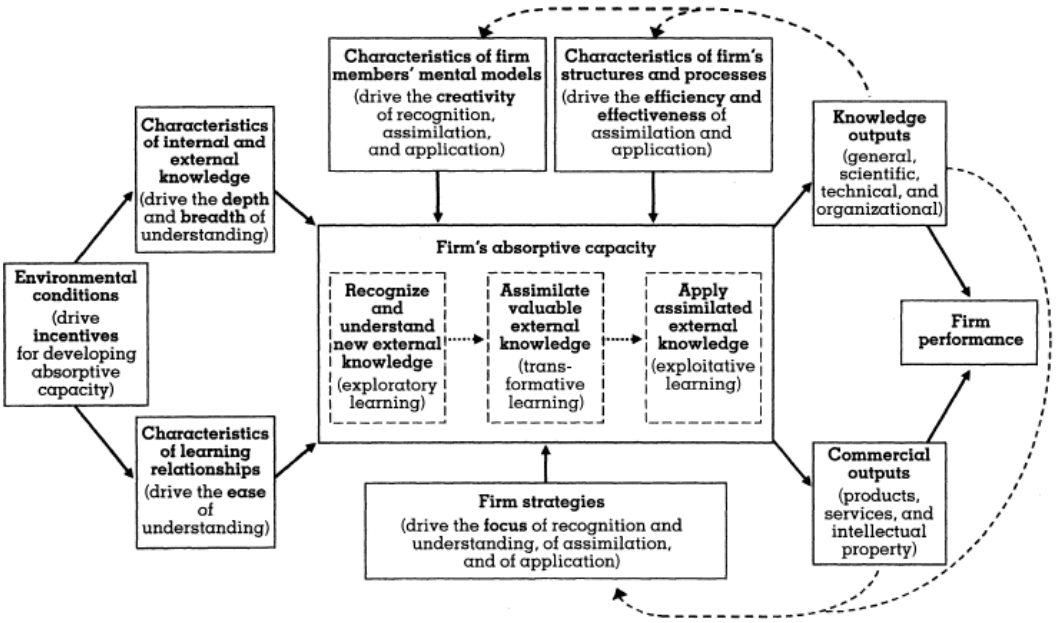

Figure 4 A Process Model of Absorptive Capacity, its Antecedents, and its Outcomes

Source: Adapted from Lane et al. (2002: 856)

These studies successfully broaden and clarify Cohen and Levinthal's definition and also construct a more explicit and complete model for AC which has received attention in many pieces of AC related research in recent years (e.g. Jansen et al., 2005; Lichtenthaler, 2009; Patton, 2014). McAdam et al. (2009), for example, note the trend towards utilising Zahra and George's AC model to investigate the knowledge flow of innovation performance (Fosfuri and Tribó, 2008) and to evaluate the effect of knowledge flow on the performance of an incubator firm (Rothaermel and Thursby, 2005). They use AC as the theoretical framework for exploring proof of concept in an attempt to improve the commercialisation of UTT.

2.3.2 Determinants of Absorptive Capacity

Prior Related Knowledge

Cohen and Levinthal (1990: 128) argue that the AC "to evaluate and utilise outside knowledge is largely a function of the level of prior related knowledge". They consider that at the most fundamental level, prior knowledge includes basic skills, a shared language, or the most up-to-date scientific or technological knowledge in a given field. At the firm's level, it includes prior experience of a particular production process, which provides the company with the ability to better recognise, assimilate and exploit new outside knowledge, whilst the successes and failures of prior experience also enable the firm to predict future technological potential more accurately (Nelson and Winter, 1982; Cohen and Levinthal, 1990; Zahra and George, 2002). Such AC could also be obtained directly by sending personnel for advanced technical training (Cohen and Levinthal, 1990).

Cohen and Levinthal (1990) also pointed out the importance of prior learning experience and problem-solving skills which constitute a firms' learning capacity to assimilate existing knowledge (as accumulated prior knowledge can accelerate learning) and problem-solving capacity to create new knowledge. The cumulative and path-dependent nature of prior knowledge, afforded by a firm's prior investment in the AC of its individual staff, have therefore been identified in many previous pieces of research, and can effectively speed up knowledge acquisition and assimilation for a firm which seeks to develop its AC (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998; Zahra and George, 2002). It can be seen that the diversity of prior knowledge is crucial and it facilitates the innovative process by strengthening assimilative capability, providing the individuals with the basis for learning and enabling them to make novel associations and linkages (Cohen and Levinthal, 1990). Furthermore, the ability to disclose knowledge through the depth, breadth, and diverse sources of its external and complementary knowledge also positively and distinctly influences the development of that firm's acquisition and assimilation capabilities (Zahra and George, 2002).

Other than the diversity of knowledge, "the awareness of where useful complementary expertise resides within and outside the organisation" is also

critical and could enhance AC (Cohen and Levinthal, 1990: 133). Lane and Lubatkin (1998) stressed the importance to the firm of developing a level of self-awareness through a thorough understanding of its own knowledge, capabilities, and the process of converting knowledge to capability in a competitive knowledge environment. Given such awareness, a firm can react to market forces, develop its own new capabilities, and establish the clear criteria required to identify the best-qualified partners to learn from most efficiently. Finally, in order to make use of the associations between prior knowledge and experience and to achieve an effective AC (especially PAC), the intensity of effort and activation triggers are important. The greater the effort and number of triggers involved, the more prior knowledge and experience will be utilised in developing a firm's PAC (Cohen and Levinthal, 1990; Zahra and George, 2002).

The present study identifies a number of key determinants which have been considered in different investigations. It can be seen that the main determinant is prior related knowledge, but from the discussion above it is apparent that researchers have various interpretations of the level and diversity of knowledge. This study acknowledges the different views of previous researchers and recognises that prior related knowledge consists mainly of: knowledge or skills (prior general or scientific knowledge, basic skills, and problem solving skills); experience (prior related experience in production or procedure and prior learning experience); and a number of other factors (self-awareness of useful complementary expertise within and outside the organisation, intensity of effort, and activation triggers). Having a comprehensive understanding of what exists enables the firm to access, evaluate, and act upon what is new, and especially benefits the development of its PAC.

As a supplier, a university can provide diverse and continuous knowledge from academics. However, the tacit nature and complexity of university research is the first barrier which a TTM has to overcome. McAdam et al. (2009) found that if both TTMs and academics have some related prior knowledge or experience, this will allow them to work more efficiently and closely. Antecedent factors are seen to play an important role within UTT, especially at the stage of acquiring and assimilating knowledge; based on prior experience, they also guide the process at the beginning.

Given the diverse knowledge base of AEs and TTMs, a basic ability to recognise the value of university knowledge is required (Lane and Lubatkin, 1998). Zahra and George (2002: 189) emphasise the need to "have different areas of expertise within a firm to successfully import external technologies". Although there is no proof that specialised knowledge is required by general knowledge receivers (Lane and Lubatkin, 1998), McAdam et al. (2009: 208) suggest that, in the case of UTT, there is a need to outsource some "market and technology assessment activities to specified industry experienced consultants, coordinated and managed by TTOs to avoid some specific technologies not being properly assessed".

Although the importance of prior knowledge has been recognised (Cohen and Levinthal, 1990; Van Den Bosch et al., 1999; Zahra and George, 2002; Lichtenthaler, 2009), as Jansen et al. (2005) pointed out, there is still a lack of relevant research; in particular, the relationship with different dimensions of AC has not been examined empirically.

Combinative Capabilities

On the one hand, the study has discussed the individual level and the firm's level in the prior knowledge section. On the other, AC has also been utilised as a multilevel construct by other researchers (e.g. Cohen and Levinthal, 1990; Van Den Bosch et al., 2003). Cohen and Levinthal (1990) claim that organisational AC is acquired from its individual members' ACs and it tends to develop cumulatively, however, it is not the sum of its employees' ACs. Kogut and Zander (1993: 384) are of a similar opinion and mention that hiring new employees is not the same as changing the skills of a firm, and therefore "introduce the concept of a combinative capability to synthesize and apply current and acquired knowledge". Van Den Bosch et al. (1999) consider prior knowledge to be an individual level determinant and suggest that organisational forms and combinative capabilities should be considered as organisational determinants for AC.

In order to understand AC at the organisational level and how combinative capabilities are being amalgamated by individual levels of AC, previous research

indicates that we can look at synergistic effect and the relationships between individuals through the structures of communication, shared languages (Cohen and Levinthal, 1990; Kogut and Zander, 1993), interactions (Lane and Lubatkin, 1998), trust and conflict (Chen, 2004), and connectedness (Jansen et al., 2005).

As mentioned in the prior knowledge section, the diversity of knowledge is significant to a firm's AC and the boosting of innovation. However, previous studies have also pointed out that, to facilitate effective internal communication and transfer of knowledge within groups or subunits of a firm, some overlap of critical relevant knowledge − for example, substantive, technical knowledge across individuals, which represents a shared language − is essential (Cohen and Levinthal, 1990; Zahra and George, 2002); such knowledge could also reside in individuals who are aware of where useful complementary expertise, and the capabilities and knowledge of other parties exists within and outside the firm (Cohen and Levinthal, 1990). Especially with regard to tacit knowledge, which is more complex and harder to transfer, tighter interaction and more communication are required (Kogut and Zander, 1993; Chen, 2004).

Cohen and Levinthal (1990: 132) argue that understanding of a firm's AC, "depends on the individuals who stand at the interface of either the firm and the external environment or at the interface between subunits within the firm". The importance of a cross-functional boundary spanning role for certain individuals within a firm has therefore been recognised by several studies (e.g. Cohen and Levinthal, 1990; Kogut and Zander, 1993; Henderson and Cockburn, 1994; Jansen et al., 2005), where the expertise of the individuals within the firm is considerably different from that of external actors. It is especially important when technology transfer is horizontal or external technical information is difficult for internal staff to access, assimilate, or integrate flexibly (Cohen and Levinthal, 1990; Kogut and Zander, 1993; Henderson and Cockburn, 1994; Jansen et al., 2005). Research results from Jansen et al. (2005) confirm that such a role could enhance both a firm's PAC and RAC.

From the discussion above, previous studies identify a social aspect to the interaction between the subunits of a firm and external actors (due to their shared language, values, experience, complementary expertise and close communications), which helps to develop an extensive network of internal and

external relationships that encourage the development of AC (see for example Cohen and Levinthal, 1990; Kogut and Zander, 1993; Jansen et al., 2005). Thus this study recognises and addresses another research gap that applies to the development of university spin-out AC. The research findings of Jansen et al. (2005) show that the density of the linkages, or connectedness, can affect knowledge exchange efficiency, trust, and cooperation and that increased density could therefore enhance a firm's RAC. Although this dense network can also prevent staff from exploring a greater variety of external knowledge and could result in increasing redundancy of information and reduced access to divergent perspectives, connectedness still contributes strongly and positively to a firm's PAC, and particularly to the assimilation of new external knowledge. The findings also suggest that, as well as establishing networks with various sources of new external knowledge, it is also crucial to establish a dense network within the subunits of a firm to develop both PAC and RAC (Jansen et al., 2005).

Cohen and Levinthal (1990) argue that a firm can generate new knowledge from extra-industry sources, such as university labs. The use of universities for commercial gains is, in effect, another way of investing in R&D. Connectedness involves linking private-sector to public-funded basic science (open science communities), sharing research results, and engaging in research collaboration, which are all key drivers in a firm's ability to acquire knowledge and also important for utilising knowledge spillovers (Cockburn and Henderson, 1998). Agrawal (2001) believes that connectedness, which allows firms to interact with university inventors directly, may increase the efficiency of the process of transferring and codifying knowledge. The above studies all indicate that university research is one of the most important extra-industry sources of the knowledge which many firms would like to acquire. However, it can be seen that previous research only deals with the impact of universities as external sources in a firm's network, there is no research which indicates how connectedness influences the AC of university spin-outs internally.

Furthermore, Rynes et al. (2001: 345) "highlight the importance of good social relations between academics and practitioners for successful knowledge creation", as well as team- and trust-building activities (Amabile et al., 2001; Mohrman et al., 2001). Van Den Bosch et al. (2003) and Chen (2004) both

suggest that trust between partnered firms positively affects the outcome of knowledge transfer, and can also be considered as the basis for collaboration.

The importance of trust has been acknowledged in various areas in organisational studies (Mayer et al., 1995; Mishra, 1996). However, both the concept and its definition remain vague and problematic. Some studies indicate that the conception of trust can be made more explicit by looking at its different dimensions. Mayer et al. (1995) summarised past literature on the antecedent factors that lead to trust and concluded that ability, benevolence, and integrity constitute a great proportion of trustworthiness. Mishra (1996: 261) identified four key dimensions of trust from previous literature and defined it as "one party's willingness to be vulnerable to another party based on the belief that the latter party is 1) competent, 2) open, 3) concerned, and 4) reliable". Interest has also been widely shown in the idea that trust leads toward cooperative behaviour at the individual, group and organisational levels (Mayer et al., 1995; Jones and George, 1998). Jones and George (1998) look into trust at the level of cooperation and teamwork between people in an organisation by examining the psychological sense of the interaction of people's values, attitudes, moods and emotions; in so doing, they explain why cooperation occurs and the different degrees of cooperation which develop. The findings show that the development of competitive advantage that leads to tacit knowledge requires there to be unconditional trust between people; it strengthens cooperative behaviour, leading to synergistic team relationships. The establishment and maintenance of unconditional trust, however, is a time, effort and resource hungry process, and some organisations may not be willing to support the development of such trust (Jones and George, 1998).

Trust building is especially significant for UTT because a lack of trust or misunderstanding could become a major issue between AEs and TTMs. McAdam et al. (2009) observed that, with regard to some of the case studies in their research, mistrust and scepticism between AEs and the TTO might ultimately result in those spin-outs failing to make further progress in UTT, as well as with regard to RAC and commercialisation. Empirical evidence presented by Chen (2004), however, addresses the theory that average levels of conflict (as opposed to high or low levels), and an understanding of the nature of conflict, can contribute positively to collaboration and subsequent knowledge transfer.

2.3.3 Absorptive Capacity and University Technology Transfer

Research has shown that universities contribute to AC at different levels in the process of knowledge transfer. UTT has solid and advantageous foundations in helping to develop the AC of a firm (Kitson et al., 2009; NESTA, 2010). University innovation seems to provide firms with an effective solution to seeking external knowledge in a changeable, knowledge-based environment (Lambert, 2003). Where firms are influenced by internal and external triggers to seek out external knowledge and to invest externally in the development of PAC (Zahra and George, 2002), government policy is one of the triggers in favour of UTT – see for example the innovation policy of the UK government (DTI-funded innovation schemes including the Grant for Research and Development, Knowledge Transfer Partnerships, Knowledge Transfer Network, and HEIF) and the Bayh-Dole Act in the US (Mowery et al., 2001; Debackere and Veugelers, 2005; Decter et al., 2007; NESTA, 2007). The rapid and efficient acquisition and assimilation of university innovation can enable a firm to gain first mover advantage and build up sustainable competitive advantage within firms (Cohen and Levinthal, 1990; Zahra and George, 2002). This resonates with Zahra and George's (2002: 196) proposition that firms with well-developed PAC "are more likely to sustain a competitive advantage because of greater flexibility in reconfiguring their resource bases and in effectively timing capability deployment at lower costs than those with less developed capabilities".

As discussed, the transfer of tacit and less commercially focussed knowledge from universities to commercial organisations is the first barrier to UTT, and many universities thus establish TTOs to assist with the process (Lambert, 2003; Siegel et al., 2004). TTOs provide university academics and scientists with lower cost patent protection, an efficient way to spend less time identifying opportunity, searching for potential buyers and developing university spin-outs using their business and commercial expertise/network (Macho-Stadler et al., 2007; Link et al., 2015). Universities therefore use TTOs as a key element in the development of spin-out AC in different stages of the UTT process. TTMs are now not only considered as intermediaries but also reduce the uncertainty of the seller and

resolve the problem of asymmetric information between sellers and buyers (Macho-Stadler et al., 2007; Link et al., 2015).

In the UTT process, McAdam et al. (2009) believe that academics and TTMs can accumulate AC retrospectively at both individual and organisational levels, by learning from their internal and external communications; they note that communication can be very difficult for both parties due to the complexity and uniqueness of each UTT application. TTOs require TTMs with diverse knowledge to handle the whole process of UTT; they need background knowledge in scientific innovation, business and management skills, marketing and pricing skills, and expertise in handling and protecting IP, amongst other things. Cohen and Levinthal (1990: 131) mention that "an organization's absorptive capacity will depend on the absorptive capacities of its individual members." Most importantly, a TTO needs a TTM who has the ability to handle and coordinate different fields of knowledge, and also to connect with academic expertise and bring knowledge from one party to another through explorative learning. Muscio's research (2010) provides evidence that TTOs can be better run by non-academic managers. Case studies of universities such as Cambridge and Southampton show that there has been a marked increase in the number of technology transfer specialists working in universities in the past decade (Kitson et al., 2009). Furthermore, it is hardly possible for a small TTO team to possess all of the expertise to be found across the faculty of a university (McAdam et al., 2009). Many universities manage their own TTOs, but few of them have a sufficiently strong research base to maintain a high quality TTO (Muscio, 2010), and variable TTO quality can become a barrier to the commercialisation of university technology (Lambert, 2003).

Most research related to UTT focusses purely on performance, productivity, or efficiency in achieving the desired results (Lambert, 2003; Siegel et al., 2004, 2007; O'Shea et al., 2005). Few, in recent years, have analysed the importance of the relationship between university academics and the TTMs engaged in UTT (Franklin et al., 2001; Muscio, 2010), but the need for further and in-depth analysis about their synergistic relationship and contribution to UTT should be addressed. Hence, this study aims to understand how university spin-out companies develop their AC at both individual and organisational levels by looking in-depth at the prior related knowledge of TTMs and AEs, their combinative capabilities, their relationship building and collaborations, and their

impact upon different stages of the spin-out process and different dimensions of AC.

The Constitution and Impact of University Spin-out Absorptive Capacity

Previous studies provide a comprehensive understanding of the key constituents of AC, and in the past few decades, researchers have begun to look at the strength of the impact of these constituents upon the process of developing AC, as well as on interorganisational learning (Lane and Lubatkin, 1998; Lichtenthaler, 2009). This study develops a process model for university spin-out AC and aims to understand the key constituents of AC and their impact upon the development of university spin-out AC (see Figure 5). University spin-out seeks to develop its AC through the formation of a learning alliance; an alliance between the spin-out (the 'student') and the two key stakeholders (the 'teachers' – otherwise known as the AEs and TTMs). This interactive learning method allows the spin-out to look closely at the AEs and TTMs and to understand the key elements of their capability, as well as "the more tacit components: the 'how and why' knowledge" (Lane and Lubatkin, 1998: 463).

As indicated in Figure 5, this study also then attempts to discuss how the prior knowledge of the individuals, together with combinative capabilities, leads to the development of organisational level AC as an emergent process in the formation of university spin-out. In line with AC theories, Lane and Lubatkin (1998: 464) argued that interorganisational learning also depends on the ability of a firm to "recognise and value new external knowledge, to assimilate that knowledge, and to commercially utilise it". Recent research mainly considers and debates how a firm develops AC by utilising external knowledge through explorative and exploitative learning and how it affects outcomes or performances in turbulent or stable environments (Lane and Lubatkin, 1998; Hughes et al., 2007; Lichtenthaler, 2009).

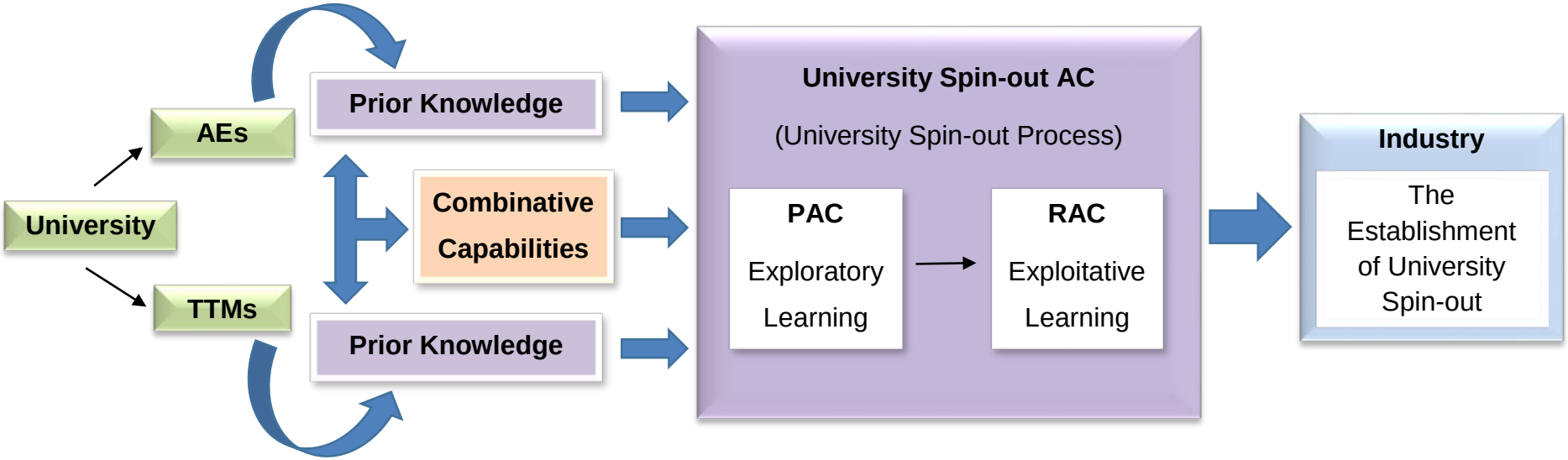

Figure 5 A Process Model of University Spin-out AC, its Determinants, and its Impact

In AC theory, explorative learning, or PAC, usually refers to knowledge recognition, acquisition and assimilation (Lane et al., 2002; Zahra and George, 2002), whilst organisational learning mainly refers to the finding of new possibilities through “variation, risk taking, experimentation, play, flexibility, discovery, innovation” (March, 1991: 71). Prior knowledge is vital and an in-depth understanding of a firm’s existing prior knowledge is especially critical in exploratory learning because it builds the foundation from which that company can recognise and assimilate new external knowledge. The ability to access diverse sources of external and complementary knowledge within the developed internal and external network, and the degree of overlapping knowledge between the firm’s and any external knowledge bases could also enhance the firm’s PAC (Lane and Lubatkin, 1998; Zahra and George, 2002). Technological knowledge is commonly considered to be the most important knowledge and also the determinant in explorative learning (Cohen and Levinthal, 1990; Jansen et al., 2005; Lichtenthaler, 2009). University science and technology are therefore advantageously placed to share research output and connect research with the private sector so that they may explore new opportunities together (Cockburn and Henderson, 1998). Lichtenthaler (2009) pointed out that a high level of exploratory learning is the key to helping firms to acquire external knowledge and most importantly to achieving innovations and improving performance having gained sustainable competitive advantage through their first mover strengths. It assists firms to detect and meet the needs of a turbulent environment (Jansen et al., 2006; Lichtenthaler, 2009).

In AC theory, exploitative learning, or RAC, usually refers to knowledge application (Lane et al., 2002; Zahra and George, 2002), whilst organisational learning mainly refers to the exploitation of old certainties and is typified by words such as “refinement, choice, production, efficiency, selection, implementation, [and] execution” (March, 1991: 71). The aim of exploitative learning is to convert assimilated knowledge and to apply this knowledge to a matching market (Lane et al., 2002; Lichtenthaler, 2009). Prior market knowledge is therefore considered to be an important component of prior knowledge in exploitative learning (Van Den Bosch et al., 1999; Jansen et al., 2005; Lichtenthaler, 2009) because it affects the discovery of exploitation opportunities (Shane, 2000). A high level of exploitative learning allows firms to apply assimilated knowledge more efficiently

in the process of innovation by combining new and existing knowledge (Jansen et al., 2005; Lichtenthaler, 2009).

Whilst it can be see that variations in prior knowledge lead to variation in the performance levels of explorative and exploitative learning, work by Gann and Salter (2000) points out that firms usually have different prior knowledge and capacities to acquire, assimilate, transform and exploit knowledge. Previous studies have stressed the importance of the complementarity of learning processes and the importance of thoroughly balancing and developing both technological and market knowledge in order to actively enhance learning processes as a whole (Lichtenthaler, 2009). It has been widely discussed that excessive focus on one aspect of prior knowledge, or on a learning process, might result in negative consequences (see for example, Lane et al., 2002; Zahra and George, 2002). For instance, although some overlapping knowledge is required for a firm to absorb external knowledge, a very strong overlap might limit the chances of gaining new insight (Lichtenthaler, 2009). Hughes et al. (2007) also strongly discourage firms from making exploitative learning their dominant orientation and instead encourage more entrepreneurial and exploratory learning. Meanwhile, some firms seem to place more emphasis on their search for external knowledge than on their exploitation of acquired knowledge; thus they have limited market knowledge with which to complement their technological knowledge which results in inefficient exploitative learning (Zahra and George, 2002). In addition to the balanced and complementary processes needed to absorb complex knowledge, it is crucial to have an interactive (face-to-face when necessary), participative, and collaborative relationship between teacher and student when building effective AC (Lane and Lubatkin, 1998; Patton, 2014). All of this has a bearing on the interactive learning method adopted by TTMs, AEs and university spin-outs, and how TTMs and AEs contribute to the AC of the spin-out.

Research by McAdam et al. (2009) evaluates in-depth the relationship between the roles which participate to improve UTT for each dimension of AC. The research results are consistent with Rothaermel and Thursby's findings (2005) which show that the AC development engaged in by universities improves the commercialisation of UTT. Such research explores the process of UTT from the beginning and exposes the possibility of further discussion on crucial unanswered

research questions about, for example, how a university spin-out (between TTMs and AEs) builds up and develops AC, how AEs and TTMs work together to establish internal and external environments, and how this relationship building impacts upon the development of PAC and RAC, or AC as a whole. Meanwhile, the extent to which trust and conflict within the relationship building can affect UTT and the outcome of spin-out activity is also worthy of further investigation.

With regard to the UTT process, McAdam et al. (2010) argue that the lack of in-depth scientific knowledge on the part of TTMs might make it difficult for them to assist academics when determining the potential commercial opportunity of university-based technology (PAC). At the same time, they address the lack of commercial and business skills on the part of academics, which is also a barrier to increasing AC within the UTT process (McAdam et al., 2010). McAdam et al. (2009) and McAdam et al. (2010) suggest that the best way to make the communication between academics and TTMs more effective is to improve the business and marketing skills of the former, so that they understand the key business processes involved in UTT, and also, so that they can develop their network together with the TTO team. Once academics acquire business and marketing knowledge, the process could be termed two-way AC development. McAdam et al. (2009) identified a need to improve the exploitative learning capabilities of the spin-outs and the effectiveness of their communication by developing academics' business and marketing related knowledge/skills, but did not say whether TTMs needed further scientific knowledge in order to better assist academics. Further research is required to assess the need to balance the explorative and exploitative learning of a university spin-out in AC development, and also to determine to what extent scientific or technological knowledge and business and marketing knowledge can affect the collaboration between TTMs and academics.

The TTO's cross-functional boundary spanning role and their impact upon university spin-out and the UTT process also need further investigation. Siegel et al. (2003) and Siegel et al. (2004) consider this to be a critical personal skill that TTMs must develop in order to facilitate effective communication between the various individuals (each with different expertise) involved in the UTT process. In addition, it can be observed that university academics are key to the process of UTT; they are especially important because the whole UTT originates from their

research. It is also crucial that TTMs recognise their importance in the knowledge transfer between the highly skilled staff and academics within their universities (Hughes et al., 2007). Such recognition can be seen as a foundation stone, the first step in initiating the university spin-out process, industry-university collaboration, licensing, or any other UTT related activity.

CHAPTER 3

Research Objectives and Methodology

This chapter explains the research objective, philosophy and method guiding this study. Previous chapters discussed the existing related theory and examined the empirical work which has been undertaken to date. In Section 3.1, the study outlines the knowledge gaps identified in the previous chapter and then poses the research questions. Section 3.2 determines the research philosophy and paradigm which guide the research method, and in Section 3.3, the chapter addresses the methodology, data collection, and analysis which will be used to answer the research questions proposed in Section 3.1.

3.1 Research Objectives

Having established the theoretical framework, this section links the unresolved questions identified in the literature and discussed in the previous chapters with the research objectives. From these objectives, it defines the research questions.

The general aim of this study is to reduce the ambiguity of the UTT process by monitoring the interactions and the antecedent factors, including prior knowledge and experience, of the key stakeholders–TTMs and AEs. Given the changing role and contribution of universities in boosting the innovation driven economy, questions have emerged about how UTT matches the commercialisation ambitions of a university with its capabilities and resources. This study therefore focusses on the creation of university spin-outs. The complicated spin-out process involves various stages, and also requires close collaboration between the different individuals involved (TTO/TTMs, AEs, the university, venture capitalists, and other entrepreneurs), our understanding of which is still vague. Not only does the study address a critical research gap within the current

literature, it also provides a good opportunity to look in detail at the tacit and complex nature of effective knowledge transfer to future related activities and the innovation process.

Although the current literature shows the individual roles of TTMs and AEs within the UTT process, there is little empirical work which explains how they begin to work together, how they identify the commercial potential of academic output, and choose the commercialisation route. Research by McAdam et al. (2009) evaluates in-depth the relationship between the roles that participate in the improvement of UTT with each dimension of AC. The research results are consistent with Rothaermel and Thursby's findings (2005) which show that the AC development, in which universities engage improves the commercialisation of UTT. Such research explores the process of UTT from the beginning and exposes the possibility of further discussion on crucial unanswered research questions, such as how technology is transferred from university to business and how academics and TTMs work together, build up and develop AC, and contribute to UTT. The collaboration between TTMs and AEs has mainly been discussed at the individual level in previous research (e.g. McAdam et al., 2009; McAdam et al., 2010). However, given one of the main duties of TTMs is to serve as a bridge between academics and business, the collaboration between TTMs and academics and the development of the spin-out's AC have not been fully discussed in the literature. Empirical evidence is required to analyse their complementary, cooperative, and synergistic relationship and the influence this has on university spin-out creation. Therefore, the need to investigate the actual contribution of TTMs and AEs to university spin-out, the development of explorative and exploitative learning processes for progressing spin-outs, and the need to appreciate how they overcome barriers and their impact upon the spin-out process, all lead to the central research question for this study.

RQ. How does the interaction between AEs and TTMs contribute to the development of AC within university spin-outs and how does this affect the commercialisation process?

There are two research objectives is this study.

RO1. What are the key determinants of university spin-out AC and how do they shape the role of TTMs and AEs in spin-out?

The importance of TTMs and AEs is recognised in the university spin-out process, as is the need for more empirical evidence on the antecedent factors that shaped their role and triggered their collaboration in establishing a university spin-out. This study looks at the two determinants that constitute university spin-out AC, as discussed in Section 2.3.2 – namely, the prior related knowledge of TTMs and AEs and their combinative capabilities.

RO2. How does the role of TTMs and AEs and their collaboration impact upon different stages of the university spin-out process?

The second objective seeks to understand what synergistic effects are created as the relationship between academics and TTMs develops and the impact this has upon different stages of the university spin-out process.

The results of this study are expected to contribute to knowledge transfer and UTT literature, to enrich the methodological literature through their use of AC theory, and most importantly to guide, improve, and make more effective the development of present and future university spin-outs, the roles of TTMs and AEs, their collaboration, and the function of the TTO.

3.2 Research Philosophy and Paradigm

Easterby-Smith et al. (2008) consider that an understanding of the philosophical issues of the relationship between theory and data is especially important to research design and can also have a serious influence upon the quality of management studies. First, it can refine the research design, from determining the data required to data collection and interpretation, and then help to provide

answers to the research questions. Second, it provides the researcher with a knowledge of philosophy which enables them to assess the feasibility of the design, and reveals the limitations of various ways of conducting the study. Third, it can help to establish a design which is outside the researcher's past experience and may also encourage modification of that design in line with new knowledge and/or subject structure (Easterby-Smith et al., 2008).

Easterby-Smith et al. (2008) indicate that social science research can be conducted in accordance with two major contrasting traditions – positivism and social constructionism. The paradigm, Social Constructionism, which has developed over the past few decades holds a completely contrasting view to positivism. It focuses more "on the ways that people make sense of the world especially through sharing their experiences with others via the medium of language" (Easterby-Smith et al., 2008: 58). The notion of social constructionism, which regards reality as being socially constructed and given meaning by people, thus has also been raised and is referred to as an interpretive method of determining how people make sense of the world, especially through experience sharing with others (Saunders et al., 2007; Easterby-Smith et al., 2008). Furthermore, since the interpretation can vary with different observers, facing different situations, holding different views of the world, it also affects social interactions with others (Saunders et al., 2007). Therefore, it is crucial to recognise the subjectivity of observers "in order to be able to make sense of and understand their motives, actions and intentions in a way that is meaningful" (Saunders et al., 2007: 109). Easterby-Smith et al. (2008) summarise the contrasting implications of positivism and social constructionism as shown in Table 2.

Table 2 Contrasting Implications of Positivism and Social Constructionism

	Positivism	Social constructionism
The observer	Must be independent	Is part of what is being observed
Human interests	Should be irrelevant	Are the main drivers of science
Explanations	Must demonstrate causality	Aims to increase general understanding of the situation
Research progresses through	Hypotheses and deductions	Gathering rich data from which ideas are induced
Concepts	Need to be defined so that they can be measured	Should incorporate stakeholder perspectives
Units of analysis	Should be reduced to simplest terms	May include the complexity of 'whole' situations
Generalisation through	Statistical probability	Theoretical abstraction
Sampling requires	Large numbers selected randomly	Small numbers of cases chosen for specific reasons

Source: Easterby-Smith et al. (2008: 59)

Table 3 Methodological Implications of Different Social Science Epistemologies

Social science epistemologies	Positivism	Relativism	Social constructionism
Elements of methodologies			
Aims	Discovery	Exposure	Invention
Starting point	Hypotheses	Suppositions	Meanings
Designs	Experiment	Triangulation	Reflexivity
Techniques	Measurement	Survey	Conversation
Analysis/interpretation	Verification/falsification	Probability	Sense-making
Outcomes	Causality	Correlation	Understanding

Source: Easterby-Smith et al. (2008: 63)

The research philosophy for this study has been determined on the basis of ontology and epistemology. It is important to consider different approaches when discussing the research philosophy because, as Saunders et al. (2007) point out, each one incorporates features which will affect the way the researcher thinks about the research process. Ontology refers to philosophical assumptions about the nature of reality. It is considered to be the starting point from which philosophers begin most debates (Saunders et al., 2007; Easterby-Smith et al., 2008). Easterby-Smith et al. (2008) consider that there are three main ontological positions of social science including, representationalism, relativism and nominalism. The first two are based on the internal realist and relativist view of natural science, but they look only at people and not at physical objects in social science. Reality is constructed by the verification of the observer's predictions in representationalism; the viewpoints of different observers in relativism; and by all human creations, such as experiences and events, in nominalism (Easterby-Smith et al., 2008). Easterby-Smith et al. (2008: 60) refer to epistemology as the "general set of assumptions about the best ways of inquiring into the nature of the world". They summarise the methodological implications of different social science epistemologies in Table 3.

Positivism and relativism both state that reality exists independently of the observer. The positivist therefore, uses experimentation to verify hypotheses and the relativist uses triangulation to test their propositions. The social constructionist, however, is totally different from the positivist or the relativist. The observer does not make any pre-assumptions about existing reality, but aims to understand "how people invent structures to help them make sense of what is going on around them" (Easterby-Smith et al., 2008: 63). They use sense-making to create or give meaning to the conversations between people.

As mentioned in Chapter 2, UTT can be seen as a dynamic process of knowledge acquisition, assimilation, transformation, and exploitation while at the same time developing the AC of TTMs and AEs (Amesse and Cohendet, 2001). The process is complex and consists of various social actions and interactions but mostly remains vague due to the lack of empirical evidence and the difficulty of interpreting different situations with different stakeholders. The ontology and epistemology enable this study to focus mainly on understanding social interactions, including the motivations and intentions which exist between two

stakeholders; the TTM and AE (Saunders et al., 2007). In order to achieve the goal of understanding such social interaction, conversation or communication is suggested as the research technique (Saunders et al., 2007; Easterby-Smith et al., 2008). This study therefore involves a number of semi-structured and open-ended interviews with stakeholders as the primary strategy for revealing the whole picture of interaction between TTMs and AEs; it aims to understand both the history (e.g. prior experience) and development of the process.

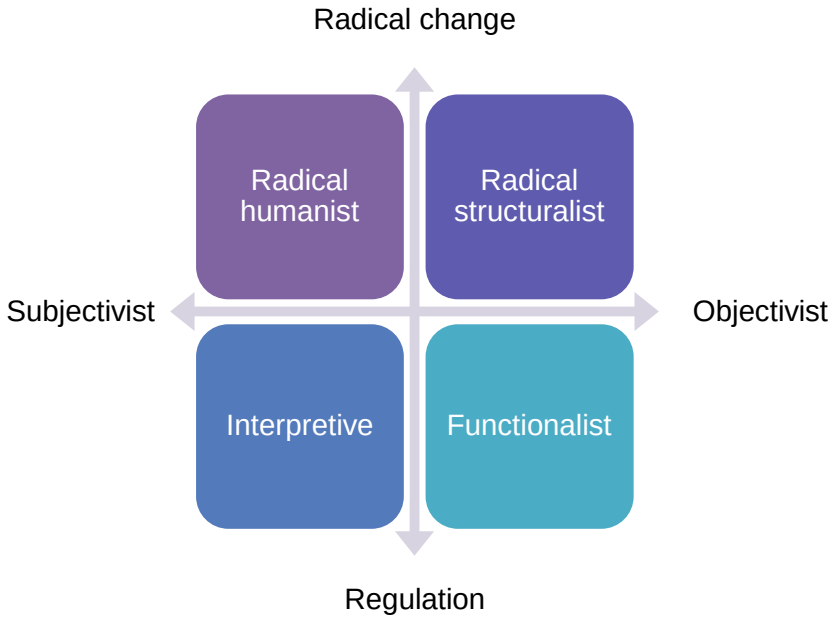

Figure 6 Burrell and Morgan's Four Paradigms for the Analysis of the Social Sciences

Source: Burrell and Morgan, (1979: 22)

The research philosophy of this study can be explored even further through the concept of research paradigms which are defined as the ways of "examining social phenomena from which particular understandings of these phenomena can be gained and explanations attempted" (Saunders et al., 2007: 112). Burrell and Morgan (1979) identify four paradigms including radical humanist, radical structuralist, functionalist, and interpretive (see Figure 6) to help researchers to clarify and summarise the epistemologies and ontologies of their research (Johnson and Duberley, 2000; Saunders et al., 2007). From the epistemological and ontological stance shown above, it is clear that the interpretive paradigm

should be adopted for this study. The study has to work within this paradigm for the purpose of understanding and explaining what is happening. The result is expected to help the researcher to answer the research questions of this study (Saunders et al., 2007).

3.3 Research Methodology

From the research model and philosophy of this investigation, as mentioned above, it can be seen that this is an exploratory study the purpose of which is to develop a better understanding of what happens between TTMs and AEs during the spin-out process. Robson (2002: 59) classifies the purposes of exploratory study which are: “to find out what is happening, particularly in little-understood situations; to seek new insights; to ask questions; to assess phenomena in a new light; to generate ideas and hypotheses for future research”. Saunders et al. (2007) point out that it is especially useful when people want to clarify their understanding of a problem. They also address the importance of literature searches and conducting interviews for exploratory study.

In order to answer the research question, this study adopts a multiple case study methodology and qualitative approach to investigate relationship building and collaboration between university AEs and TTMs within the process of spin-out. The case study technique can be defined as a qualitative strategy for researching a particular phenomenon in a real life context utilising various sources of evidence (Robson, 2002; Yin, 2003a; Saunders et al., 2007). The research design of multiple case studies has a replication logic which allows the analyses of multiple cases to be regarded as a set of independent experiments (Brown and Eisenhardt, 1997; Yin, 2003a). Most importantly, it generates findings from the evidence of diverse cases and also permits the researcher to take a closer look at the details and differences which may be considered highly important among case studies (Yin, 2003a). The aim of the case study method is to answer exploratory and explanatory research questions such as ‘why?’, ‘what?’ and ‘how?’ (Patton, 2002; Yin, 2003a).

Furthermore, exploratory study is flexible, which allows the researcher to change the research direction when new data or insights are available (Saunders et al.,

2007). The focus can be broad at the beginning and then gradually narrow down during the research process (Adams and Schvaneveldt, 1991; Saunders et al., 2007).

Before the formal and large scale data collection, the researcher decided to run a pilot study. Van Teijlingen and Hundley (2002) pointed out the importance of pilot studies, which are small scale versions, or trial runs, before a full-scale major investigation (so-called feasibility studies). They can also serve as pre-testing for a specific research instrument, such as an interview schedule for questionnaires, especially in social science research (Baker, 1994; Polit et al., 2001). The primary data allows the researcher to determine the resources and cases that are needed for more complete research planning, and then to adjust the research tool to make it more workable and efficient. In addition, a pilot can pre-test the data analysis techniques to uncover potential problems. Whether a success or a failure, a pilot study can help the researcher to improve future research and, in some cases, inform the possible outcomes (Van Teijlingen and Hundley, 2002). Therefore, the aim of the pilot study in this investigation was to develop a more adequate and efficient research process from which to answer the research questions and also to examine the feasibility of the interview questions with a view to conducting more in-depth interviews during formal data collection.

3.3.1 Sampling

Sampling techniques need to be carefully considered when adopting a case study strategy using a large organisation/case study and collecting data by unstructured interview; the researcher has to choose the case study organisation and a group of people from within that organisation to interview (Saunders et al., 2007). Saunders et al. (2007: 204) state that sampling techniques “provide a range of methods that enable you to reduce the amount of data you need to collect by considering only data from a subgroup rather than all the possible cases or elements”. For an exploratory study, it is better to use non-probability sampling (or so-called non-random sampling) techniques which give a variety of alternative means of selecting samples based on the researcher’s subjective judgement (Saunders et al., 2007).

The study began by narrowing the focus of the samples from all UTT activities to spin-out activity. Spin-out rarely happens compared to other activities such as licensing. However, it is also the only activity that is relatively long and time consuming. This left the researcher in a good position to monitor the whole relationship building process between TTMs and AEs.

The pilot study used a self-selection sampling technique to obtain the sample. The study targeted University A and used email to make all TTMs aware of the need for cases. It sought out those where one TTM and one AE as a pair were either currently working (or had worked) on a university spin-out process and would also be happy to give their time to be interviewed. Although such an approach allows data to be collected from all those who respond, it ultimately enables the researcher to choose the participants they prefer or those most suited to the study (Saunders et al., 2007). The pilot consisted of three case studies with six participants (three TTMs and three AEs) within University A. The research directions and questions were subsequently modified and became more precise as a result of the pilot, creating a strong foundation for the study.

The detailed procedure for the pilot study data collection will be explained later, but was identical to that used for the formal data collection. Following the pilot study, the researcher was well prepared to move forward into larger scale data collection. With the experience of having selected a sample for the pilot study, the author then adopted the purposive sampling (or judgemental sampling) technique for the formal data collection. As Saunders et al. (2007: 230) mention, it “enables you to use your judgement to select cases that will best enable you to answer your research question(s) and to meet your objectives”. From the pilot study, it was apparent that each spin-out process and relationship building experience can be distinguishing for various reasons. The study therefore, established its criteria for the formal data collection by using the heterogeneous (or maximum variation) sampling technique. This enables the research to collect data to define the key themes that can be observed (Patton, 2002; Saunders et al., 2007). Although it might contain very different cases, Patton (2002) takes this as a strength which enables the researcher to document the uniqueness of each one. This study looks at the relationship building and collaboration between TTMs and AEs from the beginning of the spin-out process. In order to reveal the full post hoc process from the beginning, it was essentail that the participants had

fresh and clear memories of, and feelings about, the relationship and process. It was important that each case had one TTM and one AE who were currently working on (or had just completed) a spin-out process; a pair who had worked together from the beginning, built up a relationship, and who had identified the commercial potential of the research output.

Although spin-outs are less common than other UTT activities, the study aimed to explore case studies within different universities that had spin-outs which were being progressed or had just completed. The difficulties involved in finding participants (many TTOs/TTMs refused to participate because of the confidentiality of their university spin-outs, also university spin-out developments in the UK in recent years have been relatively scarce), however, meant that the formal data collection stage began immediately after the pilot study and lasted for almost a year. Due to the shortage of informants, the researcher decided to combine the primary data with that from the pilot study for the analysis.

In order to gather accurate, in-depth observations of university spin-out cases and the relationship building between TTMs and AEs, the study selected cases where the TTMs and AEs involved had worked together on a particular spin-out case for at least six months and up to three years (at the time of data collection). The final study was made up of thirteen case studies with twenty-six participants (thirteen TTMs and thirteen AEs, including six pilot study participants), from eleven universities across the UK. It also included interviews with eight TTO Directors (TTDs)/Heads of commercialisation (some of the TTDs were also the TTMs responsible for the case studies), and three UTT experts who were the heads of knowledge/technology transfer associations or managers of major venture capital companies in the UK.

3.3.2 Data Collection

The data collection techniques for case studies can include observation, documentary analysis, questionnaires and interviews (Saunders et al., 2007). In this study, the research gathered both primary and secondary qualitative data. First, initial secondary documentary data about the background of each AE, TTM, and university spin-out was obtained and organised. This was collected from the

news, websites, and internal documents (AE and TTM profiles, TTO and spin-out documentation), and university TTO reports. The next stage consisted of one-to-one semi-structured interviews with AEs and TTMs. Interviews were the primary method of collecting data for the purpose of the study. Saunders et al. (2007: 310) state that "the use of interviews can help you to gather valid and reliable data that are relevant to your research question(s)". The questions and themes were based on the research question but varied from interview to interview (Saunders et al., 2007).

Table 4 Research Stages

Stages	Purpose	Method	Unit Involved
1. **Literature search**	• To understand the theoretical and empirical background of the research	• UTT related literature • AC literature	
2. **Pilot study**	• To develop a more adequate and efficient research process with which to answer the research question • To examine the feasibility of the interview questions	• Secondary data collection • Semi-structured and open-ended interview • Analysis of case studies	• Three TTMs and three AEs who, as pairs, were working (or had worked) together within the spin-out process • Experts such as TTO directors, experienced spin-out founders, and TTO trainers • Three spin-out case studies
3. **Formal data collection**	• To collect data which is relevant to the research questions	• Secondary data collection • Semi-structured and in-depth interviews	• Ten TTMs and ten AEs who, as pairs, were working (or had worked) together within the spin-out process • Ten spin-out case studies
4. **Final data analysis and discussion**	• To answer the research questions	• Organise and code the interview data • Use AC as a main framework to analyse the data • Case studies analysis	

Yin (2003b) indicates that, in exploratory study, fieldwork and data collection are usually undertaken before determining the final research question and hypothesis. This investigation began with a pilot study consisting of semi-structured and open-ended interviews with a small number of TTMs and AEs. The purpose of the pilot study was for the researcher to develop an understanding of the participants' instincts, experiences, and perceptions, and to gather together their perspectives and try to learn from them. Following the pilot, the researcher designed more precise interview questions in order to carry out in-depth interviews with the rest of the TTMs and AEs. This was an important process which required great care; as Yin (2003b) pointed out, incorrect use of the data collected during the pilot phase is a serious problem because it will affect all subsequent work – in this case, all of the following case studies. In-depth interviews are invaluable to qualitative research, particularly in case studies which rely on past development experience (Marshall and Rossman, 2006).

This study expects to explore, through individual interviews and discussions, the fine-grained information pertaining to the relationship and collaboration between AEs and TTMs. The study database was initially compiled from information gathered from the TTMs. It should be noted that the researcher had previous research experience with TTOs and university spin-out companies and that that experience in general could be considered the foundation of the database. The researcher first contacted all of the TTMs, established a relationship with them, and then identified potential interviewees who met the criteria described above.

Initial contact was made through emails sent to TTMs or AEs. They were asked to briefly introduce themselves and the university spin-out activity they were currently working (or had worked) upon in their email reply or during the first phone meeting before the interview. This affirmed their working relationship and also provided the study with some background information before the formal interview stage. The main data collection made use of a qualitative method with semi-structured, in-depth interviews. The interviews were conducted face-to-face or over the phone and, because of the purpose of the pilot study, they employed open-ended interview questions. For the pilot study, the interview questions were relatively broad and the interview time was unlimited (the longest approaching two hours). For the formal data collection, the interview questions were more precise and the interview time was controlled, at approximately one hour. After

transcribing the first round interview data, the researcher maintained contact with the participants in order to gather missing information or to probe for more detailed responses where necessary.

All of the interviews were recorded and the data transcribed by the researcher. In order to ensure the confidentiality of the participants, the data was anonymised by replacing names with labels such as TTM1, AE1, and TTD1. In order to understand their roles and interactions in the spin-out process, both TTMs and AEs were asked the same questions, and the interviewer tried to avoid guiding the participants, allowing them to progressively disclose information about themselves and their particular spin-out. First, the participants were asked to discuss their own background and motivation for participating in UTT. Second, they were prompted to recall how the relationship was initiated with another party, their perception and expectations of each other's role, and what knowledge/skills were required for those roles in the university spin-out process. Third, they were asked to discuss the spin-out process from the beginning, how the relationship developed, and the communication that took place. Finally, they talked about each other's contribution to spin-out and how that contribution and their relationship impacted upon the process. TTDs were asked questions about the role of TTMs and their contribution to university spin-out, and broader questions regarding the strategic goals for university spin-out development.

The researcher's previous experience with TTMs and the observations accumulated from the pilot study allowed her to encourage the participants to disclose the information needed and led to a satisfactory final dataset of good quality which enabled her to address the research questions in-depth. Having established the validity of the data, the study analysis was begun.

3.3.3 Data Analysis

Easterby-Smith et al. (2008: 172) explain that it is important that the "researcher chooses methods of analysis that are consistent with the philosophical and methodological assumptions made in the research designs that underpin the study". As mentioned, all interview data collected was recorded and transcribed. During the transcription process, the researcher attempted some initial coding

and added the notes taken during the interview. In order to analyse this rich text-based data in a more efficient way, this study also used the qualitative data analysis computer software package NVivo 10 to organise, code (the term “node” is used in NVivo 10), and analyse the narratives of the respondents. More importantly, it was expected that NVivo 10 might take the data analysis to an in-depth level by classifying, sorting, and linking findings or even uncovering unexpected subtle discoveries through the use of its powerful query tools.

There are many ways in which qualitative data can be analysed. Since this study adopts a social constructionist perspective, the researcher made every possible effort not to differentiate between the collection of data and its analysis and interpretation (Easterby-Smith et al., 2008). In order to interpret the whole story of the relationship building and collaboration between TTMs and AEs, the study used narrative analysis as the primary approach to analysing the interview data. Easterby-Smith et al. (2008: 182) believe narrative analysis is based on “how people describe or account for events, real or imagined, often referred to as the telling of stories”. Saunders et al. (2007: 504) say that it is “based on individuals’ subjective interpretations and relate them to constructions of the social world in which they live”. They broadly outline the structural elements generally present in narratives, based on Coffey and Atkinson’s (1996) study:

- What is the story about?
- What happened, to whom, whereabouts, and why?
- What consequences arose from this?
- What is the significance of these events?
- What was the final outcome?

As Yin (2003a) suggests, if researchers use existing theory to formulate the research questions and objectives, they may also use the theoretical proposition to set up a framework to organise and lead the data analysis. This study therefore creates the initial coding constructs based on the literature reviewed and the observations made. The analytical methods of this study are mainly guided by Miles and Huberman’s (1994: 9) suggestions on qualitative data analysis as follows.

- “Affixing codes to a set of field notes drawn from observations or interviews
- Noting reflections or other remarks in the margins
- Sorting and sifting through these materials to identify similar phrases, relationships between variables, patterns, themes, distinct differences between subgroups, and common sequences
- Isolating these patterns and processes, commonalities and differences, and taking them out to the field in the next wave of data collection
- Gradually elaborating a small set of generalizations that cover the consistencies discerned in the data base
- Confronting those generalizations with a formalized body of knowledge in the form of constructs or theories”

In response to the research question, the analysis of this study was carried out in terms of three key dimensions. First, the study attempted to identify the prior knowledge of TTMs and AEs that triggers or motivates their participation in UTT and their perceptions and expectations of each other’s role in the university spin-out process, and it sought to understand how these antecedent factors shaped those roles and could potentially affect their relationships and collaborations. Second, it set out to identify the combinative capabilities amalgamated by TTMs and AEs from their relationship building, communications, and trust building during the spin-out process. Third, based upon the previous two analyses, which provide a comprehensive understanding of the key determinants of university spin-out AC, the study reveals a comprehensive story of how TTMs and AEs work together in the spin-out process and their impact upon the different dimensions of AC development. The detailed coding process and data analysis are further described in Chapters 4 and 5.

CHAPTER 4

Prior Knowledge and the Role of TTMs and AEs in University Spin-out

The aim of this study is to develop a better understanding of the complementary, synergistic, and collaborative relationship between TTMs and AEs as it relates to the creation of university spin-outs. The study as a whole will use the analysis and discussion of this chapter and Chapter 5 to examine how these two parties develop the AC of spin-outs and contribute to the spin-out process.

In this chapter, the study focuses on the fundamentals that constitute the AC of university spin-outs. The data analysis is carried out in terms of two dimensions. First, the study identifies the prior related knowledge, which differs between TTMs and AEs, such as background knowledge/skills, experience, intensity of effort, and the triggers which motivate UTT (Cohen and Levinthal, 1990; Zahra and George, 2002). Second, the analysis investigates how prior knowledge is built up and shapes the complementary roles AEs and TTMs play in the university spin-out process, by looking into their perceptions and expectations of each other. The analysis in this chapter constructs a comprehensive understanding of TTMs and AEs individually and their role in the university spin-out process; in so doing, it lays the foundations for the next chapter which seeks to understand how they develop combinative capabilities and contribute to the university spin-out process.

In Section 4.1, the study will present the detailed background and experience of each TTM and AE, supported by narratives which explain how that background, experience, and their personal attributes and motivations qualified them, or triggered their involvement in, and contribution to, UTT. The key antecedent factors that could potentially shape their roles in university spin-out and further impact upon their contribution to the process will be identified from the narratives.

In Section 4.2, the study will present selected narratives which reflect TTM and AE perceptions and expectations of each other during university spin-out. Once the understanding of each other's role has been established, the study will examine the antecedent factors which affect the performance of those roles and how important these roles are in the spin-out process.

Table 5 Narratives of Background, Experience, Attitudes, and Aspirations which Motivate TTMs' Participation in UTT

Participant	Background and Experience	UTT Experience	How their background, experience, attitudes, and aspirations motivated them to become involved with and contributed to UTT, as reflected in the narratives
TTM1	• PhD in Chemistry (research collaboration with industry) • 3 years working experience in the chemical industry • 3 years fellowship of technology transfer training	• 10 years UTT experience	*"…an opportunity arose at the university I was at to do my PhD, [a 3-year UTT fellowship], and the idea of the fellowship was to take people that have a strong scientific background, to make them into technology transfer people. So it was a year's training in order to teach the basics around business development, technology transfer, business plans, and negotiations." (N1)* *"My industrial experience has been quite limited. (…) it really was mainly around seeing how companies worked, how they operated. There weren't that many transferable skills from working in industry across to the tech transfer activities really." (N2)* *"Without the experience that I've gained within the TTO I wouldn't be in a position to advise and to help the spin-out company. So what I've learned from my experience in the TTO, it is very much around how best to take things forward - contacting investors, looking at what funding opportunities there are available, access to external advisors - and all that has come through me working with the TTO, and how I can then bridge the links between the spin-out company and my contacts and also advise them." (N3 & N4)* *"I'm happy in the role that I'm in at the moment. I think out of the universities it's not a particularly great place - we're going through a double dip recession at the moment, and to be honest every month of my job is different as well. I get different technologies every month. I get involved in different activities every month. So, although I've been in the same job here for about 6 years now, that doesn't mean to say that I've not progressed and that I'm not having different activities. The variety is quite important for a day-to-day job." (N5 & N6)* *"I think it looks good on the CV, if you can say you've been involved in a start-up company - some of the pros and cons and some of the highs and lows of a start-up company." (N6)*
TTM2	• PhD in engineering design management and artificial intelligence • 10 years in industry as an electrical engineer	• 24 years UTT experience • 3-4 university spin-outs	*"I have related technical background, I'm a creationist, so tech transfers isn't separate. It's part of the research. (…) I have a range of experience all supporting research, developing research and managing research inside the university area and I suppose it's just I'm interested in the whole life cycle of research, and tech transfers is just part of that spectrum." (N1)* *"Being aware of business needs and time scales and so on and what makes a successful company. So taking all of them, it gives you a breadth of understanding that informs my choices and advice in a tech transfer context." (N2)* *"Every spin-out is different, even if they are in the same sector they will be different. You learn bits and pieces from each one (…) some of it's quite common, legal terms and are important and which parts aren't." (N3 & N4)*

TTM3	• PhD in pharmacology (research collaboration with industry)	• Worked for a university spin-out • 2 years UTT experience	*"I think my research background put me in an ideal position to work on this type of activity within the university." (N1)* *"I've got experience on both sides. I've worked from the academic side within industry and also worked for a university spin-out, so I understand the motivation from the business and industry side, what they are looking for and what are the sort of risks they work with - how they evaluate projects. And because I've been an academic myself I understand where they are coming from and what pressures they have." (N1 & N2)* *"My skills with management are really important as the academic staff have the technical side but you need someone to manage it for them. It developed into my current job. It's something I thought I could really make a difference with." (N3)* *"The experience of setting up a spin-out company, understanding the business processes, the legal requirements, the financial management, there are a lot of different skills which are important skills to know when talking to potential investors or businesses." (N6)*
TTM4	• BA in philosophy • 9 years in retail industry	• 4 years UTT experience	*"Yes definitely, I think my industrial experience gives an understanding of how a real company operates. I project managed the board of directors working at high levels within the company, so when you've had that experience on how to deal with suppliers and other people within the organisation, those people skills help enormously. And the project skills on how to work help which is something academics don't do; they are very different." (N2)* *"I was looking for a change and this seemed like an interesting thing to do; it's not my life dream just a change of career. It's incredibly interesting to be involved in this kind of activity. You may have a meeting to discuss microchips which you may think will be dull, however academics are very enthusiastic about their work and it's often very interesting work so being able to talk about all of this is very interesting." (N5 & N6)*
TTM5	• First degree in geological sciences, MBA, post graduate certificate in IP law • Worked as a management consultant and market researcher for small businesses	• 11 years UTT experience • 3-4 university spin-outs	*"The first degree does help quite a bit. It involved a lot of chemistry and a lot of maths and a lot of physics. (…) So I could understand, to a level, some of the technology behind the spin-out." (N1)* *"The MBA, that helped me in business because it helps to put many business things into perspective. (…) the IP course I did at Bournemouth has been extremely helpful." (N1)* *"Well, a lot of practical experience, I think, a very practical understanding, and also it allows you to see things from the perspective of the other side." (N2)* *"But there is an unwritten skill that you need, which you can only build through experience, and that's the ability to have a lot of common sense, in particular inter-communication and interpersonal skills. And also you've got to have this ability to hold what I call 'gravitas' with the academics. You've got to get their confidence and trust with that, and that only comes with experience." (N3)* *"So I think the other factors, such as the experience, count an awful lot. I am the person that really pulled everything together. (…) so, it's a bit of PR really." (N3 & N4)* *" (…) maybe at some point it will be nice to go to a more research intensive university, and to move up the scale - something where I think I would like to get involved, in a university where there are much greater spin-out prospects," (N6)*

TTM6	• First degree in environmental protection and MBA • Few years traditional manufacturing start-up experience • 4 years experience as a quality assurance manager	• 12 years UTT experience • 1 university spin-out (failed)	*"I've got a slightly scientific background, although I've got no academic qualifications. I like working with engineers because I feel I can understand good technologies and bad technologies and then find a suitable home for them." (N1 & N5)* *"I got the job and that's how I started learning about technology transfer and how exciting it potentially was, but at the same time also how difficult it was to achieve." (N3)* *"Our university is a research intensive university. It's very interesting because people have been saying that there is always a lack of quality technology coming through the system. You come to our university and the reverse is true. You've got a wealth of technology that could be exploited in some way." (N6)* *"We set it up too high in this university. My aspiration would be for us to set up alternative mechanisms to deal with lower value technology which still has social academic benefit." (N6)*
TTM7	• PhD in biomedical science • Helped friend starting up a company • Fellowship of technology transfer training • Founded and now owns a university spin-out	• 7 years UTT experience • 4 university spin-outs	*"I think in experience there is a big difference between knowing what to do, and having the experience and knowing what to do, and I thought, if you put some experience in there and some decision making processes, you get rid of your rubbish projects and focus on your good ones." (N1, N2 & N3)* *"I was a PhD student in a lab where my supervisor had her own spin-out company, and therefore I saw the benefit of doing something with the research rather than just publications." (N1 & N6)* *"(…) academic literature and research bodies don't allow you to move their ideas far enough towards the market and for the market to then adopt them in lots of technologies. So whilst there is a lot of information being produced, there is then a gap where development needs to happen, and if you don't do that then it will be decades and decades before anyone sees the benefits of the research. So I was interested in trying to plug the gap and trying to get things to market more quickly so that they could make a difference." (N6)*
TTM8	• MBA • Worked in a variety of industries and in medicine for 15 years	• 7 years UTT experience • 3-4 university spin-outs	*"My MBA involved a huge amount of educational knowledge which is very useful in running a small company and running a small team within the university." (N1)* *"(…) particularly relevant as I think that there are lessons and procedures used in the commercial world and methods of communication that are used. Therefore having that external reference point is extremely useful." (N2)* *"I think any experience you have within your professional life is useful. It's useful to have on your CV and useful to be able to talk about within your future professional life and I suppose my experience being involved with a small spin-out company has given me more experience that I wouldn't have had if I didn't work within the university." (N6)*

TTM9	• PhD degree in physical organic chemistry • 20 years industrial experience in chemistry • Founder of a university spin-out (sold)	• 11 years UTT experience • Worked as a scientist in a successful university spin-out	*"My background gives me a more empathetic understanding of (…). If an academic comes to me and says I've got a super idea and I would like to commercialise it, I can easily identify it, but it may or may not be a good thing. I don't know. Maybe you have to look at everything totally objectively. Don't let your feelings get involved." (N1, N2 & N3)* *"All my previous experience gave me a backup. I had a broad background in the science and technology field. I have been intimately involved with generating businesses through the research I have done based on myself and the companies I worked for. So all of these things mean I am disposed toward being interested in such things as what AE9 is doing." (N1 & N2)* *"If it is possible to get a return on that investment which benefits the tax payer by spinning out business that is a good thing to do. Personally I think it is a joy getting involved with a spin-out or business, especially when it goes on very successfully, I'd imagine that must be a pretty rewarding thing to do. I think it is very motivating to try to help with the process." (N5)* *"I would like us to be one of the best universities in the UK. I know there is some very good stuff going on out there. I have been associated with the university for a long time. I want it to be successful." (N6)*
TTM10	• PhD in molecular biology • Post-doctoral collaboration with industry for 3 years	• 10 years UTT experience	*"I had very little real first-hand experience of business or IP but I had a very strong scientific background, so our model for the associate position is you come in like that and then over the years you get trained up." (N1, N2 & N3)* *"(…) so the reason for doing it was really that I liked the fact that research into basic science led to improved products for people, and I thought that was very interesting. I also liked being very broad in my experience of science." (N1, N5 & N6)* *"I got further funding for another 3 years that was working on a project that was collaborative with an established company and I think by that stage I knew that I did not really want to be working on the bench in a biotech company any more than I wanted to be working on the bench in academia. So what I decided to do was to look for jobs that were somewhere on the interface of the two (…) after some degree of searching I saw that there were some posts available for technology transfer. I liked the fact that research into basic science led to improved products for people, and I thought that was very interesting." (N2, N5 & N6)* *"Actually it is more about expanding my role and becoming more valuable doing perhaps slightly different things. But at the moment I still enjoy working here. It is a challenging career. It is a point in my career that I see as an end in itself, rather than a route to somewhere else." (N6)*
TTM11	• First degree in mechanical engineering and MBA • 5 years mechanical engineering experience	• 6 years UTT experience • 2 substantial UTT activities • 1 university spin-out (recently completed)	*"I worked with the research development department of a big company and worked with them with licensing and technologies they were creating." (N2)* *"I guess I have accumulated certain abilities to deal with the academics. (…) You have to give them more options in decision making. (…) You will have to explain to them what issues might happen during the process." (N3)* *"A significant component is my job expects me to do it. I am very positive. I appreciate that universities are unusual (…) It is significantly a support for research and education." (N5)* *"I thought about moving to this university because it had several examples of having done real spin-out which is what attracts me to do it. Rather than in a large organisation, where you feel you are one of many people doing similar*

	• 6 years business analysis and consultancy experience	• 1 university spin-out (failed)	*roles and contributing a little bit to the company overall, if you are doing some activity which is creating a brand new thing, it is like a small cog in a big wheel." (N5)* *"I was interested in moving because I think our university's track record shows positiveness that they have done spin-outs." (N6)* *"I suppose for my track record, if the spin-out is successful, I put that on my CV and people who see it might say I must be good. So I want it to be as successful as possible. Then secondary to the first thing is, if there was a spin-out which is close to what I have done, then I might move to work in the spin-out." (N6)*
TTM12	• PhD in chemistry • Worked in telecoms industry for 10 years (including a university spin-out for 4 years) • Limited experience in assisting a start-up	• 5 years UTT experience	*"I'm trained as a scientist and after a period of post-doctoral research I spent many years working in the industry in engineering and development type roles - new products introduction. And following that I had a spell with a university spin-out and from there I found myself back in university life again doing technology transfer. So I have a bit of a mixed background and industrial experience. […] I think it's really more because of my history working at the interface between industry and academia. A lot of the time I spent working within the industry was in new product development. So there [UTT] was a direct sphere of research into new products and services, and that's just something I enjoy doing." (N1, N2 & N6)* *"I worked with one of the university spin-out companies for four years before getting involved with technology transfer so I was employed through the company not the university. My engagement was through people I knew who were involved, when I was employed by the university spin-out in the past." (N2, N3 & N4)* *"I haven't directly started any businesses myself but I was involved in that at a very early stage. And I spent a lot of time in fund-raising and investment related activities." (N2)* *"What motivated me to get involved with spin-out? I think primarily it's finding applications for the ideas and inventions that come across my desk. Finding the right route to commercialisation." (N6)*
TTM13	• Worked in industry for years • PhD in agricultural biotechnology • Fellowship of technology transfer training	• 6 years UTT experience • 1 university spin-outs	*"There were a few things that motivated me to go into UTT. One, I was interested in applied application science but I thought I might not be able to follow my own research area myself. But then also watching other career post docs and seeing the difficulties and challenges they had in finding long term secure employment, I don't think the job market is very good. It is really to continue to get different experience of commercialising different technologies in different ways, to be creative, but also to keep learning and trying new things, and to do different deals, bigger deals and think about better ways of doing this. (…) But longer term I would probably look to move into industry and use those skills or move into a start-up or something." (N6)* *"As I graduated from my PhD I did a 12 months fellowship in tech transfer across medical sciences and biotech, sort of school of biology. It gave me a foot in the door to more of the commercial and development science, but also broadened my expertise from the narrow." (N1)* *"I guess across every aspect of it really. I understood the process a lot more; I understood what my role as a TTM really is. There are lots of UTT deals happening and lots of spin-outs happening, so there is a lot of knowledge and experience about achieving the best results for the university and the academics." (N3)* *"My motivation has been personal career development from gaining experience that I can then go on and use in my future career. (…) in as many technology areas and methods or modes of exploitation technology as I can." (N6)*

Table 6 Narratives of Background, Experience, Attitudes, and Aspirations which Motivate AEs' Participation in UTT

Participant	Background and experience	UTT experience	How their background, experience, attitudes, and aspirations motivated them to become involved with and contributed to UTT, as reflected in the narratives
AE1	• Professor of Medicine • Industry-university collaboration throughout his academic career	• Patents	*"(…) teaching is important of course, but from where research is concerned for too many years the university has seen the final product of that research is the publication of that research into high ranking journals and then stopping it; I think that's wrong. I think if you do research you should be wishing to take that research as far as you can to provide benefit." (N6)* *"The reason we did that was because there was a TTO and the staff were there as they were interested in technology transfer. When they saw the work that we do they encouraged us to do future spin-out activities. If it wasn't for TTM1 we wouldn't have even thought about it or had any encouragement from anywhere else within the university to do that." (N5 & N6)*
AE2	• Senior Lecturer in Economics	• None	*"I think it can be a very good idea, otherwise I wouldn't have done it, but not always, it depends on the context. I certainly don't think all academics should be encouraged to commercialise their research. The core of research is not that it is commercial; the core is the advancement of knowledge - sometimes that can be commercialised. If the academic is interested in so doing then jolly good, if not then fine." (N5)*
AE3	• Professor of Organic Chemistry • Industry-university collaboration	• Patents • Founder of an established university spin-out	*"I think it just makes you aware of what the constraints that particularly small companies are working under are, (…) and it makes you more aware of their concern with IP." (N2)* *"It helps in a loose way yes, because I know what needs to be done. And I don't intend to run these spin-outs myself, I intend to get professionals in to run them, and so it has helped me with the procedures for doing that yes." (N3)* *"My attitude is that we don't do it enough, we need a better system for commercialising university research." (N5)* *"I have been an academic for over 40 years. For the first 20 years I was working on very pure science and then I decided at one point that it was appropriate to apply that science to something that might be useful in industry. And 20 odd years ago was the first time I got involved in commercialisation." (N6)*
AE4	• Research Fellow in Electronics • Industry-university collaboration	• None	*"For ages I thought it would be really nice if we could apply these to real world problems that actually did something useful." (N6)* *"The reason for doing this spin-out is obviously because I am really interested in the technology that we have developed. You start on a path of developing technology and you get really into it and want to see if it works, and then you see it working and think what else could we try it on to see if it works on that? (…) That is the reason I am interested in it, and in some ways it adds a bit more excitement to the day job too!" (N5 & N6)*
AE5	• Research Fellow in	• Patents	*"I have often been out with companies on their premises; seeing the problems they see every day. So I like to think I have some experience of industry even though I have not worked in industry, as I have been to a lot of companies and helped them solve a lot of problems. So I know what it is about; but still a lot of it is a surprise." (N2)*

	Material Science • Industry-university collaboration		*"So that is exciting, to see something that you developed go somewhere rather than just come towards the end of a research project and then just stop. Also I think it is always good to get out of the lab, get out of the university and see the real world. […] I am still in the university, I still have my job, so it is good to explore but not have too much risk involved. It is a safety net, its good." (N5 & N6)*
AE6	• Doctoral Researcher in Mechanical Engineering • Worked in industry for about 20 years	• None	*"My supervisor and my department weren't that interested in pursuing it commercially. I had enough experience to say: "Actually this is probably worth looking at". I don't think a student straight from a university would necessarily know that, or have the confidence to say that, so that's been valuable." (N1 & N2)* *"It is very important that you feel that you do have people who are enthusiastic and that they encourage the very early steps towards trying to commercialise it. Because that is usually when people decide whether they can be bothered or not." (N5)* *"Engineering is making pure science actually work and solve a problem. So I'm very keen to see engineering research commercialised purely because it's the way to make sure it works. (…) and the only way for that to happen is to make it worth somebody's while to manufacture and sell them, so it needs to be commercial really." (N6)*
AE7	• Innovative Fellow in Physics • Industry-university collaboration	• None	*"My PhD supervisor first realised the commercial potential and then we carried on following the process. He had applied for three other patents before so he is a very commercially aware academic." (N1 & N3)* *"I think it'll help with my future career because the skills you learn are so transferable to other jobs and businesses it is not a waste of time, and you never know where the product might take you as well." (N6)*
AE8	• Senior Occupational Therapist	• None	*"Because there is a clear need for this sort of technology to be available to the public and the health service doesn't have enough resources to provide the sort of level of therapy people need and this is a way to do it." (N6)* *"Yes, because it has been a steep learning curve, I think any new knowledge is good. I have learnt a lot about business and the legal side of getting a product to market." (N6)*
AE9	• Reader in Electronic Computer Science • Industry-university collaboration	• Founder of an established university spin-out (sold)	*"Yes, definitely you got lots of experiences which was a gain and also lots of industrial connections. So it makes it a lot easier [to apply] for grants and so on." (N3 & N6)* *"I think it's definitely an important thing. I think people don't usually bother so much to try and do this. But it's a very important activity for academics to try to do." (N5)* *"It'd be nice to make a second spin-out which is a lot more successful than the first one. Make a new company and make it better. I enjoy it a lot." (N5 & N6)*
AE10	• Reader and Principal Investigator in Medicine	• 8 to 10 Licenses • Patents	*"I think that what was great from doing this year in industry following my PhD is that it has really opened my mind to the private sector. (…) I think it is really important in the lab, seeing a commercial application and commercial development, because I think that is part of the mission of having worked in or collaborated with industry." (N2)* *"I think that is a really important mission in two respects. First because it is a good way to translate your work and is creating something useful which is important to me; so to see a discovery in the lab becoming a product is very*

	• Worked in industry for 1 year		*exciting I think. It is also important in terms of the societal impact of the research we are doing, creating jobs, creating business. So it is really important to me to see that is happening." (N5 & N6)*
AE11	• IT Innovation Manager in a Research Centre at a university • Industry-university collaboration	• None	*"Positive. It does not happen enough. (…) There is a huge amount of work it takes to go from that cool idea or a piece of software to a successful start-up company. That is not the thing most academics expect, get interested, or even get involved in. I mean it would work better if they are aware of what the process is and what the options are." (N5)* *"It helps me and the job I do currently. It helps my research centre in general. It is always a benefit in the CV, the jobs you're involved in, starting up a company." (N6)*
AE12	• Senior Lecturer in Materials • Worked in industry for 5-6 years • Industry-university collaboration	• None	*"My industrial experience does help in understanding how companies work, the structure of companies and what type of business is the company, but the start-up and technology base is quite different." (N2)* *"I think that the commercialisation of research will be important for research exploitation. But of course through this process I do understand these difficulties, there are some challenges (…) and I am not so sure if they have an efficient or supportive system to encourage the activity or motivate this type of activity." (N5)* *"The technology will maybe change the way people manufacture, not just manufacturing but the way people are designing and making, and also consuming the products. So I hope this company can pull out something that will really make the consumer happy." (N6)*
AE13	• Research Fellow in Medicine • Industry-university collaboration	• Patents	*"In one way the satisfaction. I feel a sense of satisfaction because my research has been commercialised and we are one step further towards helping people, which is my dream, so I feel very content about that. Secondly the company investment has helped my research. That has allowed me to employ a technician. And also the company has a lab in another country, so if I collaborate with the academics there then we can use that facility." (N5 & N6)* *"Commercialisation is different. It allows you to make your research results into a product rather than a paper, so I think that is very important for helping people." (N6)*

4.1 Prior Knowledge and Motivation of TTMs and AEs

Lockett et al. (2005) and Wright et al. (2007) suggested that there was a need to research individuals (TTMs and AEs) to understand their motivations and capabilities with regard to developing successful university spin-outs, and to examine the effectiveness of individual backgrounds. Therefore, to develop an in-depth understanding of how TTM and AE involvement affects different stages of the spin-out process, the study first investigates what and how prior related knowledge qualifies and motivates them to work in/with TTOs, and participate in UTT activities in the first place. It also asks whether such prior related knowledge is helpful to the individuals concerned, constitutes the AC of a university spin-out, and has an impact on UTT activities.

Unlike AEs, who usually voluntarily become involved with UTT, TTMs undertake UTT activity because it is one of the main duties of the post. However, there must be certain factors which motivate or allow both of them to participate in UTT. To identify all of the potential prior related knowledge which might motivate or affect TTM and AE participation in university spin-out activities, this study codes the respondent narratives in relation to six nodes, namely educational background (*N1*), industrial/business experience (*N2*), UTT experience (*N3*), personal relationships/social network (*N4*), personal attributes (*N5*), and personal motivations (*N6*). All of the nodes were discovered in narratives about participant backgrounds or identified from previous literature (such as Cohen and Levinthal, 1990; Zahra and George, 2002; Siegel et al., 2003; Siegel et al., 2004; Lockett et al., 2005; Wright et al., 2007).

Educational Background (N1)

Having a related technical or business background seems to be the most straightforward factor that led TTMs to work or consider working for TTOs. Among the thirteen TTMs, eleven had related technical degrees (eight had PhDs), seven had business related degrees (four had MBAs and three had technology transfer fellowship training). The majority of TTMs felt that their technical knowledge meant that they were well suited to working in UTT, and to understanding, to a

degree, the good and bad elements of a new technology. TTD1 said, “It is helpful if a TTM can understand the technology or has a feel for it, to be able to speak a similar language to the academic.” Some TTMs considered that having general scientific knowledge was sufficient to allow them to do their job; that they did not need a PhD because the AEs with whom they worked were at the forefront of thinking in their field (TTM5). TTD1 said, “For every technology – to have all that understanding in a single TTM is too much to ask, it’s not possible, so we have to be reliant on external sources to some degree; I think it is perfectly reasonable to admit that.” TTM5 also pointed out that “there is a tendency for universities to recruit people that have been researchers, that have got a PhD, quite often with no or limited business experience, and some universities will actually recruit people purely with business experience. The ideal person is someone that has both, but that’s a difficult person to find. And personally I think it’s a mistake to recruit someone that actually hasn’t worked in an industry or doesn’t have some experience of business practice etc.”

Having business related knowledge or a degree allowed TTMs to understand how a company works and gave them the ability to identify the potential of an opportunity. For example, a degree in business or management or an MBA brings TTMs a huge amount of educational knowledge in areas such as business operation, development, leadership, and management. Some TTMs also mentioned that IP and technology transfer related courses are extremely helpful for UTT. Three TTMs (TTM1, TTM7 and TTM13) completed technology transfer training fellowships immediately after their PhDs and all had assisted in establishing around one to five university spin-outs in the past ten years. TTM1 said: “…the idea of the fellowship was to take people that have a strong scientific background, to make them into technology transfer people. So it was a year’s training in order to teach the basics around business development, technology transfer, business plans, and negotiations.”

Only TTM4 had no related educational background, although he had completed some technology transfer training (i.e. with PraxisUnico) whilst working on UTT activities. TTM4 mentioned, “We have people in the office who can deal with technical conversations with AEs. (…) There are some aspects where you don’t need such background.” TTD4 confirmed, “I prefer my people to have come from outside of the university sector, preferably the private sector. They need to be

able to understand the world outside academia, so I tend not to recruit TTMs who have maybe done a PhD and a post doc and maybe had experience on a Technology Transfer Project. I don't recruit them for senior roles, I really need the external experience." He suggested that a business qualification such as an MBA was useful, especially for university spin-outs. The TTO (and the university) would support its staff with the necessary technology transfer courses, or even an MBA, which he strongly encouraged TTMs to take. However, TTD4 still admitted that having a related educational background could help TTMs to establish a certain credibility among AEs, "(…) because a TTM needs to have credibility with the academic. They don't have to understand all the finer details but need to be able to talk with them in such a way that the academic will respect them."

With regard to AEs, their educational background (technical expertise) means that they are ideally placed to create technology from research output that may have commercial potential, and therefore to become a natural partner in UTT activities. In this study, however, none of the AEs had any business related educational background. Thus there are obvious knowledge gaps between technology and commercialisation in UTT which AEs need to address. They usually need motivation to engage more deeply in UTT activities like university spin-outs, especially since the reward system for doing so is often limited and the performance and promotion decisions of their career are strictly evaluated on the basis of their publications and research grants (Siegel et al., 2003; Siegel et al., 2004). The study will further discuss AE career aspirations under the *N6* heading, which looks at aspirations and motivations.

TTMs generally consider that having a related technical or business educational background is helpful and will have a positive impact on UTT activities, but that neither is a requirement. The analysis showed that the majority of TTMs had related technical degrees and half of them had business related degrees; this is consistent with the findings of previous research which indicate that TTOs value TTMs who have technical knowledge rather than business/commercial knowledge (Siegel et al., 2004). However, TTDs deemed that having technical related knowledge helped TTMs to understand AE technology and to communicate with them better, thereby building up TTM credibility and possibly gaining AE respect. They also stressed the importance of, and the need to keep providing, business/commercial training for TTMs (such as MBAs, business

management related degrees or technology transfer related courses such as those provided by PraxisUnico and similar organisations). The study will discuss how technical and business/commercial knowledge help TTMs and AEs to build their capabilities and contribute to university spin-outs.

Industrial/business Experience (N2)

Nine of the thirteen TTMs had both related educational backgrounds and industrial experience; two TTMs who had PhD degrees had experience of research collaboration with industry. A few TTMs who had PhD degrees commented that they took this job because the competition for PhD level posts in both academia and industry was strong, but most of them felt that, since PhD candidates with both science and technical backgrounds usually collaborate with industry during their studies, or when undertaking a post-doctoral fellowship, they already had a history of engaging with both academia and industry.

TTMs agreed that they would benefit from having related industrial/business experience because it would help them to understand the motivation on the parts of both business and industry, to appreciate how a company is operated, and to anticipate possible risks. TTMs who had PhD degrees had often firstly worked as scientists in R&D departments of related industries which allowed them to see how new technology was being created and how technology transfer works in the business sector. They also admitted that the experience of working in or collaborating with industry might have influenced their preference for either academia or industry. The majority of them had made a conscious decision to work on the interface between the two. TTM10 said: “I did not really want to be working on the bench in a biotech company any more than I wanted to be working on the bench in academia. So what I decided to do was to look for jobs that were somewhere on the interface of the two (…) after some degree of searching I saw that there were some posts available for technology transfer.” TTM12 mentioned, “(…) because of my history working at the interface between industry and academia. A lot of the time I spent working within the industry was in new product development. So there [UTT] was a direct sphere of research into new products and services, and that’s just something I enjoy doing.”

Ten of the thirteen AEs had industry-university collaboration experience, only two had direct industrial working experience. AEs who had worked in or collaborated with industry felt it gave them a general understanding of how a company works, of commercial application, of the development of research results, and of how to assist a firm to solve problems. It also enabled AEs to recognise the R&D constraints imposed on a company and the need for IP in business and industry. Some AEs (e.g. AE6 and AE10) also believed that the experience of working in or collaborating with industry provided them with the necessary insight to identify the commercial potential of their research output. AE10 said: “I think that what was great from doing this year in industry following my PhD is that it has really opened my mind to the private sector. (…) I think it is really important in the lab, seeing a commercial application and commercial development, because I think that is part of the mission of having worked in or collaborated with industry.” AE6, who had worked in industry for twenty years, believed that industrial/business experience was vitally important. The commercial potential of the research was apparent to him because of his previous experience but his supervisor and department were not interested. He claimed: “I don’t think a student straight from a university would necessarily know that, or have the confidence to say that, so that’s been valuable.”

Lockett et al. (2005) implied that TTOs need to recruit more TTMs with appropriate industrial/business or start-up backgrounds which they have built up by working in the private sector or even in university spin-outs. They should recruit in preference to others who do not have such skills. As mentioned in the previous analysis (*N1*), TTD4 also agreed that it was more important to retain TTMs with experience of working outside academia than those with a PhD degree. In this study, the majority of TTMs had industrial experience, just over half of them had business experience, some had both, and some had start-up experience or had previously assisted with start-ups. Interestingly, with regard to AEs, other than their technical expertise, their university-industry collaboration experience or industrial experience is of great value to their ability with commercial opportunity discovery/identification. TTMs and AEs both considered that the industrial (technology transfer), business, commercial, and entrepreneurial knowledge accumulated from such experience was of benefit to their role in UTT. It allowed them to observe the whole commercialisation–transfer–business operational

process, from creating the technology to taking it into business, and enabled them to see all aspects from both an industrial and a business perspective. Their problem solving skills were also therefore developed through the experience.

UTT Experience (N3)

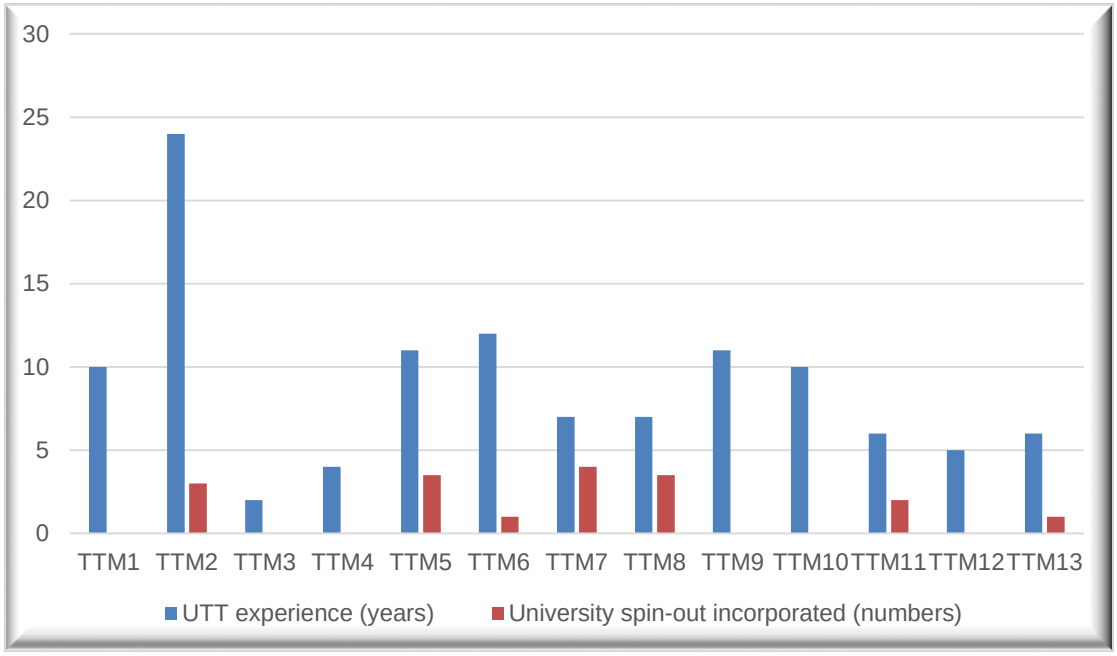

Figure 7 Previous UTT Experience and Numbers of University Spin-outs Incorporated per TTM

TTMs equate UTT experience to a continuous learning process, commencing from the moment they became a TTM. TTM7 pointed out that the big difference between having a related educational background and industrial/business experience and having UTT experience is the same as that between, on one hand, knowing what to do, and on the other hand, knowing what to do, but also having the experience to back it up. Figure 7 shows that the majority of TTMs in this study had between five and ten years' UTT experience and had successfully incorporated, on average, two university spin-outs. However, it can be seen that it was not necessarily the most experienced TTMs who created most university spin-outs. As Table 5 and Figure 7 show, TTM2 had more than twenty years' UTT

experience and had assisted with the incorporation of three to four university spin-outs. TTM1, TTM9 and TTM10 also had more than ten years' UTT experience, but had no university spin-out experience. TTM7 and TTM8, who only had six to seven years' UTT experience, had both incorporated more than three university spin-outs each. Also six of the thirteen TTMs had never successfully incorporated a university spin-out, although some had participated in discussions about that development but had never reached the incorporation stage. Therefore, for almost half of them, the study cases were their first.

The TTMs, however, argued that it did not matter how much UTT experience they had or how many university spin-outs they had created, it was more important to look at the skills and abilities they had accumulated through previous UTT or spin-out experience. First, with UTT experience, the position of the TTM is more convincing with regard to advising and assisting with university spin-outs (e.g. TTM1, TTM5, and TTM11). Second, TTMs know how to take things forward and also manage the process (e.g. TTM1, TTM3, and TTM5). Third, TTMs can bridge the gaps between the university spin-out and their contacts (e.g. TTM1). Fourth, and most crucially, TTMs will also develop inter communication and interpersonal skills/abilities, when dealing with academics (e.g. TTM5 and TTM11). After all, doing business within academia is very different from doing business outside academia as the study discussed in the previous section (*N2*). TTM5 stressed the importance of this skill: "You've got to get their confidence and trust with that, and that only comes with experience."

TTMs with previous university spin-out experience agreed that one of the most important lessons they had learned from their previous UTT experiences was to recognise the reality of how difficult it is to facilitate UTT. Even though the success rate of UTT is low, they still learn many lessons along the way, especially about dealing with AEs, which might be of benefit to future UTT activities. TTM11 learned from his past UTT experience and applied it when working with AE11. He explained that he had "accumulated certain abilities to deal with" AEs, including a propensity to anticipate what would happen two or three steps down the line.

Only six AEs had previous UTT experience, mostly in patenting and licensing. AE3 and AE9 had experience of founding a university spin-out and they both considered UTT experience helpful, especially with the procedures involved in

forming a university spin-out and expanding connections to industry. In addition, AE7 began working on his spin-out company while also studying for a PhD. His supervisor's UTT experience helped in the first instance to identify the commercial potential of his research.

TTMs value the skills/abilities accumulated from prior UTT experience for three significant reasons. First, they mean that TTMs are better placed to advise, manage, and guide the spin-out process. Siegel et al. (2004) pointed out that the facilitating role of TTMs is frequently mentioned by TTDs, but some stakeholders who have participated in UTT activities, including AEs, consider TTMs to be obstacles rather than facilitators (especially with regard to facilitating the relationship between AEs and the other stakeholders). This study will later examine whether UTT experience builds up the necessary skills/abilities for TTMs to facilitate university spin-out. Second, the analysis shows that UTT experience helps TTMs to develop the critical skill of boundary spanning, as discussed in the previous literature (Siegel et al., 2003; Siegel et al., 2004), an effective communication and personal skill which serves as a bridge between AEs and all the other contacts/stakeholders who operate in different environments. Third, TTMs consider that prior UTT experience builds up a TTM's credibility which helps to gain AE trust. This is crucial when developing a university spin-out and will be addressed in more detail in Section 5.1.3 in the next chapter. The analysis also indicates that UTT experience helped AEs to build their ability to identify commercial opportunities and to develop a familiarity with university spin-out procedures.

Personal Relationships/Social Network (N4)

All the UTT stakeholders in the existing literature believed that TTM and AE personal relationships/social networks played a significant role in UTT (Siegel et al., 2003; Siegel et al., 2004). TTM5 described himself as "the person that really pulled everything together"; a public relations person for the university spin-out activities, linking AEs with the right people throughout the spin-out process. TTM1 also addressed the importance of prior UTT experience in developing personal networks, referring to: "what I've learned from my experience in the TTO", and

"how I can then bridge the links between the spin-out company and my contacts and also advise them".

Personal networks can be developed at times other than when TTMs are working for TTOs; in this study, some started when the TTMs were scientists/researchers (during industry-university collaborations, licensing, patenting etc.), or when they were employed by or were the founders of university spin-outs. TTM12 admitted, "my engagement was through people I knew who were involved, when I was employed by the university spin-out in the past". Therefore, personal networks can also trigger TTMs to participate in UTT as a job.

For those AEs who had UTT experience, their personal networks with TTMs were usually developed over years, from the time their involvement with patenting, licencing, or spin-out began. Before embarking on a university spin-out, they all knew their TTMs well. It is difficult to say whether AE personal networks affect their aspirations to participate in university spin-out, but all knew where to go to seek help whenever they needed it. In some cases (e.g. Cases 3, 5, and 13), AEs and TTMs indicated that they had had discussions on the potential of an idea over many years, and then made the decision to finally spin-out when the idea developed. Those who do not have previous UTT experience will usually approach the TTMs who work with their department.

As mentioned in Chapters 2 and 3, formal and informal personal relationships/social networks are of great value to a TTM in the process of knowledge transfer (Siegel et al., 2003; Siegel et al., 2004; Lockett et al., 2005; Lockett, 2006). It might be difficult to see the importance of these as antecedent factors because they are things which seem to develop as a result of previous UTT activities or experience, but the study will explore these factors later, when it investigates the TTM role and the relationship initiation between TTMs and AEs.

Personal Attributes (N5) and Personal Motivations (N6)

In this study, both personal attributes (N5) and personal motivations (N6), such as enthusiasm for UTT, are identified as the key factors which encourage TTMs and AEs to become involved with UTT. TTM6 said, "I was very enthusiastic about AE6's idea from day one." AE6 considered that the TTM's attitude significantly

affected his own attitude toward the commercialisation of his research output. “TTM6 was very keen to actually see whether we can make this work. (…) It is very important that you feel that you have people who are enthusiastic, and that you encourage the very early steps towards trying to commercialise, because that is usually when people decide whether they can be bothered or not.” The enthusiasm and positivity of TTMs could significantly affect not only their own but also the attitudes and aspirations of AEs towards participating in university spin-out, and vice versa. TTM4 explained: “You may have a meeting to discuss microchips which you may think will be dull. However academics are very enthusiastic about their work and it’s often very interesting work, so being able to talk about all of this is very interesting.”

Most TTMs in this study had a positive attitude towards their job, stating that it was interesting, challenging and enjoyable. Some of them had been bored with their previous employment and looking for a change. They found UTT interesting because every case was different. TTM11 said, “Rather than in a large organisation, where you feel you are one of many people doing similar roles and contributing a little bit to the company overall, if you are doing some activity which is creating a brand new thing, it is like a small cog in a big wheel.” TTM1 also mentioned how happy he was to work in such an interesting role, dealing with a variety of UTT activities, especially in a period of economic recession. Many TTMs spoke of their aspirations for their future career and agreed that UTT activities, especially those which were university spin-out related, looked good on their CVs, thus their aim was to gain as much experience as possible. TTM13 insisted: “My motivation has been personal career development from gaining experience that I can then go on and use in my future career. (…) in as many technology areas and methods or modes of exploitation technology as I can”. It seems that some TTMs were greatly inspired by rich research output and the previous, very successful, spin-out activities of their university (e.g. TTM9 and TTM11). TTM5 also expressed a desire to move to a TTO with a stronger research incentive or a better track record for university spin-out and felt that this might motivate him to perform better at work.

The personal competences and aspirations of AEs with regard to UTT activities and commercialisation are fundamental to starting a university spin-out, and the evidence for this can be seen in many places. Research has indicated that there

are insufficient reward systems (apart from financial rewards) for AEs, and that this is a barrier to their participation in UTT. This barrier could perhaps be considered an opportunity cost in relation to both investment in teaching and research and the impact on an AE's academic career progression (Siegel et al., 2004; Wright et al., 2007). However, the analysis has shown that their passion and motivation for applying their research beyond academia is key to their participation in UTT (Shane, 2004; McAdam et al., 2010).

In this study, AEs all recognised the importance of UTT and wanted to see their idea or invention applied. Most of them claimed that, as scientists, it was their mission to do this, and it would be wrong to stop at the stage of research paper publication. Their ultimate goal, they felt, was to provide benefit to industry and the public. The analysis is consistent with the findings of Siegel et al. (2003). As AE1 said: "I think if you do research you should be wishing to take that research as far as you can to provide benefit." AE10 stressed, "It is also important in terms of the societal impact of the research we are doing, creating jobs, creating business." TTMs with a PhD degree agree with AEs and share the same strong aspirations to turn basic science into improved products to benefit people, or even to help lower value technology to become commercialised to achieve social or academic benefit. Over half of AEs considered that university spin-out brought them excitement, joy, or satisfaction other than that afforded by their academic career. They also understood the difficulties and the reasons why other AEs were not keen to involve themselves in university spin-out because it can be challenging, time-consuming, and risky. Ten of the thirteen AEs wanted to work on more university spin-outs in the future. Their personal attributes have an obvious impact on their desire to participate in university spin-out. Further motivation for AEs is the encouragement received from TTMs. AE1 and AE6 both acknowledged that the encouragement given by their respective TTMs had been a key motivator for them to initiate their spin-out from the very beginning.

A few AEs even considered working on university spin-outs to benefit their future career, especially those who were innovative researchers/managers at their universities. They considered the skills they had developed from starting up a university spin-out to be transferrable and maybe of benefit to their CV and future employment. Other AEs, who were more firmly rooted in academia, held quite a different opinion because, after all, universities still place more value on teaching

and research. Establishing a university spin-out would not necessarily count towards their achievements in research excellence or help them to gain a promotion to a more senior academic position. However, they agreed that interaction with industry had a positive impact upon their experimental work because it improved the quantity and quality of their research. In addition, AEs admitted that such interaction “makes it a lot easier [to apply] for grants and so on” (AE9), and also easier to expand connections with industry or to collaborate with academics in other countries (AE13). To a certain degree, therefore, university spin-out could also benefit the academic career of an AE.

Other than personal, social, or career aspects, all of the AEs, as company founders, will be economically rewarded due to a shareholding in their own particular university spin-out. In each case, they will usually receive between a third and a half of the shares in a university spin-out company (if there is more than one AE founder, the shares will be divided between them). The percentage of the AE shareholding and how multiple AEs divide shares varies from case to case. However, most respondents in this study emphasised that they had not entered into university spin-out to make money. As AE4 said, “By all means, if you have a successful company and it gets bought out for millions of pounds and you get a share of that then that is great! It is an added bonus! But at the end of the day you can’t be in it just for the money. If you were just in it for the money you wouldn’t have been in academia in the first place, you would have been in industry.” AE13 also stressed, “The biggest reward is the mental reward, because my goal is to benefit the people which is of most importance to me.”

As for TTMs, there is no reward system whatsoever for working in university spin-out. TTM2 and TTM5 confirmed that they might receive a bonus for their successful incorporation of university spin-outs, however, this would form part of the bonus for their overall work performance as a TTM, and would not be awarded for their work on a specific spin-out. TTM2 said, “If I do a fabulous job my boss may recommend me for a bonus as part of my regular job.” Other than these two cases, all the other TTMs felt that university spin-out was simply part of their job − this was what they did − although they might also view success as a personal achievement, good experience, a source of satisfaction at having sealed a deal, or even better, a means of gaining recognition for their work from their peers or superiors. TTM13 said: “Some of the academics we work with think that we may

also benefit as individuals from the deal, but we don't at all, so it is actually in a way quite a selfless role. I think that is where, as a TTM, sometimes it can be quite frustrating because it is up to me how much time and effort I put into something. So my motivation has been personal career development from gaining experience that I can then go on and use in my future career."

It is apparent that there is no system which rewards the majority of TTMs for becoming involved in spin-out and they consider it to be a part of their job. The study discovered that their aspirations when participating in UTT are either on a personal level (e.g. personal achievement/satisfaction, peer recognition, enjoyment of the challenge/excitement of the role in comparison to other day-to-day jobs) or related to career development based on experience gained in the UTT. With regard to AEs, there are many factors that can trigger an involvement in UTT, including: the support and encouragement of their TTMs; a desire to apply their research output outside the university setting; to benefit people's daily lives; to experience the excitement/satisfaction of pursuing something other than their academic career; to examine or improve their research quality and enable them to apply for further grants; and to achieve a shareholding from their spin-out. Interestingly, this research has shown that positive personality attributes and personal motivation in relation to UTT can encourage both AEs and TTMs to become involved with UTT, and that both have a particular passion to see the research output applied outside academia and for public benefit. This has been identified as a key factor; one which has an impact upon various aspects of the university spin-out process. The study will provide more evidence of this and investigate further in the analysis below and the next chapter.

Summary

In this section, the study investigates the motivations which result from the backgrounds of TTMs and AEs in terms of prior knowledge, experience, personal competences, and aspirations for working on university spin-outs.

It can be seen that the distinctive technical background of AEs allowed them to become involved in university spin-out. Most AEs had experience of industry-university collaboration but none of them had business experience. Only a few

had had direct interaction with industry. Yet the majority of them still managed to identify the commercial potential of their research output based mainly on their industrial-collaboration experience and some of their previous UTT experience. This is consistent with the findings of McAdam et al. (2010), that although it confers limited knowledge of commercial and market realism, previous industrial experience or industry-university collaboration can help AEs to identify commercial potential in their research output which could contribute to the spin-out PAC.

Diversity of prior knowledge (educational background and experience) serves different purposes but is of great value to TTMs. The most important thing is that it allows TTMs to accumulate credibility in the eyes of AEs regarding their capacity to contribute to spin-out. Most of the TTMs felt that general technical knowledge was sufficient because the AEs with whom they worked were at the forefront of their particular field. However, technical knowledge enables TTMs to communicate more efficiently with AEs, using the same language. It means that they are well qualified to understand both the AEs and their ideas, and most importantly, as mentioned in previous research, to see the value of their ideas (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998; Zahra and George, 2002). Even though some TTMs do not have such prior knowledge, TTDs/TTMs are still aware of where this critical relevant expertise resides outside the university and will search for external professional help through the due-diligence process (Cohen and Levinthal, 1990; McAdam et al., 2009). Similarly, with regard to industrial/business experience, most TTMs had experience in either or both areas and considered it to be a great help in their role and to their credibility, but they believed that business/commercial skills, though helpful, could also be taught at a later stage. AEs expect TTMs to perform a complementary function; to take over the commercial side of a development, and to fill the knowledge gap − the parts where they lack prior knowledge or experience (Lockett et al., 2005; McAdam et al., 2009; McAdam et al., 2010).

The analysis also confirms that previous UTT experience is beneficial for both TTMs and AEs, enabling them to accumulate communication and networking skills (Venkataraman et al., 1992; Franklin et al., 2001). UTT experience provides TTMs with a solid understanding of the UTT procedure, allowing them to face the difficulties that might occur during the process and making them better able to

deal with AEs. Whilst TTMs admit that every university spin-out case is unique, they point out that the learning process is ongoing and that their abilities develop as they handle different cases. As previous studies indicate, PAC, as a learning capacity, can be accumulated more easily when prior knowledge exists and is also a path-dependent capacity that is affected by prior experience (Cohen and Levinthal, 1990; Zahra and George, 2002). Previous UTT experience provides TTMs with credibility, with an accumulation of heterogeneous knowledge, and with PAC which enables them to efficiently guide the process, to deal/communicate with the AEs and others involved, and to gain their confidence and trust (Cohen and Levinthal, 1990; Zahra and George, 2002; Markman et al., 2005a; Gómez et al., 2008; McAdam et al., 2009; McAdam et al., 2010).

Interestingly, the personal attributes (*N5*) and personal motivations (*N6*) of both AEs and TTMs are key antecedent factors to their becoming involved with university spin-out, and are a major push in linking together all of their background and experience. TTM and AE personal attributes − such as enthusiasm, a desire to make a change, seeking a challenge or something interesting in life, or being a risk-taker − and their positive attitude toward UTT and commercialisation, provide their initial motivation to work in university spin-out. A passion or strong interest in an idea can also be a strong motivation for an AE to become involved in UTT, or indeed for a TTM to become more engaged in the process. This could be the foundation which supports them both throughout the spin-out process. Interestingly, the technical background of most TTMs not only provides a shared language for effective communication with AEs, but also triggers a shared aspiration to see research output applied outside academia (Shane, 2004; McAdam et al., 2010) and to benefit society (Abreu et al., 2009). All of this is consistent with previous research which, with regard to the achievement of effective PAC, pointed out the importance of activation triggers in making associations between prior knowledge and experience (Cohen and Levinthal, 1990; Zahra and George, 2002).

In short, the prior knowledge help TTMs constitute the cornerstone of university spin-out combinative capability, facilitating communication and relationship building with AEs and industry and helping the technology transfer process and the AC development of university spin-out. The extent to which this prior knowledge can contribute to spin-out AC is further discussed and examined in

Chapter 5. In the next section and the next chapter, this study will explore how these antecedent factors contribute to the role of TTMs and AEs and influence the development of university spin-out.

Table 7 Narratives of Perceptions and Expectations of the AE's Role in the University Spin-out Process

The AE's role in the university spin-out process	AE's perception	TTM's perception
CTO/CSO (*N7*)	*"In the spin-out we have been the technological driving forces of the project, and involved in a lot of the technical development, through the whole commercialisation process, looking at all different technical aspects, meeting contacts from industry to find out their needs and tailoring the development plan to that." (AE4)* *"I have the title of CSO of the company as well as being a member of the board and that means my responsibilities are mainly keeping an eye on the scientific side of things, in terms of the material and the measurement of it. I am also applying for future research and development grants." (AE5)* *"My role has been very much in the development of the product and its use with the user group, whereas my partner did more of the setting up of the spin-out company with the TTM." (AE8)* *"I have worked on some of the aspects of setting up the company in terms of the software license agreement and the services I provide as a CTO, trying to sort things out as best I could." (AE11)*	*"But there is a place for the academics in there, because they often have the knowledge and the research and the science - they understand that so much more than anybody external ever will do." (TTM1)* *"We work with them in regards to their own career aspirations. They provide technical input and creations, and they have a lot of contacts to work with." (TTM3)* *"He really is the lead scientist on it, but he's one of the better academics in that he understands business to a degree. AE5's role mainly was on the scientific side, and he's now realised, I think he would agree with me, that he's not a businessman." (TTM5)* *"Generally, the academics should be thinking about doing nothing more than further technical development of the research output we are looking to commercialise. So explaining the technology, explaining what the technology can do, but also being aware of what further works need to be done to possibly get it toward being a commercialised product. Academics' role should be strictly more technical." (TTM6)* *"Without the academic the companies have no credibility." (TTM10)*
To Discover/Identify the Commercialisation Opportunity (*N8*)	*"We approached the university, I think it was TTM2, and said look we have this idea, who should we talk to? (…) we thought this was commercially interesting." (AE2)* *"We have recently done an exhibition booth in one of the bigger conferences in the area, just to gain more contacts and get more industry opinion on*	*"I've known AE3 for a number of years and he had some interesting inventions and we have had some detailed conversations about how we can market his technologies and then look into plans to develop those ideas further." (TTM3)* *"They tend to come to us, we don't go looking for opportunities as we don't have the resource to do that." (TTM4)* *"I've known AE5 for many years, we first worked with him about five years ago with a completely different technology – AE5 is one of the good ones, in that he can recognise some IP which is valuable, and he will come straight to us with it." (TTM5)*

	what we had to showcase and what the opportunities were." (AE4) *"We went to see a TTO and said we think we have enough to create a spin-out company, and they did market research at the time which concluded it was not the right market, so we didn't do anything. We had to wait three years to restart the process." (AE10)* *"Identify the original opportunity and push that with TTO people. I worked with them in developing the proposition and pitch for the potential CEOs. I did a fair amount of the market analysis. I have worked on identifying what the IP is and who created it." (AE11)*	*"AE6 was already determined and had some very convincing statistics to prove there was a market for this." (TTM6)* *"It was very much AE9 and his colleagues being well aware of the commercial potential of what they have done. They know commercial opportunity and they came to us to discuss it." (TTM9)* *"Mainly AEs come to us but a bit of both. I have been around long enough that I have a good network of people, so some people get referred to me or to our office directly, and it can be at various stages." (TTM10)* *"Usually, 90% of the time, someone contacts you and says I know you and your work or I saw you 2 years ago and we talked about this idea." (TTM11)* *"AE12 did disseminate the potential of his research in this area and we got talking about what could be done commercially." (TTM12)* *"Part of my role is to build relationships with the departments and the academics within those and be a point of contact where they can come to, and they can say, I have got this question, do you think my research has any commercial potential?, or I have a good idea and I would like to pursue this further with you." (TTM13)*
Push the University Spin-out Process Forward / Commitment to UTT Activity (*N9*)	*"All the push really is from me. (…) TTM6 is being very supportive of me. (…) But the actual pushing to make the idea work or trying to make this commercial has all come from me." (AE6)* *"We've applied for all the grants and everything and are taking lead roles in the company so we are doing all the business work. We have done pretty much all of it ourselves. We have done the engagement, markets, but we have had some assistance from the first commercial champions. But for the first year or 18 months it was us by ourselves doing all aspects." (AE7)* *"Basically, somebody's got to make it happen. It is not going to happen by magic. So somebody has to take the initiative to get the thing off the ground. At the moment, that is my role." (AE9)*	*"AE2 and his colleagues were very active which was very good. Like I said earlier, if academics aren't engaged then you can't do it whatever the form." (TTM2)* *"(…) initially it is convincing everybody else it is technically scientifically differentiated and also demonstrating they have the appetite to go on the spin-out journey and [that] they are motivated, and continue demonstrating they are committed." (TTM11)* *"I think it's fundamental really from the point of view that they need to have the drive and desire to do this. I don't feel spin-outs will work very well if the founder isn't actively involved at the very least in taking a technical role in the spin-out. Without that sort of drive you can't get across the inventor's desire or ambition for a company." (TTM12)* *"I don't think you can do a spin-out without the academic being fully engaged, because often spin-outs are based, the business is based, on the fact that the licensing and the technology... but also they want the expertise of the academic there and they want the kudos of having the academic associated with them, and so the academic has to be fully engaged all the time. […] the AE has to be supportive of what is happening." (TTM13)*

An AE's Ability to Pitch Their Idea (*N10*)	*"If people can see what the potential is, then that provides a lot of feedback as to where you should go next. So it is kind of a presentation thing more than anything else. And we did that all independently without the TTO." (AE11)*	*"I've got to say AE5 is a very good salesman; AE5's presentations are fantastic. In many respects when we made presentations to inspectors it was the AEs' responsibility to do it, to convince them, to give them the confidence that the AEs knew what they were saying was right." (TTM5)* *"AEs have to work with TTMs to go and meet with investors and to promote the technology, so they have to put in a lot of time and effort themselves." (TTM13)*
Management Role in the University Spin-out (as CEO, Managing director, etc.) (*N11*)	*"Currently I am managing director so I run the company." (AE2)* *"I will be a director of the company and therefore I am trying to drive the spin-out, to balance my responsibility with operating in a way that gives the company its best chance of succeeding and making some money which will come back into the university. So it is a bit of a tightrope." (AE3)* *"We are taking lead roles in the company so we are doing all the business work (including engagement, markets etc.). For the first year or 18 months it was us by ourselves doing all aspects. We have a business development guy working with us now, and you learn it so much quicker doing it with a business. […] The university claims that the intellectual property is theirs. If they left you to do all that yourself then it would be very difficult for them to claim ownership. […] I think they should be involved from the start right up until the business is spun out and then I think they should take a back seat role. I don't think the university should have any say in the decisions of the business." (AE7)*	*"I think AE7 has unrealistic expectations about the role in the company and when he pitches to investors I think they will say that they don't think he is a CEO. That is my opinion. This is a shame because a leading role in the company does not mean you have to be CEO." (TTM7)* *"AE9 is the custodian of the IP because AE9 thinks he is the owner of it. But actually he isn't, the university is the owner of the IP. Very few academics really take that on board. They always think it's theirs. I can understand, but I don't know what AE9 is doing. (…) If AE9 doesn't get his fingers out, that is not going to be good for the university's IP." (TTM9)*

4.2 The Perceptions and Expectations of the AE and TTM Roles in the University Spin-out Process

In Section 4.1, the study identified the prior related knowledge that allows/motivates TTMs and AEs to become involved with university spin-out. It can be seen that their prior knowledge of university spin-out consists of prior technical or business knowledge, prior industrial or business experience, prior UTT experience, problem solving skills, and some other factors including awareness of expertise within and outside the spin-out, intensity of effort, and activation triggers. In this section, in order to further examine how these antecedent factors contribute to different dimensions of university spin-out AC, this study investigates the role AEs and TTMs play throughout the spin-out process. As mentioned, AEs are mainly responsible for technical development, and for completion with TTM support, while TTMs are focussed on integration and commercialisation aspects of the UTT process (Siegel et al., 2003; Chapple et al., 2005; Lockett et al., 2005; McAdam et al., 2009; McAdam et al., 2010). In this section, the analysis looks closely at TTM and AE perceptions and expectations of each other's roles and duties throughout the university spin-out process, to identify any differences in their understanding of those roles.

4.2.1 The Role of the AE in the University Spin-out Process

Based upon the thirteen cases studied, AE roles and responsibilities in the university spin-out process are considered to be as follows.

Chief Technology Officer/Chief Scientific Officer (CTO/CSO) (N7)

TTMs are firm in the view that the most significant role of AEs in the university spin-out process should be as a CTO or CSO, to handle the technical aspects of UTT by providing all the related technical support, including: innovation; improvement; adjustment; making technology commercially ready, market ready, and investment ready; and problem solving (DTI, 2003; Fontana et al., 2005; Lockett, 2006; Kitson et al., 2009). The analysis shows that, since the AEs are

the experts in their scientific and technological fields (*N1*) and – based on some of their previous industrial, industrial collaboration, or UTT experience (*N2* & *N3*) – they will not fail and are confident that they will fulfil their most important duty with regard to their role and responsibilities within the university spin-out process. This role is the foundation of university spin-out (McAdam et al., 2010). As TTM10 said, “Without the academic the companies have no credibility.”

To Discover/Identify the Commercialisation Opportunity (N8)

In this study, it was usually the AEs who first recognised the exploitation potential in their technologies, who wanted them to be patented, who made the first move by approaching the TTMs, and had sometimes identified the initial market for their idea. Six AEs discovered the commercialisation potential because there were obvious needs in the market (signified by industry observation and grants/awards they had received), two AEs spotted the market and potential while attending conferences/exhibitions, and four AEs identified the opportunity based on previous university spin-out or industrial/business experience. This is consistent with research by Lockett et al. (2005), whose findings showed that opportunity is mainly discovered by academics and/or TTMs but that academics are often relied upon to identify the potential for university spin-out. It cannot be denied that AEs are much more familiar with the technology. The analysis indicates that, together with their prior knowledge and industrial experience (*N1 & N2*, as discussed in Section 4.1), although they may have little or no commercial awareness or UTT experience (*N1 & N3*), they are better placed than TTMs to accurately and efficiently discover the commercial potential and opportunity of their idea (McAdam et al., 2010).

The majority of TTMs admitted that AEs usually take the initiative, approach them, present their ideas, which may have commercial potential, and ask for assistance with seeking possible UTT routes. However, TTMs also stressed that in many cases they already knew the AEs and had worked with them on UTT activities before. Although some TTMs (such as TTM3, TTM5 and TTM13) considered that AEs were the first to discover the commercialisation opportunity, in actual fact it is often a collaboration between TTMs and AEs that identifies the commercialisation opportunity because it is based on the relationship they build

up with AEs or the department; TTMs encourage AEs to disclose their research results, sometimes over a period of years. AEs who had previous UTT experience confirmed that they had discussed the opportunities with TTMs over some years, then finally identified the potential and decided to make the move towards spin-out. The analysis shows that the established personal relationships/networks (*N4*) of TTMs and AEs could contribute to the AE role in discovering the commercialisation opportunity of the research output.

Push the University Spin-out Process Forward/Commitment to UTT Activity (N9)

Almost all of the AEs emphasised that they considered their role in spin-out to be the key not just to identifying the commercial opportunity of their research output, but also to pushing the whole process forward. AE6 says, “All the push really is from me. (…) TTM6 is being very supportive of me. (…) But the actual pushing to make the idea work or trying to make this commercial has all come from me.”

Some AEs felt that the TTMs failed to help the university spin-out process move forward and they were doing all of the pushing themselves. AE11 did not believe he received enough help from the TTMs saying, “they should (…) represent the university’s interest in pushing the spin-out forward. And I think they did not do a particularly good job of either.” He thought that they may have been too overloaded with other work to assist with spin-out. In defence of the TTM, TTM11 thought that AEs might not be aware that it takes time to progress commercialisation through the university system. TTM9 also argues that there could be significant delays when AEs do not report the process of developing and improving the technology, or they simply lose contact. TTMs cannot rashly pursue a course of action whilst many uncertainties remain. However, TTM6 admitted, “I feel guilty because AE6 is busy doing his research and he is doing a lot of development work. But really it needs more TTM time to push that. That is a big frustration with the TTO here because you know the technology could get somewhere, but you are worried that it won’t because you don’t get enough time to devote to it.” AE6 commented: “this is the weakness of this system because all the push comes from the academics. (…) It’s [the TTMs’] job to nurture and

develop them", but he also realised, "I can get some help from TTM6, but his day job isn't to run a company for me or to set a company up for me."

However, there are still some AEs (e.g. AE1 and AE5) who recognise that they would be unable to move the spin-out process forward without the support of their TTM, especially with regard to pulling the university spin-out process together (which is considered to be one of the TTM's responsibilities and will be discussed further under *N13*). AE1 said: "I think TTM1 has made a great contribution to the company moving forward. If it hadn't been for the TTM we would never have thought of moving forward. We are completely reliant upon him." TTD4 stressed: "I think usually we drive it more than they do; if we decide, 'this is what we're going to do', we move things along. They are keen to do the technical side of it, they are usually not so keen to do the commercial side of it."

TTMs also consider that an AE's efforts with regard to pushing the whole process forward are indicative of commitment to university spin-out. As TTM11 said, they want to see AEs "demonstrating they have the appetite to go on the spin-out journey and [that] they are motivated, and continue demonstrating they are committed". TTDs agreed with this; TTD4 said, "If the academic doesn't want to do it, there is no point. If the academic says 'this is what I want to do' then we'll take a view". It can be seen that TTDs/TTMs look at an AE's level of commitment to the spin-out process from the outset; where this is low, they consider that success is unlikely and investment will be difficult to obtain (Lockett et al., 2005: 984). This also brings us back to the issues above, where AEs complained that TTMs were too busy to push the spin-out forward. Maybe AEs simply want to make sure that TTMs are as committed to the process as they are, and vice versa.

It appears that an AE's personal competences, such as positive attitude and active participation (*N5* & *N6*), in university spin-out can help shape commitment to pushing the process forward and possibly influence its success. The intensity of effort and activation triggers of AEs are proven to contribute to the AC as a whole. AEs and TTMs hold different opinions on whether TTMs support them in pushing the process forward and also on whether the support that TTMs provide is good. The study will look into this further in the next section and chapter to establish whether there is a difference in the perception of the TTM's role or

whether problems arise when they collaborate with each other in the university spin-out process.

The Ability of AEs to Pitch Ideas (N10)

It is crucial that AEs are able to demonstrate to people (such as TTMs and venture capitalists) that their idea is technically and commercially feasible without using technical language, and also that they show their commitment to participation in the complex UTT process. TTM11 argues that, “the role of academics in the process of university spin-out, initially, is convincing everybody else it is technically scientifically differentiated and also demonstrating they have the appetite to go on the spin-out journey and they are motivated”. This can be a great barrier for AEs, who are capable, and keen to show how innovative their technology is, but lack business/commercial related knowledge/experience, whilst everyone else (especially investors) wants to know about its commercial potential and how it can be commercially applied.

In some cases AEs and TTMs are aware of the importance of the AE’s ability to demonstrate that their idea is unique and commercially viable when attracting investors. With related business knowledge/experience and prior UTT experience (*N1*, *N2* & *N3*), although TTMs should be able to complement and help AEs to present the idea in a business-like way, free of complicated technical terms, AEs are depended upon to make a significant effort to simplify the idea and highlight its potential to attract investors. AE11 believed that previous industrial, UTT, or pitching experience (*N2* & *N3*) was definitely helpful and that he had developed this ability without the TTM’s help. However, AEs have generally had limited opportunity to establish such an ability due to a lack of related knowledge and experience and will need support from TTMs.

Management Role in the University Spin-out (as CEO, Managing director, etc.) (N11)

Since AEs often consider that they initially identified the commercial opportunity for themselves and are fully committed to pushing the whole process forward, some of them argue that they should hold the majority of the shares in the spin-

out and maybe also become CEO or managing director of the company (e.g. AE7). TTMs accept this where AEs have previous business or university spin-out experience, but still suggest that professional people should also be involved. In these university spin-out cases, a few AEs express strong intentions to take over the managing role (AE2 was already the managing director, AE3, AE7 and AE9 expected to be in the near future. Only AE3 and AE9 had prior university spin-out founding experience).

Earlier studies have mentioned that university spin-out creation may be more efficient if TTMs help appoint surrogate (external) entrepreneurs (Franklin et al., 2001) or more experienced academic (habitual) entrepreneurs (Wright et al., 2004; Mosey and Wright, 2007) as advisors or to take the leading role at an early stage, because they can provide the business/commercial knowledge and skills that both AEs and TTMs lack (McAdam et al., 2009; McAdam et al., 2010). In the cases in this study, none of the AEs had such knowledge or skills (see *N1*). Although AE3 and AE9 had previously started up university spin-outs (*N3*), it did not necessarily mean that they had all of the business/commercial knowledge and skills needed to support the new spin-outs.

TTM7 and TTM9 pointed out that the reason some AEs want to assume the managerial role of a spin-out may be to fight for ownership of the IP and the shareholding of the spin-out. TTM9 mentioned, “the university is the owner of the IP. Very few academics really take that on board. They always think it’s theirs.” AE7 said, “The university claims that the IP is theirs. If they left you to do all that yourself then it would be very difficult for them to claim ownership.” AE7 had a number of reasons why he wanted to be CEO. First, he was involved in the business development of the spin-out from the very beginning. Although there was a business development professional involved in the later stages, he claimed that his early involvement helped him to learn more quickly when he ran the business. Second, AE7 was expecting to formally spin-out the company within a month of the interview and felt that the university should only be involved until the company was spun out. At that point, he believed, the university should withdraw and not have any say in the decisions made by the business. Third, AE7 was also negotiating the shareholding of the spin-out with the university and was expecting 50% of the total shares. TTM7 sensed that AE7 was ambitious and determined to be CEO of the spin-out, but said: “I think AE7 has unrealistic expectations about

the role in the company and when he pitches to investors I think they will say that they don't think he is a CEO. That is my opinion. This is a shame because a leading role in the company does not mean you have to be CEO." Although only four of the thirteen cases in this study addressed this problem, these cases show this problem lead to the delay of the process and causes the tension between AEs, TTMs, and the university. TTM3 stressed: "They need to understand that the university needs to take a lead role in this for them. It's a support role but they don't always recognise that." This can lead to many legal problems in university spin-out formation and delay the process significantly.

Summary

Both AEs and TTMs agree on the roles AEs should play in a university spin-out, including acting as the CTO/CSO who assists with the technical development, discovering and identifying the commercial potential of their idea and then committing and pushing the spin-out forward, even though they have slightly different perceptions. These roles ensure that AEs build up a solid foundation for the spin-out by releasing the commercial potential of research, codifying important tacit knowledge, solving specific problems which may occur, and then handling the whole process of knowledge transfer (DTI, 2003; Fontana et al., 2005; Lockett, 2006; Kitson et al., 2009; McAdam et al., 2010). The discussion above has shown how the antecedent factors help and allow AEs to assume these roles in the university spin-out process, and also make a contribution to both the PAC and RAC of the spin-out.

TTMs do not have any expectations regarding the AE's role in university spin-out, other than those already discussed by the study (DTI, 2003; Fontana et al., 2005; Lockett et al., 2005; Lockett, 2006; Kitson et al., 2009; McAdam et al., 2010), but many AEs do have an extra perception and expectation, which is that they should serve another vital role, other than CTO/CSO, in the university spin-out – namely, that of CEO or managing director (indeed, some have already taken up this position and some expect to do so). TTMs, however, do not support this because they suggest that most AEs do not have prior experience in this area, and even where they do, it is still better to leave the task to the business/management

professionals. The tension is especially evident in the final stage of spin-out, during formation and shareholding discussions. It can delay the process and have a negative impact on the spin-out RAC.

Table 8 The Perceptions and Expectations of the TTM's Role in the University Spin-out Process

The TTM's role in the university spin-out process	TTM's perception	AE's perception	AE's expectation
Facilitating the University Spin-out Process (*N12*)	• *Provide AEs with information, advice and support* • *Arranging meetings with/for AEs* • *Provide AEs with choices on decision making* • *Guide AEs in the right direction* • *Let AEs know what needs to be done to make their idea commercially ready, market ready, and investment ready for the university spin-out* • *Ensure evaluation/due-diligence is completed* • *Assist with patenting* • *Commercial or business guidance (including developing the business and marketing plan)* • *Assist AEs with searching for funds and raising and reaching an investment decision* • *Provide legal document services (e.g. contracts)* • *Discuss with the AEs and negotiate with them how the process is going to work*	• *Provide AEs with information, advice and support* • *Arranging meetings with/for AEs* • *Provide AEs with choices on decision making* • *Guide AEs down the right path* • *Let AEs know what needs to be done to make their idea commercially ready, market ready, and investment ready for the university spin-out* • *Ensure evaluation/due-diligence is completed* • *Assist with patenting* • *Commercial or business guidance (including writing the business and marketing plan)* • *Assist AEs with searching for funds and reaching an investment decision* • *Provide legal document services (e.g. contracts)* • *TTMs should have up-to-date experience when needed and be able to assemble a viable team of people*	• *Communicate with the AEs* • *Some expectations were low (because AEs did not fully understand what TTMs do)* • *Some expectations were high and TTMs were mostly met were met by most TTMs*

Co-ordinating and Pulling the University Spin-out Process Together (*N13*)	• *Making introductions and liaising to establish the necessary contacts for AEs, such as lawyers and senior management of the university* • *Central co-ordinator (put together the plan of approach and decide whether or not it is suitable for a university spin-out)* • *Working with AEs to make the university spin-out happen and drive it forward* • *Hold it all together and move it forward*	• *Find the right relationship with the university for AEs* • *Advising and directing and putting AEs in contact with people* • *Working with AEs to make the university spin-out happen and drive it forward*	
Encouraging AEs to disclose their innovations / Clarifying the commercialisation opportunity (*N14*)	• *Encourage AEs to apply for research grants and then create university spin-outs* • *Encouraging disclosures* • *Identify commercial opportunities* • *Start working with AEs and then identify whether the opportunity is viable*	• *Provide AEs with useful information at the early stages and then assist with identifying whether the opportunity is there and viable*	• *TTMs should be more proactive with regard to spotting commercial ideas from AEs/departments and then nurture them, so academics do not have to do all the pushing* • *TTMs should create the relationship with AEs earlier* • *Many projects do not develop because academics are not aware of the potential or are not motivated*
Making sure every process follows the university's procedures (*N15*)	• *Manage the process on the university's behalf* • *Go through the necessary university procedures with AEs* • *Ensure the legal documents are in place* • *Reassure the university that they are guiding AEs and university spin-out down the right path* • *Look after the university's interests*	• *Manage the process on the university's behalf* • *Go through the necessary university procedures with AEs* • *Reassure the university that they are guiding AEs and university spin-outs down the right path* • *Ensure the legal documents are in place*	• *TTMs should be involved from the start, right up until the business is spun out, and then they should take a back seat role* • *The university should not have any say in the decisions of the business*

	• *Making sure AEs are not giving the university's IP away because at the end of the day it belongs to the university*		
Be encouraging and supportive / Managing AEs' expectations (*N16*)	• *Be encouraging, supportive, and reassuring* • *Boost AEs' confidence* • *Keep track of what AEs are doing* • *Support AEs in achieving their aims*	• *Be encouraging, supportive, and reassuring* • *Boost AEs' confidence* • *Keep track of what AEs are doing* • *Support AEs in achieving their aims* • *Encourage AEs to move forward* • *Be flexible and listen to AEs' concerns* • *It is important for TTMs to spend time establishing trust between AEs and themselves* • *Be enthusiastic*	• *TTMs should put useful and helpful input into the university spin-out*

Table 9 Narratives of Perceptions and Expectations of the TTM's Role in the University Spin-out Process

The TTM's role in the university spin-out process	TTM's perception	AE's perception	AE's expectation
Facilitating the university spin-out process (*N12*)	*"(…) with AEs in a kind of, say, what needs to be done, what needs to be put in place, whose advice do we need, what funding do we need, and where are we going to get that advice and funding?" (TTM1)* *"Specifically, it's management from the university side, to provide support to the academic staff. They provide the technical input then it's the TTM's role to manage the process, ensure due-diligence is completed and to assist to find funding where necessary." (TTM3)* *"Business Development. (…) Commercial guidance. (…) Guiding the academics down the right path." (TTM4)* *"In the main it's to commercialise IP which comes out of the university which means working with disclosures, assessing them working with the IP protection, (…) and also managing the spin-out process when we do it. And I'll discuss with the academics and negotiate with them how it's going to work, and formulate a plan with them if we're going to approach an investor." (TTM5)* *"Facilitation and signposting. There is a journey you get to go on. The first thing in the journey is due-diligence. (…) Then is the market. (…) And then, it starts to build up the case for going for investment." (TTM6)*	*"I get the impression they are very small, so what they can do is limited. (…) they have been very helpful in finding monetary support through the university to encourage us to move forward. They helped generate some funding to enable us to do some work, to put in patent applications that we would need to have in place for the company to work." (AE1)* *"If I have something I think is patentable I expect them to help me in the process of deciding whether it is really patentable. Then providing the funding that supports the patent, putting it in place and maintaining it. That is what our TTO is set up to do at the minute." (AE3)* *"Extremely useful. We wouldn't have got to where we are now without TTMs - we wouldn't have come close. It has been very useful. They have guided us throughout the process and added a lot of important advice and information." (AE4)* *"TTM6 is always arranging meetings and helps us to find additional funding for some development work. So he's been extremely helpful." (AE6)* *"TTM7 is really strong on the patenting side of things and we get a lot of good advice from*	*"They need to understand what creating a spin-out activity is all about and be able to communicate to people like me who wish to do it." (AE1)* *"What I would like them to do is to provide me with proper commercial support so that I don't have to go out and visit lots of companies to try to sell the science, and that is what has been missing within our TTO. We actually have a lot of people employed in different departments that are meant to be doing that process. So far that has not been very effective, but there is nobody centrally doing it." (AE3)* *"The expectation I suppose was quite low because I didn't really know what they did. But actually from having a chat it became apparent what expertise and knowledge they had and how this could help to push our technology forward, so in that respect it was useful." (AE4)* *"I was expecting them to have a lot of knowledge that I don't have about things like contracts and investment agreements and negotiations and also*

	"I was involved at an early stage because we needed to give the academics some support and I was the best person to give them that support." (TTM8) *"I have to work closely with the academics. We won't force them, but if they want to use the services we offer, we will work proactively with them to improve their bid." (TTM9)* *"I would say it's to get ready for the spin-out, get the investment decision, and then legally spin-out the company." (TTM11)* *"Depending on if we're going to support it we do have people we use occasionally who will help in terms of things like business mentoring, and equity based financing which can help get the whole package together." (TTM12)* *"My role is to sort of completely manage the process, so I manage all the patents on the IP side of things. On spin-out processes I would develop a business plan, find a CEO and start building a spin-out team... to work with the spin-out team to raise investments. (…) negotiating agreements with the investors, working to license the IP from the TTO into the new spin-out company, finding lawyers to represent the new company, managing the relationships between the academics and their department." (TTM13)*	*TTM7. I think we would have liked TTM7 to be more heavily involved because we recognised we needed a lot of help." (AE7)* *"I would have thought TTM8 was key for getting everything set up, because we certainly didn't have that business knowledge; we were dependent upon TTM8 and whoever was in that role guiding us through the process. So I think his role was crucial." (AE8)* *"Firstly they were involved in the first step of the evaluation and putting us in contact, supporting the project. Then their knowledge of IP was essential because they had a portfolio of patents and knew what would be good for the company or not, and they helped with the whole IP package which was crucial at this stage as the value of the company was based on that." (AE10)* *"At the later stages, they provided support on some of the detailed aspects of the process like supporting the founders involved in the association, investment, and other legal document services etc. (…) I think much comes down to the TTO not always having people with up-to-date experience when needed or being able to assemble a viable team of people. I think there are cases where they really should have done a better job." (AE11)*	*dealing with IP. I didn't have any experience of that so my hope was that the TTO would know exactly what to do, what negotiation position to take and also what I should be expected to have as an academic. (…) They knew a lot of those things, but not all of them. My expectations were quite high and they were mostly met but I think I didn't have a problem with that as I enjoyed learning together with them." (AE5)* *"They would help with all the business aspects of it we don't have any experience of, and all the stages you have to go through to get set up because we were academics and had no experience of that end of things really." (AE8)* *"I think the TTM's role should be trying to help in the process of doing the commercialisation. So you expect them to supply advice and sometimes write a business plan; in terms of advice and finding the potential funding; help in terms of making contracts with people who might be interested in technology. So in a way, something like a business development manager. But for a company, it doesn't exist. So initially, you've got to get the ball rolling in a way. You also need a way to get a second opinion as you go along. So I think the role of the TTO is to put a sanity check on the plans of the start-up companies. Also to provide funds because without the patent you can't generally set up a company." (AE9)*

			"It is more about how this business can be efficiently formed and at what stage the spin-out should work, and also from the university, what they want from it and how we can exploit the university and the support." (AE12)
Co-ordinating and pulling the university spin-out process together (*N13*)	*"Appreciating all of the relationships along the way has been a big part of it." (TTM4)* *"I tend to be the central co-ordinator, and, in terms of what I do, we'll put together the plan of approach, and I'll decide whether or not it's suitable for a spin-out. (…) Although more people came on-board, I was sort of driving it forwards, working particularly with AE5 to make it happen. So it wasn't the academic, to a degree, who drove it in the early stages: I became the focal point because − you've got an academic there, you've got external academics, senior management here, you've got an investor over there − the only person that acts as a point of contact for all of these was me." (TTM5)* *"I am the person doing most of the making it happen, so I liaise with the lawyers, academics, the senior management of the university to get permission, all of that." (TTM7)* *"I think it's really making the introduction in the initial consultations, agreeing this was a route he wanted to go down." (TTM12)* *"I guess I am sort of the technology transfer manager who holds it all together and moves it forward." (TTM13)*	*"I think TTM1 has made a great contribution to the company moving forward. If it hadn't been for the TTM we would never have thought of moving forward. We are completely reliant upon him." (AE1)* *"TTM3 is there as a catalyst to help the company find the right relationship with the university." (AE3)* *"TTM5 also gathered a lot of intelligence on the people who were investing: who they were, what their background was, what previous deals they had done. (…)It couldn't have happened without somebody like TTM5 doing all that stuff and chasing up things behind the scenes." (AE5)* *"TTM6's role is much more advising and directing and putting us in contact with people." (AE6)*	

Encouraging AEs to Disclose Their Innovations / Clarifying the Commercialisation Opportunity (*N14*)	*"It's either me going out to the academics to see what their research is and whether there's any IP that could be commercialised or exploited, or it's them coming to me with a technology or idea they feel it's worth pursuing, and so I do workshops to sort of raise awareness around IP translatable research. (…) our job is that: going out, speaking to the academics, finding out what their research is about. (…) it may be years down the line when they actually develop something, but it's all about that awareness-raising relationship building from day one." (TTM1)* *"We do go out occasionally, but not that frequently, for two reasons: one, capacity − we have limited resources to do that too frequently; and secondly − I wouldn't want to do it too often because the academic reaction would possibly be negative if we asked them too frequently." (TTM2)* *"I've known AE3 for a number of years and he had some interesting inventions and we had some detailed conversations about how we could market his technologies and then look into plans to develop those ideas further." (TTM3)* *"Mainly they come to us but a bit of both. I have been around long enough that I have a good network of people. (…) In fact my role goes right from the early point of early stage identification and commercial opportunity, and putting in place the IP protection." (TTM10)* *"AEs need to make a formal declaration and disclosure of the invention information. And then, I would say I need due-diligence to clarify whether there is a commercial opportunity there." (TTM11)*	*"TTM1 said, why don't you apply for this grant to help you move this forward?, and that's what we did. (…) at some point when TTM1 said we should create a spin-out company, we went along with it." (AE1)* *"I think in the early stages they helped provide useful information on what we needed to look at so that we had a viable opportunity." (AE11)*	*"But I think this is the weakness of this system because all the push comes from the academics. In some ways, it would be nice if the TTM acted more like a talent scout. But I wonder if the university has a similar system where somebody goes to the department and spots commercial ideas and then nurtures them. It's their job to nurture and develop them. So academics don't have to do all the pushing." (AE6)* *"What they could have done earlier was to create this relationship. (…) A lot of projects don't develop because academics are not aware of it or not motivated." (AE10)*

Making Sure Every Process Follows the University's Procedures (*N15*)	*"It was my role to give the reassurance of the university that this was the right thing to do and we had gone through the right process and it was going to be successful." (TTM2)* *"My role is to bring university strategy to bear and ensuring we follow the correct process, ensuring the legal documents are in place and they provide me with the technical information I need, and we work together to write briefing documents and proposals." (TTM3)* *"Making sure AEs are not giving the university's IP away because at the end of the day it is the university's IP." (TTM6)* *"My role tends to be more looking after the university's interest and also trying to help them find the smoothest way through the necessary procedures AEs have to go through." (TTM12)*	*"I approach TTM2 and he knows what to do, who to point and direct me to, and there is a procedure which doesn't depend on inefficient university committees, if you like, outside of that university structure that can make decisions as to whether or not to invest." (AE2)* *"TTM3 has assisted by making the process within the university straightforward at the minute." (AE3)* *"It is more about him leading activities to go through the university process to support me and set up a spin-out company." (AE12)*	*"I think they should be involved from the start right up until the business is spun out and then I think they should take a back seat role. I don't think the university should have any say in the decisions of the business. I think they can override things which require a majority shareholder vote, which is standard agreement, but they don't have any control in the company or any voting rights really on the board of directors. I think that is the way it should be." (AE7)*
Be Encouraging and Supportive / Managing AEs' Expectations (*N16*)	*"I think well, hopefully I was supportive and boosted their confidence and was reassuring. They want to continue being an academic with company involvement on the side, and then your role is giving them enough confidence, so that is an appropriate thing to do." (TTM2)* *"(…) hold their hands through the process to the creation of the company." (TTM3)* *"The TTM is there to help and encourage academics. The academics are our customers. That is the way I look at it. But other people look at it where we are there to please the academics or to keep track of what they are doing. (…) I understand the process might just be to get going, and explaining to the academics, and also managing their expectations." (TTM6)* *"We stand in a supportive role to the AEs in achieving their aims." (TTM12)*	*"TTMs sit with us, laugh with us, and encourage us. (…) The TTM's role has been to encourage us to move forward. The TTO have some good people and they work hard and they are very encouraging." (AE1)* *"It was also good because the TTM listened to our concerns. The TTM didn't just have his agenda but was flexible and realised we had concerns that needed to be addressed.As I said earlier, there was a period of us needing to build up some trust and I think he was very important in establishing that trust. He offered us advice, he listened and he was supportive, he thought it was a good idea and that is the most important thing." (AE2)* *"TTM6 is also very enthusiastic and encouraging. Always saying yes. It is enormously helpful to have somebody have confidence in what you are trying to do." (AE6)*	*"In terms of managing the process and trying to encourage us to do it, yes they are definitely doing that, but in terms of putting useful and helpful input into it, so far not a lot." (AE9)*

4.2.2 The TTM's Role in the University Spin-out Process

Based on the perceptions and expectations of AEs and TTMs in the thirteen cases, the roles and responsibilities of the TTM in the university spin-out process are expected to be as follows.

Facilitating the University Spin-out Process (N12)

TTMs consider facilitating the commercialisation of UTT to be a key task of their job which includes, amongst other things:

1) Providing AEs with information, advice and support
2) Arranging meetings with/for AEs
3) Providing AEs with decision making choices
4) Guiding AEs in the right direction
5) Letting AEs know what needs to be done to make their idea commercially ready, market ready, and investment ready
6) Ensuring evaluation/due-diligence is completed
7) Assisting with patenting
8) Providing commercial or business guidance (including development of business and marketing plans)
9) Helping AEs to search for funds and make investment decisions
10) Providing legal document services (e.g. contracts)
11) Talking with the AEs and negotiating with them about how the process will work

AEs are highly reliant on this because, as mentioned, they rarely have commercial/business or spin-out knowledge/experience (N1, N2 & N3). As previous research has indicated, they expect TTMs to take over the commercial side of a development, and to fill the knowledge gaps − the parts where they lack prior knowledge or experience (Lockett et al., 2005; McAdam et al., 2009; McAdam et al., 2010). Therefore, they expect to seek assistance from the TTMs. From the data, AEs do recognise the TTM's role in facilitating university spin-out and have the same perception as TTMs about their role especially with regard to the areas of knowledge and experience which AEs lack.

Among these university spin-out facilitation tasks, it is especially important to help the AEs to prepare their research output for commercialisation, the market, and investment, since this assists them to fulfil their role in the process. An AE's ability to pitch their idea has been identified as a part of their role (*N10*). AE6 believes that TTMs occupy an important position and are able to help AEs identify the problems, first, with two questions − "Is the idea commercially viable?" and "Is the idea technically viable?" − and second, by setting out to solve those problems. TTM9 says, "What I desire is that they keep the technical details to a minimum. What we should be all focusing on really is that what they are doing is commercially significant and what the technical risks are." This is the way in which TTMs can provide the best assistance and advice in making technology commercially, market, and investment ready. Failure to do so could delay the spin-out process, especially the exploitation stage (RAC).

Every AR had very different expectations of their TTM. The expectations of some AEs were low because they did not know what the TTO did and their knowledge or experience of TTMs was thus in short supply; they gradually discovered what they could do for them as they worked together through the process. Some AEs appeared to have higher expectations and held very different opinions on whether they had been met by TTMs. AE5 admitted that his expectations were high from the outset, and commented that, although the TTMs had not known everything, his requirements were mostly met. Some AEs, however, felt that although their TTMs were helpful and met their expectations, they were limited in what they could do. As AE1 said, "I get the impression they are very small, so what they can do is limited." AEs in other research pointed out that TTM expertise and experience are restricted by the small size of their teams, which means that it is impossible for them to possess the skills needed to cope with an entire university (McAdam et al., 2009). The analysis in this research also made it clear that it is almost impossible for a TTM to possess the knowledge required to focus on a particular spin-out, since the area of interest is typically narrow and advanced.

For a number of reasons, some AEs (such as AE11 and AE12) did not think that TTMs were doing a good job. AE11 said that TTMs "really have little involvement (...), besides occasional suggestions, advice, or setting up the contacts, like people to talk to". He also doubted whether TTM11 had the up-to-date experience to provide the support he needed. Looking back at Table 5, however, TTM11 had

all the prior knowledge required, including both a technical and a business background and industrial and business experience, he had incorporated two spin-outs, and was highly motivated to create another and even to work for the spin-out afterwards, yet he still lacked credibility in the eyes of AE11. AE12 did not think he had received much business/commercial support when developing his spin-out. He said, “from my experience they haven’t really taken part as an active stakeholder (…). So it has kind of diminished its role instead of being a really core member in the business.” This is repeatedly mentioned in other empirical research, and is considered to have a crucial and deleterious effect on UTT effectiveness and TTO productivity (e.g. Siegel et al., 2004; McAdam et al., 2009).

Co-ordinating and Bringing the University Spin-out Process Together (N13)

Other than facilitating the university spin-out, TTMs and AEs both considered it important that TTMs should work as the central co-ordinators, liaising with and making introductions between those involved throughout the whole process − including AEs, the senior management team of the university, lawyers, investors etc. − and demonstrating great ability to advise, direct and put AEs in contact with the right people. TTMs consider this role to be very important in the university spin-out process, especially in the early stages, where TTM7 emphasised that he was “the person doing most of the making it happen”.

This role of the TTM relies significantly on the TTM’s previous UTT experience (*N3*) and personal relationships/social networks (*N4*). Meanwhile, as Siegel et al. (2004) suggested, this could facilitate relationship building and effective communication with all UTT stakeholders and could also help TTMs to develop skills in their boundary spanning role of connecting AEs with all the necessary contacts, within and outside the university, throughout the spin-out process.

As noted, most AEs believe they play a key role in driving the university spin-out forward, and TTMs also consider themselves to be key in holding everything together and moving things forward. As TTM5 described, “Although more people came on-board, I was sort of driving it forwards, working particularly with AE5 to

make it happen. So it wasn't the academic, to a degree, who drove it in the early stages: I became the focal point because − you've got an academic there, you've got external academics, senior management here, you've got an investor over there − the only person that acts as a point of contact for all of these was me."

Encouraging AEs to Disclose Innovations/Confirming the Commercialisation Opportunity (N14)

From the perspective of the TTMs in this study, they do encourage AEs to disclose their research output. As mentioned in Section 4.1, some TTMs and AEs establish a relationship before the AE becomes interested in UTT, and this can be of benefit to, or can trigger, the AE's involvement in discovering the commercial potential of their research output. When AEs discover the commercial potential of their own research output and then approach the TTO, it is the TTM's responsibility, by arranging due-diligence (undertaken by professionals), to evaluate the opportunity and confirm that it is technically feasible and commercially viable.

As TTM10 mentioned, "Mainly they come to us but a bit of both. I have been around long enough that I have a good network of people." In over half of the cases, AEs and TTMs had known or talked to each other before the commercialisation opportunity was identified. TTM3 described his relationship with AE3 as follows: "I've known AE3 for a number of years and he had some interesting inventions and we had some detailed conversations about how we could market his technologies and then look into plans to develop those ideas further." The interviews show that TTMs could encourage innovation disclosure by building up relationships with AEs. TTM1 stressed, "it's all about that awareness-raising relationship building from day one", and also mentioned that he held workshops/seminars to raise such awareness.

Some AEs agreed that their TTMs had supported and encouraged them to disclose their research output once they were a part of the UTT process. However, they felt that TTMs were not sufficiently proactive in encouraging and spotting commercial ideas from academics/departments, especially those of AEs who had not thus far been involved in UTT. AE9, who already had university spin-out

experience, said: “quite a few of my colleagues come to me and say ‘we are interested in setting up a company’. And ‘how would you do it and what would we need to do?’ They don’t really have the time to take the business training. One thing that could be done is most people here don’t even have a clue what a TTO does or who the people are and what actually they are doing. So really they should have the educational role of helping people to do this.” Some TTMs, however, offered reasons for their lack of proactivity. As TTM2 claimed, “We do go out occasionally, but not that frequently, for two reasons: one, capacity − we have limited resources to do that too frequently; and secondly − I wouldn’t want to do it too often because the academic reaction would possibly be negative if we asked them too frequently.” Time constraints and their multiple roles and duties in UTT mean that TTMs, as a priority, tend to deal first with those AEs who have already approached them.

Other than building up awareness or relationships to encourage innovation disclosure, TTMs agreed that assisting AEs to confirm the commercial opportunity for, and potential of, academic research output would seem to be their main mission. Siegel et al. (2003) state that once the invention has been disclosed, the TTM evaluates the commercial potential and decides whether it can be patented. AEs involved in this study had primarily discovered for themselves that there might be commercial opportunity and potential for their research output. They then went to the TTMs to confirm that this was the case. When TTMs are first alerted to the commercial potential of a piece of research, they measure that potential through official due-diligence to confirm that commercialisation of the research output is technically feasible. TTM11 explained that, “AEs need to make a formal declaration and disclosure of the invention information. And then, I would say I need due-diligence to clarify whether there is a commercial opportunity there.”

Previous research had also emphasised the importance of TTMs working closely with AEs and departments, a.) to practically identify commercial potential (Wright et al., 2004), or b.) to raise awareness of, and consequently participation in, UTT through promotional sessions held by TTMs/TTOs (McAdam et al., 2010). Previous UTT experience (*N3*) and establishment of personal relationships/networks (*N4*) between AEs and TTMs, prior to the AE’s involvement with UTT, are again seen to be important in this respect. The cases

show that relationship building between TTMs and AEs can be initiated and can significantly affect a spin-out from the very early stages, when encouraging invention disclosure (before commercial potential has been discovered or identified). The relationship building between TTMs and AEs will be discussed in more detail in Chapter 5.

Following University Procedures (N15)

Once AEs decide to disclose their research output, there is no doubt that they will turn directly to a TTM to have it protected or patented. TTM6 emphasised that TTMs have to make "sure AEs are not giving the university's IP away because at the end of the day it is the university's IP". This is especially important as some AEs develop a belief that they should have more control over the process, and that this can perhaps be achieved by their becoming CEO/managing director (*N11*). TTMs (such as TTM6, TTM7 and TTM9) considered that they had a duty to keep reminding their AEs that the university was still one of the owners of the IP.

TTMs need to follow university strategy while developing university spin-outs. TTMs have to manage the process on the university's behalf, go through the necessary university procedures with AEs, ensure the necessary legal documents are in place, and finally reassure the university that they are guiding AEs and university spin-out in the right direction. AE3 agreed that, "TTM3 has assisted by making the process within the university straightforward at the minute". However, the bureaucracy and inflexibility of university procedure has been identified as a barrier to UTT by AEs in other research (Siegel et al., 2004), as well as in this study. AE12 acknowledged TTM12's role in helping him to form a university spin-out in accordance with university procedure, but felt he had received no support other than this (especially with regard to business/commercial aspects). TTM12's opinion of his role is consistent with that of AE12. He said: the TTO "do have people occasionally help in terms of things like business mentoring, equity based financing which can help get the whole package together. (…) My role tends to be more looking after the university's interest and also trying to help them find the smoothest way through the necessary procedures." AEs in research carried out by Siegel et al. (2004: 133)

noted, “these procedures are cumbersome and often not clearly specified”, and some AEs in this study (e.g. AE9 and AE11) also agreed that the university procedures had taken too long and delayed the university spin-out process.

The majority of AEs acknowledged the role of the TTM in developing university spin-outs in accordance with university procedure. In the cases of TTM3 and TTM12, for example, even though they had no prior spin-out experience, their AEs were still satisfied with their assistance. However, although TTM11 had assisted with the incorporation of two university spin-outs (one completed very recently), AE11 still had doubts about his experience and ability to fill the role properly and felt that the spin-out related information he provided was not up-to-date. It is interesting that a TTM’s prior UTT experience (*N3*) does not seem to have a direct impact on their performance in the role in some cases, whilst failure in the role could lead to delay in the spin-out process. Furthermore, only around half of the TTMs interviewed had successfully previously incorporated university spin-outs. As TTD8 claimed, “There are too few TTMs that have experience of multiple spin-out companies. And therefore, they really don’t develop the company as effectively as a commercially experienced manager would.” TTD8 also pointed out that the TTM role should not only be to ensure that university strategy is followed when establishing university spin-outs; first and foremost, they should facilitate the process by adding value through their knowledge and experience (see *N12*). Where TTMs fail to do this, or where AEs feel that TTMs focus primarily on university procedure, AEs may feel that TTMs have failed in their role.

Encouraging and Supportive/Managing AE Expectations (N16)

The majority of AEs consider that university spin-outs could not be started, proceed, and become established without TTMs, and the crucial encouraging and supportive role TTMs should play in university spin-out formation is also noted. TTMs believe that it is important to be there for AEs, be enthusiastic about their idea, boost their confidence, keep track of what they are doing, and ultimately support them in achieving their aims. TTM6 said: “the TTM is there to help and encourage academics. The academics are our customers. That is the way I look at it.” AE6 noted, “TTM6 is also very enthusiastic and encouraging. It is

enormously helpful to have somebody have confidence in what you are trying to do." Some AEs considered this to have been their motivation to initiate a spin-out and to move forward. The importance of the TTM's personal traits (*N5*) and their impact upon the process are again noted here.

AE2 commented: "It was also good because the TTM listened to our concerns. The TTM didn't just have his agenda but was flexible and realised we had concerns that needed to be addressed." More importantly, AE2 thought this was how TTM2 gradually established trust with him, which was important and necessary in the university spin-out process. In some of the case studies (e.g. Cases 2, 3 and 6), it can be seen that encouragement and support were the foundation of how AEs and TTMs built up trust.

In addition to being encouraging and supportive, another skill which emerged from the analysis of the TTM's role in the university spin-out process was their ability to manage the expectations of AEs. TTM6 said, "I understand the process might just be to get going, and explaining to the academics, and also managing their expectations." AE6's response was consistent with TTM6's: "Although I don't understand the system very well, TTM6 is very good at explaining it." This is particularly important because, as mentioned (see *N12*), some AEs have low or non-existent expectations because they are unaware of what TTMs can do and have no knowledge of the university spin-out process. TTM11 also commented, "You will have to explain to them what issues might arise during the process." The study will examine in the next chapter how TTMs develop an ability to manage AE expectations and whether failures in this area should be construed as miscommunication or expectation management problems. It also considers whether there are other reasons why TTMs fail to meet AE expectations.

Summary

TTMs and AEs reached most agreement about how TTMs could facilitate the university spin-out process (*N12*) and make sure that it followed university procedures (*N15*). Some AEs said that TTMs met most of their expectations, but others were unaware of what to expect, especially with regard to how TTMs could facilitate a spin-out. Only a small number of AEs (such as AE11) doubted that

their TTM had the ability or experience to support them, or felt that what TTMs could offer was limited because of the small size of the TTO (such as AE1). Most AEs acknowledged the role of their TTMs and the effort they made to facilitate university spin-out in accordance with university procedures (*N15*). However, TTD8 pointed out that AEs and TTMs might have different perceptions of this role because: “For the academic they are forming something that is theirs, for the TTM they are forming something in which they are trying to ensure that the university gets an appropriate return. (…) so the academic is intrinsically conflicted in the spin-out company process and that can create tensions, and that can make them think that the TTM is a policeman rather than someone helping them.” This informs the other concerns, as it creates a negative environment that the relationship has to overcome. Consequently, AEs might wish to assume a management role in order to do battle with the university (e.g. AE7), some AEs may worry that TTMs will focus too specifically on this area and neglect the commercial aspects of the process (e.g. AE12), whilst some might consider the process too bureaucratic and time-consuming and likely to delay the spin-out process (e.g. AE9 and AE11).

This study identifies a knowledge gap in the existing literature (Siegel et al., 2003; Wright et al., 2004), concerning the role of TTMs in encouraging invention disclosure and confirming the commercial opportunity of an AE’s idea in university spin-out PAC development. The analysis shows that TTMs in this study did try to raise awareness of UTT amongst AEs and encouraged them to disclose their research output, through relationship building, before the commercial potential was discovered, and that they helped to confirm the opportunity through due-diligence (*N14*). However, AEs considered that they were usually more supported and encouraged when they were already a part of the UTT, and also that TTMs were not proactive in the discovery and identification of commercial ideas. As mentioned in 4.2.1, most of the commercial potentials were first discovered or identified by AEs (N8), this was also admitted by the TTMs. TTMs claimed that, due to constraints on the resources and capacity of TTOs, time limitations, and their multifunctional role, they tended to deal first with the cases which sought their help, and that these cases were more than enough for them to handle. This is inconsistent with the role TTMs should play in the TTO, as they work closely

with academics, and should be in a good position to explore opportunities which may have striking commercial potential (Siegel et al., 2003; Wright et al., 2004).

Most AEs recognised the importance of TTMs, especially in coordinating and liaising with all the necessary contacts for university spin-out (*N13*) – those that set the spin-out on a forward trajectory. With their previous UTT experience (*N3*) and personal relationships/networks (*N4*), TTMs agreed with this perception, citing their ability to bring together all the necessary people/elements considered key to progress in the early stages of the spin-out process and to push ahead with the process.

From the analysis it can be seen that TTMs serve a multifunctional role throughout the university spin-out process. Some AEs might held different opinions about their role due to their lack of understanding about the background and experience of the TTM, and of the university spin-out process. Based on the narratives in these cases, this could lead to problems in the areas of relationship building, communication, and trust building, amongst others. The study will discuss this further in Section 5.1. Nevertheless, it is acknowledged that the TTM role of encouraging, motivating and supporting AEs in the university spin-out process is important (N*16*). Almost all AEs were also agreed that university spin-out could not happen without TTMs.

CHAPTER 5

Combinative Capabilities and the Contribution of TTM and AE Collaboration to the University Spin-out

In Chapter 4, the findings of this study identified the prior knowledge that motivates TTMs and AEs to become involved with UTT activities, and also investigated TTM and AE perceptions and expectations with regard to each other's role in the creation of university spin-outs. Having understood how individual level determinants contribute to university spin-outs, in this chapter, the study looks further into how organisational level determinants, combinative capabilities amalgamated by TTMs and AEs, affect and contribute to the development of AC in spin-outs (Van Den Bosch et al., 1999).

In order to understand the synergistic effort and collaboration between AEs and TTMs, Section 5.1 presents narratives concerning the histories of their relationship building, communication, and trust building (Cohen and Levinthal, 1990; Kogut and Zander, 1993; Lane and Lubatkin, 1998; Chen, 2004; Jansen et al., 2005). It seeks to identify the key aspects that help TTMs and AEs to utilise shared languages, complementary expertise, close communication, connectedness, density of linkage, trust (internally within the spin-outs and externally with the outside environment), and the impact that these have upon university spin-out creation from the perspectives of both parties.

Section 5.2 will then use narratives from the viewpoints of both TTMs and AEs to illustrate the TTM's actual contribution to different stages of university spin-out AC, and the knowledge or skills that equip them to contribute to the process. Ultimately, the study will look at both prior knowledge and combinative

capabilities to identify how TTMs work with AEs, and the issues that affect their efficiency and contribution to the university spin-out process.

Table 10 Narratives of the Relationship Initiation and Building between TTMs and AEs during the University Spin-out Process

Participant	Relationship initiation and building	
	How was the relationship initiated?	**How does the relationship affect the process?**
AEs	• **Initiated by TTMs** o *"It was initiated on one occasion because the TTO were looking for some research that may have some commercial viability. They were invited to a seminar so I went to the seminar. They were interested in talking to us some more. They said why don't you apply for this grant to help you move this forward and that's what we did." (AE1)* o *"Originally TTM4 sent emails around all departments saying about a regional funding body that used to exist, and that if anybody had anything which they think could be suitable for this let her know. So we thought we would give it a go to see if we could get the cash to continue working on it, and it just so happens that we met her through that and chatted a bit, and did trips to the partners who could be involved, and then worked together on this document." (AE4)* • **Initiated by AEs** o *"I think we initiated it for sure. We approached the university, I think it was TTO, and said look we have this idea who should we talk to? TTO then put us in touch with the TTM2." (AE2)* o *"I asked the academics in my department. They simply gave me a name, TTM6's name, and I phoned him. (…) It is very important that you feel that you do have people who are enthusiastic and encourage the very early steps towards trying to commercialise it. If he just keeps saying no or can't be bothered at the first meeting, I wouldn't be bothered." (AE6)* o *"What this TTO have is called an invention disclosure form. So if an academic is aware, or they think there is potential, you fill out a form to give the background, the sector you want to do it in and the product at the end, and then they do initial search reports to see if there is anything similar out there. If they don't find anything, then they will tell you what to publish, because you don't want to put it in the public*	• *"Very positive and very constructive. If the relationship wasn't positive then it [the spin-out] would never have happened." (AE2)* • *"We all have a very good relationship, and as I say it has developed over the last few years and it is at the point where we actually understand what each other is talking about now so that is great." (AE4)* • *"TTM6 was always so enthusiastic, so I liked him right away. I think you have to have a good relationship with the TTM. (…) Otherwise, nothing happens. (…) TTM6 is asked to be committed to this spin-out as I am which is great. If he won't, then I won't have enough enthusiasm and energy on my own to make it happen. But he is just as keen to see this happen as I am, therefore, we will work together and try to overcome all the problems" (AE6)* • *"TTM9 is a very helpful guy. He's got lots of good ideas and apart from the university spin-out activity he has come along with lots of ideas. However, having a closer relationship with TTM9 doesn't really help with the spin-out because it is much more complicated than that. It's involved a lot more people than just me and TTM9. We spent a lot of time over a two year period sitting down with TTM9 and having nice chats about the technology and how we could do this kind of stuff. But that didn't go anywhere at all. So we decided on talking to another TTM." (AE9)* • *"Very friendly, I think we have a very good relationship, and a good understanding of what we want from each other, we have never been in conflict." (AE10)*

	domain; so that is something because academics always want to publish their results, so we have been trying to stop our supervisors. But they are commercially aware so they knew not to publish the results before we filed for the patent." (AE7) o *"We approached them, is my understanding about setting up the spin out company." (AE8)* o *"TTM9 was only involved deeply in the process when we started looking at the formality of the process, we needed their help for investment agreement, association with the company, what the founders' role would be in terms of the conditions we put in place for the founders." (AE9)* o *"As soon as we get a patent idea we have a process in the university where we submit a form to apply for patent and they evaluate it, then we meet and discuss." (AE10)* o *"The other AR involved in this case knew TTO3, so we sent him an email saying we'd got some ideas for patenting. So he helped with the patenting process." (AE11)* o *"We just knew TTM12 from the college because he was responsible for the commercial exploitation so that is why I contacted him." (AE12)* • **Consistently working with each other before the university spin-out** o *"I had a patent portfolio in place before she was employed in the university. She was moved onto this job in place of the person I had been dealing with before, so it was a natural progression on the previous work. And then we were well aware that the work we were doing was patentable, so there was an obvious progression in that when anything new came along I would go to TTM3, fairly naturally." (AE3)* o *"Because of my job, because I work a lot and over the years, before this particular opportunity I knew TTM5 very well anyway. The relationship developed over maybe 5 or 6 years, slowly, with different projects where we needed IP protection and so on. The relationship slowly developed into a relationship of trust through previous past experiences, smaller projects, by the time we got to this project I was very comfortable. I think it would have been different if we had started completely from scratch but I already knew Rob before." (AE5)*	• *"It is okay. TTM11 is still supportive. (…) I think the spin-out probably would have happened without them [TTMs and the TTO as a whole]." (AE11)*

TTMs	• **Initiated by TTMs** o *"It's all around that kind of relationship building really, and a lot of our job is that: going out, speaking to the academics, finding out what their research is about, and they may not come to you for another 2/3 years with a technology, but it's sort of getting your name known out there, and getting those relationships started. It may be years down the line when they actually develop something, but it's all about that awareness-raising relationship building from day one." (TTM1)* • **Initiated by AEs** o *"In the vast majority of cases when the academic comes to us we have an open door and a mechanism so people can disclose an invention and we also have a proof of concept fund." (TTM2)* o *"One of the academics spoke to AE6 and told him to talk to me." (TTM6)* o *"I knew the other AR involved in this case before we even started. They came to me with their invention and wanted it to be put forward to be patented." (TTM9)* o *"About 3 years ago, AE9 first came to me and said we've got this idea, but we have to go away because we need to do the work." (TTM11)* o *"It was initiated as a result of an invention disclosure and some broadcasting work AE12 did to essentially disseminate the proviso of his research in this area and we got talking about what could be done commercially." (TTM12)* • **Consistently working with each other before the university spin-out** o *"*I've *known AE3 for a number of years and he had some interesting inventions and we had some detailed conversations about how we can market his technologies and then look into plans to develop those ideas further." (TTM3)* o *"I've known him for many years. We first worked with him about five years ago with a completely different technology - he's one of the good ones, in that he can recognise some IP which is valuable, and he will come straight to us with it." (TTM5)*	• *"Maintaining that communication and relationship is very important, so then I can act as a Champion for them to the University and say that it's all on track we've had a couple of hic cups but we're working around that so they don't feel like they are on their own." (TTM3)* • *"I think you get to have a good working relationship. When you get a good working relationship, you work out how to handle dispute resolution." (TTM6)* • *"When AE9 wants something to happen, he gives me the impression that he gets a bit exasperated if we don't do it instantly. (…) If I had not had the sort of technical background I've got, I suspect it would be even more exasperating for AE9, because it would be even harder to get me up to speed with the significance of what they had got. I would like to think of my relationship with AE9 particularly as being helpful rather than unhelpful." (TTM9)* • *"A generally good relationship. I think if you have a weak relationship - say you've worked with someone already, and they were not that friendly with you - I would be very sceptical as to whether you'd get into the process, even if the investment committee says 'yes we want to invest that money'."(TTM11)* • *"On the whole it's good. Obviously there are always opportunities to improve; there's always going to be little problems that occur from time to time. I think on the whole they have a good relationship with the academics. And the academics are happy to talk to them and happy to bounce ideas off them as well which is very important." (TTM12)* • *"I would say very good, there have certainly been times where we have had to have difficult conversations or I have had to say things that he doesn't necessarily agree with, but that is part and parcel of life and developing a business really, you can't always keep everyone happy. I think overall the relationship is very good and hopefully TTM13 has had a very good experience, but then* there *are some things I have had to say no to that he wants and, other times I have been able to work round and I have solved problems, because that is my role as well." (TTM13)*

5.1 Building Relationships, Communication and Trust between AEs and TTMs

The study first looks into the stories of how TTMs and AEs initiate and build collaborative relationships with each other and how these relationships impact upon the university spin-out process. The study also attempts to understand the extent to which the individual AC levels of TTMs and AEs contribute to or complement each other when developing the cumulative combinative capabilities of university spin-out AC, through tighter interaction, communication, and trust building (Cohen and Levinthal, 1990; Kogut and Zander, 1993; Lane and Lubatkin, 1998; Chen, 2004). The impact these organisational determinants have upon the development of university spin-out AC is also examined.

5.1.1 The Initiation and Process of Relationship Building

As mentioned in the previous chapter, in this study, the majority of AEs took the initiative and discovered the commercial potential of their idea (*N8*). Seven of the thirteen AEs actively approached their TTMs about the possibility of commercialisation. Five of the thirteen were encouraged by TTMs or already had previous experience of working with them. Only one AE's idea was noticed by a TTM. This raises the questions: How do AEs know who to talk to at the beginning of the university spin-out process when the commercial potential is being discovered?; What was the relationship between AEs and TTMs during the process?; and How was it affected by this relationship? This study therefore takes a closer look at the initiation and building of the relationship between TTMs and AEs.

Based on the narratives, the relationship between AEs and TTMs for university spin-out can begin in three ways. The relationship could be initiated by TTMs. This happened when AE1 participated in seminars which TTMs held to encourage AEs to participate in UTT activities and when AE4 noticed the funding information TTM4 had circulated around his department. AE1 stated: "I went to the seminar. They were interested in talking to us some more. They said why don't you apply for this grant to help you move this forward and that's what we

did." In some cases, the relationship was initiated by AEs; three AEs (AE2, AE7 and AE8) contacted TTOs and informed them that they had an idea which was potentially suitable for commercialisation and asked for assistance with patenting and possibly university spin-out. Five AEs (AE6, AE9, AE10, AE11 and AE12) either knew or were introduced to their TTMs by colleagues who knew them through the department because they were the TTMs who were responsible for all the potential exploitation from those departments. Finally, the association could also have originated and developed through a consistent working relationship between AEs and TTMs (Cases 3, 5, and 13) which had grown over a number of years. TTM3 commented: "I've known AE3 for a number of years and he had some interesting inventions and we had some detailed conversations about how we can market his technologies and then look into plans to develop those ideas further." It can be seen that the majority of the relationships began before the commercial potential of the AE's idea was clarified, and that this was due to the efforts of the TTMs, their previous relationship with AEs, or their connection with the academic's colleagues or department.

Initiating a relationship between TTMs and AEs, not to mention further maintaining that relationship, is not easy. Some TTMs and AEs (such as TTM3, TTM6, TTM13, AE5, AE6 and AE10) emphasised the importance of having a good interactive relationship with each other and stressed that it is important to resolve any problems or conflicts which do occur during the university spin-out process. The AEs and TTMs working with them all agreed that they had a certain degree of confidence and trust in each other. This is certainly supported by previous studies which found that a good social relationship and trust between AEs and TTMs can form a strong basis for collaboration and have a positive impact upon knowledge transfer (Rynes et al., 2001; Van Den Bosch et al., 2003; Chen, 2004). The attitudes of TTMs and their role of encouraging, supporting, and managing AE expectations (*N5* & *N16*) could significantly benefit and help to maintain good relationships and communications.

TTMs commonly considered that they had good interactive working relationships with their AEs, and agreed that this was important for handling some of the problems or conflicts that might occur from time to time during university spin-out. TTM6 said, "When you get a good working relationship, you work out how to handle dispute resolution." TTM13 also considered this to be one of a TTM's

duties and commented, “there are some things I have had to say no to that he wants and, other times I have been able to work round and I have solved problems, because that is my role as well”. This is something which the TTMs raised; the need to establish an ability, from the beginning of the relationship, to resolve tensions and disagreements with AEs. TTM6 mentioned, “Everyone is always very friendly when you start building a team at the beginning of a spin-out company. People get together and sit around the table and they are enthusiastic and excited. That is the time to sort out dispute resolution when people get together.” TTM1 and AE1 especially emphasise the importance of maintaining a good working relationship and communicating with each other from the beginning of university spin-out creation. TTM3 stressed that it is important to maintain relationships and communication with AEs, so that they do not feel they are on their own. This is consistent with the TTM role of encouraging and supporting AEs (*N16*).

In general, AEs considered the TTMs to be friendly, positive, and supportive, and admitted that their university spin-out would not happen/have happened without the involvement of the TTMs. AE10 further commented, “I think we have a very good relationship, and a good understanding of what we want from each other, we have never been in conflict.” However, some AEs thought that, although they had a good relationship with their TTMs, this did not necessarily mean it would help with university spin-out, and might indeed be irrelevant. For example, although AE3 and AE5 felt comfortable and were confident to undertake more UTT with TTMs with whom they had worked consistently, AE9 and AE11, who had also previously worked with TTMs, held very different opinions.

AE9 considered TTM9 to be “a very helpful guy. He’s got lots of good ideas and apart from the university spin-out activity he has come along with lots of ideas.” However, AE9 did not think that having a closer relationship with TTM9 would have helped with their particular spin-out: “We spent a lot of time over a two year period sitting down with TTM9 and having nice chats about the technology and how we could do this kind of stuff. But that didn’t go anywhere at all. So we decided on talking to another TTM.” It was TTM9 who noticed the problem with the relationship; he said, “When AE9 wants something to happen, he gives me the impression that he gets a bit exasperated if we don’t do it instantly. (…) If I had not had the sort of technical background I’ve got, I suspect it would be even

more exasperating for AE9, because it would be even harder to get me up to speed with the significance of what they had got. I would like to think of my relationship with AE9 particularly as being helpful rather than unhelpful." In this case, TTM9, having spotted that the problem existed, worked harder to maintain the relationship, but did not manage to resolve AE9's impatience with the university spin-out process.

AE11 considered TTM11 to be relatively unimportant, although someone who had relevant experience and could help out with the standard process when establishing a university spin-out. Even though AE11 recognised TTM11's input, he saw TTM11 only as a consultant whose help could be called upon when dealing with formalities. As the relationship grew, although AE11 commented "It is okay. TTM11 is still supportive. (…) I think the spin-out probably would have happened without them [TTMs and the TTO as a whole]", he still insisted "they did not play a major role, certainly in the most important stages". TTM11 also acknowledged that there was sometimes tension between himself and AE11, and said: "The small number of things you fall out over, awkwardly you sort of move on from them. There are a few pressure points where clearly AE11 felt disappointed by the things I was telling him." TTM11 felt that they had to move on and that the relationship between them should be good, so that the spin-out process could continue.

It can be seen that some AEs (such as AE9, AE11 and AE12) did not consider that having a stronger or a good working relationship was of benefit or important to developing university spin-outs. Those TTMs who worked with them recognised that a problem existed between them but seem to have chosen not to deal with it, opting instead to maintain a peaceful relationship with their AE and to move on. The TTM decision to move on without resolving the issues might be the reason why their relationships were problematic. TTD8 said: "AEs may be very inexperienced or be impatient. (…) most universities would say it is a team and if you are lucky you have a TTM who has got quite a lot of commercial experience, and therefore, they can really add value. I think there are occasions when the TTMs forget that their job is to add value and they try really to compete with them and that doesn't really work because the academics don't respond to that kind of approach."

It is interesting to note that those AEs who considered that a tighter working relationship has a vital and positive impact on the university spin-out process generally had a consistent or positive perception of the TTM role, and those who did not consider closer working relationships to be important usually had negative perceptions or higher expectations of TTMs. This study will further discuss the connection between AE and TTM perceptions and expectations of each other's roles, and their relationship building, in Section 5.2, after an examination of TTM and AE communication and trust building in the following sections.

Table 11 Narratives Concerning the Communications between TTMs and AEs during the University Spin-out Process

Participant	Communications	
	How effective is the communication?	**Are there any barriers to communications?**
AEs &TTMs	**1. Emails, phone calls, and occasional meetings** o *"We email and meet to communicate, once every three weeks. We always meet all together." (AE1)* o *"We have quite a lot of meetings here where we discuss a lot of things, we have various emails back and forth, we have phone calls and Skype, you name it we have had lots." (AE4)* o *"With TTM5 mainly, on the phone because we like to have a chat, we both like to talk, also when we are not available, email is very useful. With TTM5, it is on the phone or face-to-face. I can walk over here in two minutes from my office. As long as TTM5 is available, then sometimes face-to-face over a cup of coffee in the cafe over at Main Campus (…) and [we can] go through all the problems. Face-to-face is a very important way of dealing with it." (AE5)* o *"Mostly we get in contact when there is something needs to be dealt with. And then, we normally have a quick meeting after that. But I just like to keep up with him whenever I can keep in touch with him. But the primary communication would be email probably because it is so much more convenient. I quite like talking on the phone rather than email. So emails, phone calls, and then we meet." (AE6)* o *"It depends, telephones, meetings, emails, we keep in very close contact; it's easy as it's a small city and small university. We prioritise making ourselves available to others [when it comes to the spin-out]." (TTM3)* o *"I will say the majority, and progressing, is email based. Usually face-to-face is reserved for trying to defuse the very difficult situations." (TTM11)* o *"It depends, it's usually a mixture of telephone and email but personally I prefer to just walk over to his office and talk something through with him directly because it's easier to get things misunderstood or miscommunicated by email or even by phone. (…) If I get a sense of something like that I go and see him face-to-face and talk about it, so it's*	**1. Knowledge gaps** o *"I think at the beginning there were inevitably barriers because we didn't understand each other. So at the very beginning of the process it was important that the university understands what we are trying to do and how, and obviously at the beginning they did not know that, so that was a barrier. Equally it was important for us to understand what the university wanted in terms of our involvement and what their expectations were. So at the beginning there is an issue of expectations, and it just takes some time to communicate and understand each other." (AE2)* **2. Geographic Barriers** o *"The greatest barriers were geographical and time barriers, they were the main ones. (…) We weren't very far away but I think if you aren't working close with people it is very hard to speak to them and harder to move things along." (AE8)* o *"I mean AE11 is a scientist, so he far prefers communicating by email. But some of the things in my experience are better face-to-face. Also he is located in the science park, not in the campus. So communication was more limited." (TTM11)* **3. Heavy Workloads and Time Constraints** o *"*The *only problem I will say has been he is busy and I am busy. Therefore, we are not often able to really focus on the spin-out and chase the system down and get things done." (AE6)*

	resolved. I think interpersonal contact is absolutely vital. (…) You can't always understand what someone is trying to convey if you can't see the body language that goes with it.." (TTM12)	o *"But generally, getting on with those people at the TTO could be very difficult. (…) I think it is because they are just overloaded, or they can't turn things around fast enough. Or when they did turn it around, it was incomplete or not properly thought through. That delayed things. (…) I think it is because they are just overloaded, or they can't turn things around fast enough. Or when they did turn it around, it was incomplete or not properly thought through. That delayed things. (…) That is largely because TTM11 did not have time, I do not think he did the job properly. He just rushed something through and got it out and it was not great." (AE11)* o *"The academics' time is a challenge. The academic involved in this spin-out is also a researcher with quite a heavy research workload, and a research portfolio and has to have time for the company, and to have that time for the company is difficult." (TTM8)* o *"There is so much communications going on. There are always bound to be the things that go wrong. For example, we were in a conference call once, and I had to stop to literally go to do the next thing I have scheduled because AE11 and his boss were late calling in. I will still be around, but I kept saying I've got to go. We obviously did things in a rush, and that was one of the things that caused the problem and it fell apart because we were discussing in a rush." (TTM11)*

5.1.2 Communication

TTMs and AEs regularly communicated using a variety of formal and informal methods. Kraut et al. (1990) identified several variables that distinguish formal from informal communication. Whilst formal meetings consist of conversations that take place at a predetermined time, with agreed participants, and are about the topics in hand, informal meetings are not scheduled in advance, and their participants and agenda are flexible (Kraut et al., 1990). Informal communication is considered to be more interactive because the participants are able to respond promptly to the subjects raised and to the other participants' reactions. They can also instantly modify what they say in order to deal with the other participants' objections or to correct misunderstandings (Kraut et al., 1982; Kraut et al., 1990). In this study, AE and TTM communications were generally informal, such as in Case 5, where AE5 said: "I can walk over here in two minutes from my office. As long as TTM5 is available, then sometimes face-to-face over a cup of coffee in the cafe over at Main Campus (…) and [we can] go through all the problems." Research results from McAdam et al. (2010: 469) showed that informal meetings and discussions between AEs and TTMs "were important in communicating and coordinating activity and building network relationships".

Most TTMs and AEs considered their communication to be frequent and trouble free. TTM3 believed that he communicated very closely with AE3. "We prioritise making ourselves available to others [when it comes to the spin-out]," TTM3 said. This is consistent with the findings of McAdam et al. (2009) which indicate that, to facilitate the UTT process, TTMs should have flexible agendas. Meanwhile, AEs should also understand the need to free up time for UTT activities from their academic schedule. The frequency of communication varied across the thirteen case studies, and TTMs and AEs also stated that it varied at different stages of the university spin-out process. Some had regular meetings, some did not. Therefore, the communication could be as frequent as a few times a week or as infrequent as a few times a month. In Cases 1, 4, and 7, TTMs and AEs usually had official monthly face-to-face team meetings with all stakeholders (e.g. other founders and the CEO). The study showed that, although TTMs and AEs found it easy to contact each other via email and phone, most of them still preferred face-to-face contact (including Skype). Some TTMs (such as TTM1, TTM6 and TTM12) addressed the importance of face-to-face contact for either formal or

informal meetings. TTM12 said: “personally I prefer to just walk over to his office and talk something through with him directly because it’s easier to get things misunderstood or miscommunicated by email or even by phone. (…) If I get a sense of something like that I go and see him face-to-face and talk about it, so it’s resolved. I think interpersonal contact is absolutely vital. (…) You can’t always understand what someone is trying to convey if you can’t see the body language that goes with it.” This supports the findings of previous studies (e.g. Lane and Lubatkin, 1998) which report that it is important to have an interactive (face-to-face) relationship between AEs and TTMs to develop effective university spin-out AC.

AE and TTM communications have also illuminated AE perceptions of the TTM role in the university spin-out process. In some cases (e.g. Cases 3, 5, 6 and 13), AEs feel they have built up a friendship with their TTMs and see them as someone with whom they can work and can solve the problems encountered in the development of university spin-out. As AE6 mentioned, “I think we are good friends actually. We get on very well. He is very easy to get on with.” AE6 believed the friendship to be of considerable benefit to relationship building, communication, the entire collaboration on university spin-out, and even further, of use to future UTT activities. TTM5 agreed, “I think we have the right personalities and we get on well with each other. We understand, we like to talk, discuss rumours, have a gossip and things. Sometimes we spend too long talking.”

In general, TTMs and AEs do not believe they have serious problems communicating with each other during the spin-out process. However, some AEs do have particular concerns with regard to existing barriers; some, they feel, could be handled properly with good communication whilst others could lead to miscommunication. This study identified the barriers to communication between AEs and TTMs as follows.

Knowledge Gaps

It has been widely acknowledged by many TTMs and AEs (e.g. TTM1, TTM4, TTM9, AE2 and AE6) in this study that knowledge gaps could be the first and

most noticeable barrier to a university spin-out. Past research has also emphasised that TTMs and AEs usually have different knowledge bases and backgrounds which could result in misunderstanding, lack of communication, and even tension and disagreement (Siegel et al., 2004; McAdam et al., 2009; McAdam et al., 2010). To fill the knowledge gaps, it was suggested that there is a need to establish formal monthly meetings between TTMs and AEs to improve interaction, resolve misinterpretation issues, and speed up UTT progression (McAdam et al., 2010). Meanwhile, provision of critical complementary or external expertise, such as business and marketing skills, to AEs could also lead to more effective communication and improve the two-way AC development and exploitative learning capabilities (RAC) of the spin-out (McAdam et al., 2009; McAdam et al., 2010).

TTM1, TTM4 and TTM7 all recognised the importance of filling the knowledge gaps for AEs and holding formal monthly meetings with them. This is important, especially since AE1, AE4 and AE7 had no prior spin-out experience. In this study, the majority of AEs were totally new to university spin-out and half of them had no prior UTT experience (including with patents) (see *N3*), so had no idea what to do or expect. As AE2 stated: “I think at the beginning there were inevitably barriers because we didn’t understand each other. So at the very beginning of the process it was important that the university understands what we are trying to do and how, and obviously at the beginning they did not know that, so that was a barrier.” However, AEs also mentioned that this barrier could be simply removed if TTMs could improve the communication and tell them what to expect and what to do. As AE2 mentioned, “Equally it was important for us to understand what the university wanted in terms of our involvement and what their expectations were. So at the beginning there is an issue of expectations, and it just takes some time to communicate and understand each other.” Finally, TTM1 also stressed the importance of face-to-face meetings in filling knowledge gaps, not just for AEs, but for every stakeholder involved in the process.

Geographic Barriers

For AEs and TTMs on the same campus or whose offices were close to each other, perhaps within walking distance, they would meet frequently where

necessary (e.g. Cases 3, 5, 6, 9 and 12). The convenience of having face-to-face meetings could affect the communication between AEs and TTMs (e.g. Cases 8 and 11). AE8 said: “The greatest barriers were geographical and time barriers, they were the main ones. (…) We weren’t very far away but I think if you aren’t working close with people it is very hard to speak to them and harder to move things along.”

In another case, TTM11 and AE11 had serious problems communicating efficiently with each other. In contrast to AE11’s feelings about how difficult it was to contact TTM11, TTM11 said: “AE11 is a scientist, so he far prefers communicating by email. But some of the things in my experience are better face-to-face. Also he is located in the science park, not in the campus. So communication was more limited.” Despite the geographical barrier, AE11 admitted that they had weekly meetings and that TTM11 would respond to his urgent emails. AE11, however, was still not happy with TTM11’s busy work schedule, and this will be discussed further below. The different understandings of their communication led to a great deal of miscommunication.

Heavy Workloads and Time Constraints

Time was another obvious issue that was discussed with regard to communication since both AEs and TTMs have extremely busy schedules. AEs are still mainly focussed on their academic and research jobs and TTMs usually have multiple UTT activities to manage. Sometimes AEs and TTMs consider this to be a mutual problem (e.g. Cases 2, 4, 6 and 13). As AE6 mentioned: “The only problem I will say has been he is busy and I am busy. Therefore, we are not often able to really focus on the spin-out and chase the system down and get things done.” TTM6 thought that he should have put more time into working on AE6’s spin-out. AE13 said: “Sometimes I felt TTM13 was a bit slow but that never gave me the impression that she was more focussed on other projects. I always thought she took mine as a priority.” Lack of time does become a common problem when pushing the university spin-out forward, since both parties are busy people, but it can be overcome with stronger relationships, understanding, and communication.

However, especially when AEs are fully committed to the university spin-out process, they expect the same from their TTMs. They feel sometimes TTMs have too great a workload and neglect or even rush the process. AE11 complained: “The miscommunication comes largely from TTM11 I think. He was not explaining properly what the process is. (…) it is a result of TTM11 failing to understand not to speed through the process and failing to look after it properly with us as founders. (…) That is largely because TTM11 did not have time. I do not think he did the job properly. He just rushed something through and got it out and it was not great.” As can be seen, the issues between TTM11 and AE11 arose at the very beginning of the relationship, and then led to communication problems. This study will not use this particular case as a basis for making sweeping generalisations as the participants may have been biased, but it was interesting to identify a case which involved all of the known barriers to communication. TTM11 recognised the communication problem with AE11 and acknowledged that it delayed the spin-out process. He did not, however, try to explain to the AE or to resolve the issues, preferring instead to press forward and to move away from the problem. This resulted in further miscommunication or misunderstanding which could have been solved simply by filling the knowledge gaps for AE11 who apparently had no prior UTT, and limited industrial, experience.

AE8 also thought that miscommunication and time limitations were the major reasons for delay in the university spin-out process. He commented: “I think probably everything we do could be better if we communicated more frequently, but we are restricted by time and other commitments.” However, TTM8 pointed out that it was challenging to reach AE8 and that this made it difficult to progress the university spin-out efficiently. TTMs and AEs were both agreed that heavy workloads and time constraints can cause miscommunication and have negative impacts upon university spin-out, either delaying or rushing the process, but since both are busy, they find it difficult to address these problems and to improve their communication.

Table 12 Narratives Concerning the Trust Building between TTMs and AEs during the University Spin-out Process

Participant	Trust building
AEs	• *"I think the greatest difficulty at the beginning which we all had to work hard to achieve, was for us to trust the university and for them to trust us. (…) As I said earlier there was a period of us needing to build up some trust and I think TTM2 was very important in establishing that trust." (AE2)* • *"I think that as you work with people over a few years certainly that relationship grows and I think TTM3 came into the job, she was rather thrown into it, and she has developed in her role very quickly and certainly I think that we work reasonably well together." (AE3)* • *"I think so yes, there is definitely a very trusting relationship. We are at the point now where if we say something that is maybe an idea on where we would like to go and TTM4 doesn't like it, then she will say 'no that is completely wrong we are not doing that'. Likewise, if they say something, we will say 'no that is not going to happen'. We will quite happily say what will and won't work to each other. It is a very democratic discussion and normally by the end of it we come out with a very useful result." (AE4)* • *"Because of my job, because I work a lot and over the years, before this particularly opportunity I knew TTM5 very well anyway. The relationship developed over maybe five or six years, slowly, with different projects where we needed IP protection and so on. The relationship slowly developed into a relationship of trust through previous past experiences, smaller projects. By the time we got to this project I was very comfortable. I think it would have been different if we started completely from scratch but I already knew TTM5 before." (AE5)* • *"I think we have built a very good working relationship and we have all felt like we were on the same side of working together, really getting the shareholders agreement and the point where we start to become more independent, that puts a bit of stress on the relationship because TTM7 gets the comments back from her lawyers and we come back with ours, and that legal side of things can cause a bit of tension in the relationship because you both have different motivations." (AE7)* • *"I personally think TTM8 is a very ethically driven individual who is very careful to be thinking what is best and what is right all the time, so yes I do trust him because I think he has a lot of integrity, so that is my personal opinion." (AE8)* • *"TTM9 eventually became convinced enough that he is interested in to take us to talk to TTD and trying to push it forward. So in terms of helping to put the thing forward certainly, without that, nothing will probably happen." (AE9)* • *"I think I now have a much better feeling for what they are able to do or they are not. So I will probably have a more confident relationship with them. But that is based on the understanding of what they failed to do I think in the past. And I am not asking them to do this sort of thing again." (AE11)* • *"It is quite a formal process no matter how your relationship is you have to go through the process. There are things holding you back, things like slow administration rather than personal relationships between me and the TTMs."(AE12)* • *"I always thought TTM13 was a bit slow with things, but in the end I realised she was doing many things in a very careful way, so that showed me that in the future I should trust her, but yes she is very good. (…) For example, we lost this important investor but I didn't show any of my disappointment in front of her because generally speaking she is doing a great or excellent job, and I think probably it was the investor who was too rushed. (…) I think the trust between us is the most important thing" (AE13)*

TTMs	• *"To actually work with the academics, it's very much a personal relationship that you have to build up; you need their trust and they need to trust you to show that you actually know what you're talking about. To work with academics in general you have to massage their egos at times but also - to build that relationship you want that trust, and once you've got that trust in there, then you can be a bit more open with them, but they're often unusual creatures of initially get that trust and relationship. So I think often we're looking at it in - how can we get more money into the company - that's our regular things, and the decision has to be made: do we present now or do we present in a few months' time, and my opinion is that we should present in a few months' time and when we're ready, I think they now respect my opinion; they know I have knowledge of the investors, and they know that I know the situation better than what they do, and therefore they take my advice around delaying the investment pitch. Whereas I think if they didn't have the trust there they wouldn't necessarily take my opinion." (TTM1)* • *"AE2 was comfortable with my answers so there is a level of trust between us but he was asking on a formal level so it was my role to give the reassurance of the university that this was the right thing to do and we had gone through the right process and it was going to be successful." (TTM2)* • *"I think AE6 will be fully aware there is more stuff I should have done. But that is fine for him. He knows I've got my job to do and I know he's got his research to do. I think the mutual trust we've got in place is the fact that we know either one of us would sort it out. […] to manage AE expectations is very important and make sure there is dispute resolution." (TTM6)* • *"AE7 doesn't trust me at all. It has massively impacted upon the process, for everybody and not just me. I think this is a big problem because he is very paranoid. He latches on to the negative potential and he gets paralysed with fear and indecision. But those aren't the qualities of an entrepreneur, he spends too much time worrying." (TTM7)* • *"Generally I think I work very hard on my relationship with all of my academics, and I don't think you can get anywhere without a certain degree of trust." (TTM10)* • *"I think it needs a lot of trust. A very high level trust is absolutely essential. In fact, to some extent, we get through the procedure of signing the agreements as well. I think you have not got a reasonable amount of trust, you probably would not get to finish initial document. There will be some flash points around something in every process. So I think you have to have that very strong level of trust and appreciation of each other. So you can recover to a reasonable level again from the falling out."(TTM11)* • *"I had to very carefully manage AE13's expectations, and also give him the ability to trust that we were the right people to do the job, and that takes a lot of patience and careful management really. (…) what I would say is that a TTM has to build a good working relationship with the academic otherwise it won't work and sometimes it doesn't work and it falls apart. I think for me, my style is very collaborative and engaging but different people work in different ways. So I work in a very collaborative manner where I say I am working for the academics and I feel I work for the academics and I also work for the people we are trying to license things to so in a way I have to take my ego out of the equation. And if I don't agree with something then I have to be persuasive and use methods to get them to change their mind or understand the reason why I have to do something. But that is up to different technology transfer officers who may have different approaches, but I find that a collaborative approach works best for me." (TTM13)*

5.1.3 Trust Building

Having developed an understanding of the communication and relationship building between TTMs and AEs, the study investigates in-depth the density of the linkages which allow them to build trust, and the influence this has upon the university spin-out process. The majority of TTMs and AEs in this study agreed that they had built a certain degree of trust, alongside relationship building and communication, during the university spin-out process, and considered that it had had an extremely positive impact.

Relationships built on previous experience working with TTMs (like those of AE3 and AE5, see *N3*) could make AEs more confident and comfortable when dealing with the difficulties posed by more complicated UTT activities, such as university spin-out. AE5 said: “The relationship developed over maybe five or six years, slowly, with different projects where we needed IP protection and so on. The relationship slowly developed into a relationship of trust through previous past experiences, smaller projects. By the time we got to this project I was very comfortable.” TTM1 commented: “To actually work with the academics, it’s very much a personal relationship that you have to build up; you need their trust and they need to trust you to show that you actually know what you’re talking about.” TTM10 also believed that it was important to work hard on the relationship with AEs in order to move the university spin-out forward. With trust as the basis of the relationship between TTMs and AEs, they are well placed to go through the time consuming and varied decision making processes that possibly lead to success (TTM2). AE2 held the same opinion as TTM2 and felt that the greatest difficulty with university spin-out was to build trust between the AEs and the university, to believe in the university spin-out, and that, although it took time, the TTMs were crucial to establishing that trust.

However, it has been shown that mistrust and scepticism between AEs and TTMs can cause UTT failure (McAdam et al., 2009). This study has also proven that failure to build trust can have a severe negative influence on the university spin-out process. In Case 9, TTM9 found it difficult to trust AE9 because, as an experienced TTM who had previously founded his own university spin-out, he doubted that AE9 was telling him the whole truth about the technology development and related risks, and had a tendency to oversell it in order to attract

investment. AE integrity and openness, which are the key components of building up trust (Mayer et al., 1995; Mishra, 1996), were questioned by TTM9, and the trust between them, therefore deteriorated. As TTM9 said to AE9: “I have a real understanding of what we have got here and I can help you with better advice. If you are just trying to lead me to believe that what you have is the best, I’ll let you know perfectly well it is not.” He admitted that he should have been clearer with AE9 from the beginning, but that he had failed to be so. “One has to be respectful to the academics, but I think it is also your duty to tell them the facts and to be realistic. (…) He [the AE] is not helping you, and you can’t help him, if he is not honest with you.” As mentioned, AE9 did not think that his relationship with TTM9 helped with the process. In fact, TTM9 was not keen to proceed because he did not trust AE9 and the process was therefore frozen for months. Here we see how failures in trust building between TTMs and AEs can seriously impact upon university spin-out creation.

In Case 11, although AE11 considered relationship building to be unimportant from the outset and obviously had serious communication issues with TTM11, he mentioned: “I think I now have a much better feeling for what they are able to do or they are not. So I will probably have a more confident relationship with them. But that is based on the understanding of what they failed to do I think in the past. And I am not asking them to do this sort of thing again.” As a result, AE11 tried to build up the confidence and trust between himself and TTM11 based on his understanding of what TTMs can do. AE11 still doubted TTM11’s competence and reliability, and this became an obstacle to the building of trust between them. TTM11 believed that university spin-out requires a high level of trust since TTMs and AEs have to reach many agreements when working through complicated procedures. They can only recover a relationship which has fallen apart with a “strong level of trust and appreciation of each other” (TTM11).

In some cases (such as Cases 4 and 6), trust allows TTMs and AEs to be open and honest with each other in decision making, which usually leads them to a positive and more useful result from the university spin-out. AE4 said: “There is definitely a very trusting relationship. We are at the point now where if we say something that is maybe an idea on where we would like to go and TTM4 doesn’t like it, then she will say ‘no that is completely wrong we are not doing that’. Likewise, if they say something, we will say ‘no that is not going to happen’.” In

Case 6, where both TTM6 and AE6 believed they had built up trust in each other from the very beginning of the spin-out, this reflected positively on their communication and problem solving during the spin-out process. As TTM6 emphasised: “I think AE6 will be fully aware there is more stuff I should have done. But that is fine for him. He knows I’ve got my job to do and I know he’s got his research to do. I think the mutual trust we’ve got in place is the fact that we know either one of us would sort it out. […] to manage AE expectations is very important and make sure there is dispute resolution.” AE6 said, “Although I don’t understand the system very well, TTM6 is very good at explaining it. […] There are processes where you struggle and try to sort it out in the spin-out process. You need a good relationship to start with. Otherwise, nothing happens. Inevitably, through the ups and downs of the process, if there is a mutual commitment to the project, then the relationship is the strength. You see TTM6 is asked to be as committed to this spin-out as I am which is great. If he won’t [commit to it], then I won’t have enough enthusiasm and energy on my own to make it happen. But because he is just as keen to see this happen as I am […] we will work together and try to overcome all the problems.” They both had great confidence that they would be able to deal with all the problems that might arise in the future. In both Case 4 and Case 6, both parties were straightforward with each other and happy to share their thoughts and feelings about all decisions. They believed that their discussions were democratic and usually led to a useful outcome.

TTMs are also able to better manage AE expectations throughout the university spin-out process through communication and trust building. TTM13 had been trying hard to both manage AE13’s expectations and earn his trust. As TTM13 emphasised: “I had to very carefully manage AE13’s expectations, and also give him the ability to trust that we were the right people to do the job, and that takes a lot of patience and careful management really. (…) what I would say is that a TTM has to build a good working relationship with the academic otherwise it won’t work and sometimes it doesn’t work and it falls apart”. AE13 said: “I always thought TTM13 was a bit slow with things, but in the end I realised she was doing many things in a very careful way, so that showed me that in the future I should trust her, but yes she is very good. (…) For example, we lost this important investor but I didn’t show any of my disappointment in front of her because generally speaking she is doing a great or excellent job, and I think probably it

was the investor who was too rushed. (…) I think the trust between us is the most important thing."

Interestingly, TTM7 and AE7 seemed to have no problems with their relationship and communication until the very final stage of the spin-out process when they began to work on the issue of shareholdings (see *N11*). As discussed in Section 4.2.1, AE7 wanted to be CEO of the company in order to gain a greater shareholding, but TTM7 considered this to be unrealistic because AE7 had no business knowledge/experience and no prior UTT experience (*N1*, *N2* & *N3*). "AE7 doesn't trust me at all. It has massively impacted upon the process, for everybody and not just me," TTM7 said. Even though TTM7 tried to convince AE7 that the role of CEO is not the only leading role in a spin-out, AE7 felt that TTM7 and the university should have no say in the spin-out formation. The process was therefore delayed and their relationship and trust adversely affected.

The analysis frequently indicates that, where TTMs and AEs considered the relationship and communication between them to be important to university spin-out, that relationship was more efficient and less prone to conflict (e.g. Cases 1, 2, 3, 4, 5, 6, 10 and 13). Even though they recognised they might encounter barriers or conflict during the process, the TTMs had built up closer relationships and good communication with their AEs, filled the knowledge gaps, and managed AE expectations from the beginning; they had confidence in each other and had established trust that any problems would be resolved in the end (Van Den Bosch et al., 2003; Chen, 2004). As TTM2 pointed out: "If you've got a healthy relationship you're more likely to have the dialogue you need, you're more likely to have an open disclosure and to talk about the issues even if you disagree with each other. And it's easy to say, 'I see what you're saying but I completely disagree with you', or 'let's see how we're going to make this work'." In this section, the analysis shows that the trust developed through strong communication and relationship building could also further strengthen this role and could enhance spin-out AC (especially RAC).

In other cases (e.g. Cases 8, 11 and 12), although there had been miscommunication, and barriers had been encountered, TTMs and AEs both wanted to maintain their relationships and had tried to build trust, mainly because they wanted to keep the process moving forward. However, the data shows that

the problems which existed between them either delayed or had negative consequences for the process. In some cases (e.g. Cases 7 and 9), even though TTMs and AEs seemed to have no obvious problems with their relationships and communications, the problems which did exist finally arose when they tried to build trust. It appears that lack of trust can delay the university spin-out process, restrict progress, and in some extreme cases cause the cessation of the spin-out.

Summary

In this section, the study looks at the combinative capabilities which are considered to be organisational determinants for university spin-out AC.

In Section 5.1.1, although almost all AEs were the first to identify the commercial potential of their work, ten of the thirteen had initiated a relationship with a TTM as a result of TTM efforts to raise awareness of commercialisation opportunities (through workshops, proactively building relationships with departments, or working with AEs over a period of time) or to encourage innovation disclosure during relationship building. This supports one of the findings from the previous chapter concerning the role of TTMs, that they should encourage AEs to disclose their innovations (*N14*) at an early stage in university spin-out. It is also considered to be one of the determinants of UTT activity (Siegel et al., 2003; Wright et al., 2004; McAdam et al., 2010).

The findings reported in the previous paragraph mean that, almost a quarter of AEs approached their TTOs unprompted, seizing the initiative themselves to start the university spin-out process. In their opinion, TTMs are not proactive enough to begin the relationship; they give no encouragement to disclose ideas before the commercial potential is discovered, and contributed nothing to the discovery of their commercial opportunities. AE10 said: “I think they did a lot. What they could have done earlier was to create this relationship [for the spin-out]. They were not super proactive in this spin-out process. They were waiting for someone to do something and weren’t people who would initiate the process; that needed to come from the academic.” It can be seen that the prior knowledge of AEs allows them to contribute more to a university spin-out’s exploratory learning capacity (PAC) in terms of knowledge recognition, acquisition and assimilation (Zahra and

George, 2002; Lane et al., 2006), whilst the contribution of TTMs seems to be limited.

The connectedness that developed from the collaboration between TTMs and AEs allows TTMs to interact with AEs directly, and largely increases the efficiency of the process of knowledge/technology transfer (Agrawal, 2001). PAC would be greatly enhanced if complemented by a TTM's expertise (i.e. with regard to raising AE awareness of, and participation in, commercial opportunity discovery and disclosure). Then, after the commercial potential of AE ideas is identified (either by the AE or with support from TTMs), TTMs need to evaluate the opportunity and confirm that it is technically feasible and commercially viable by arranging due-diligence (undertaken by professionals).

In Chapter 4, we identified the importance of prior knowledge, including shared language, experience, and complementary expertise, which constitute the social aspect of the combinative capabilities of TTMs and AEs. In this section, the analysis further explores combinative capability in terms of the density of linkage, connectedness, and trust building which is developed through the relationship and communication between TTMs and AEs. As indicated by previous research (Cockburn and Henderson, 1998; Jansen et al., 2005), combinative capability can be expected to facilitate the knowledge transfer process more efficiently and also enhance a firm's PAC and RAC. Mirroring the good working relationships which existed between TTMs and AEs, the majority still considered that they enjoyed relatively good, frequent, and convenient communications. Although most contact was rather informal (unscheduled face-to-face meetings which took the form of a random pop-in or coffee-break chat, a phone call, a skype conversation or an email), it was efficient and beneficial and had a positive impact upon the university spin-out process. Meeting face-to-face is the key to both formal and informal meetings. In some cases (Cases 3, 5, 6 and 13), good relationships were reflected in good communication and even developed further into friendships or trust. Good communication also allows TTMs to perform their roles better (e.g. *N12*, *N13*, *N15* & *N16*) and to progress the spin-out process more efficiently and smoothly.

In some cases (e.g. Cases 9, 11 and 12), TTMs choose to avoid dealing with the relationship or communication problem and simply to forge ahead with the spin-

out process. However, the purpose of developing good communications and relationships with AEs is to further facilitate university spin-out. TTMs sometimes focus more on university spin-out procedures than on adding value to the spin-out process through their knowledge and experience which may result in poor communication and relationship building and hence delay the process.

Although the knowledge gaps between AEs and TTMs are seen to be a key barrier to their communication, most TTMs and AEs in this study seemed to handle them well and to have developed good communication strategies – namely: getting to know each other gradually; TTMs filling knowledge gaps by providing complementary or external knowledge, explaining the process to AEs, and having regular face-to-face meetings; and TTMs clarifying what AEs are expected to do, and what TTMs are able to offer. Naturally, people as intelligent and professional as AEs like to feel that they are in control and that their understanding is complete. Furthermore, as discussed, most of the cases in this study indicate that the meetings between TTMs and AEs are rather informal. Less than one-third of the cases hold monthly face-to-face meetings. Although informal meetings allow TTMs and AEs to keep each other up-to-date and to keep the contact frequent and meaningful (Kraut et al., 1982; Kraut et al., 1990), the analysis also shows that it is crucial to have regular face-to-face formal meetings to ensure that the UTT knowledge gaps are filled, not only for AEs, but for all the stakeholders involved in the process.

The analysis shows that trust between TTMs and AEs is important and, as long as it lasts, can have a positive impact on the development of university spin-out and its AC, whilst a loss of trust can delay or even block the spin-out process. It can also be seen that the building of good working relationships does not necessarily lead to trust building and that trust needs to be maintained carefully because it can be broken, for various reasons, at any stage of the spin-out process.

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Table 13 Narratives Concerning the Knowledge or Skills that Equip TTMs to Contribute to the University Spin-out Process

Participant	The knowledge or skills TTMs require for the process	How do TTMs really contribute to the process?
TTMs	**1. Personal Skills or Traits** • *"To actually work with the academics, it's very much a personal relationship that you have to build up; you need their trust and they need to trust you to show that you actually know what you're talking about. To work with academics in general you have to massage their egos at times (...), but also - to build that relationship you want that trust, and once you've got that trust in there, then you can be a bit more open with them." (TTM1)* • *"Hopefully I was supportive and have boosted their confidence and was reassuring. I hope I was challenging so that it wasn't too easy and created a robust company that could survive and do business." (TTM2)* • *"You have to have good people skills, be able to manage academics that aren't used to being managed; you have to learn how to deal with that, you can't tell them what to do. Time management is important, prioritising and basic work skills are very important. You need to be able to talk to people outside of the university and sell the concept to potential funders and be a sales person. Basic project management skills you have to have at the back of your mind all of the time. Risk analysis and lots of things like that. You have to be able to ask difficult questions of academics and other people." (TTM4)* • *"You need to be a good negotiator, and a mediator. And also from my own experience you need to be able to gain people's respect and confidence in a good way." (TTM5)* • *"It is a personality thing. You need to have the personality. It is very easy to just sit in front of the desk and just respond to the emails. This is very different to try to do a bit more and lead the academics on the journey to do a bit more. I think that is what is needed." (TTM6)* • *"One of the things you need right at the beginning is quite good personal skills because, unless you can establish a comfortable working relationship, I think it is*	**1. Facilitating the University Spin-out Process** • *"I don't think it would have happened. I also got involved in an internal political situation, and I just forced it through. I generally say it wouldn't have happened." (TTM5)* • *"It would never have happened without me, and it won't be viable without me either. There is a big difference between having a spin-out company and having a viable one. What I make happen is all the extra work which means the difference between whether it is going to get any money to survive, and I think that is what academics don't appreciate really. They don't realise how hard it is to raise money, or how they really don't have the skills to do it. I know how hard it is and how much time it takes and what level of detail you need to get money. That is always the key to spin-out companies, raising the finance. (…) I think spinning out a company requires such a complicated mix of skills and experience that you need at least one person, and in this case it was me." (TTM7)* • *"I wrote the initial business plan with AE13, I helped talk to and identify a CEO for the company, talked to investors and I negotiated IP agreements with a US university where there was a claim on ownership on the IP which could have stalled the whole process. I have worked with AE13 to understand what development the technology needed and what he was able to do in-house, what we needed to outsource. Implemented relationships with the funders and negotiated all the commercial agreements for the spin-out. (…) So I guess it probably wouldn't have happened without me or without a manager who believed in the technology or*

	hard to work with somebody else if they don't match properly so I think that is important." (TTM9) • *"Strong personal skills, people skills like a people orientation toward listening, understanding what their issues are, and then utilise them individually." (TTM11)* • *"Lots of personal skills, persuasion and negotiation with very many different types of stakeholders, and energy and motivation from the individuals to do things. (…) So we need to understand, we need to be commercial, highly motivated, highly organised, and we need to be aware of what the needs of each of the different stakeholders are." (TTM13)* **2. *Commercial or Related Process Knowledge, Experience or Skills*** • *"You also need to have knowledge around funding opportunities that are available; so investors, but also grant funding and different initiatives." (TTM1)* • *"It should be the TTMs who bring the commercial knowledge or just the knowledge about the process. A commercial mind is required for TTMs, but not a strong commercial track record − just knowing when to bring people in." (TTM6)* • *"The most important knowledge and skills are general business skills, understanding of the commercial world and being able to operate within it. Being able to translate sometimes quite complex scientific formulations into a business." (TTM8)* • *"I think you need to be able to understand what the economic climate or business climate is like and to be able to separate as well the difference between a very good sound technical scientific idea and a strong commercial position. I think that's a very important skill to be able to get that balance right between technical appreciation and commercial knowledge." (TTM12)* **3. General or Relevant Technical Knowledge** • *"I think you need to understand the technology to some level - I mean if you're going in not understanding it at all, that would be a problem when you're talking to investors and customers. But I think that, because forming a spin-out company doesn't happen overnight, I think that knowledge is acquired as you continue, as you work with the academics and the founders." (TTM1)* • *"I think I brought some technical knowledge certainly in reviewing documents and business problems." (TTM2)*	*who believed, or had the time and energy to put into it, because I guess TTMs can be much more passive in the role, and just do things that require doing. Whereas for a university spin-out to succeed you need to be proactive, and I think I was very proactive throughout the whole thing. So I guess I was the one who held all of the pieces together, but that is the technology transfer manager's role, so if it wasn't me and it was a different technology transfer manager and if they didn't do those things then it wouldn't have spun out or the relationships could have broken down which would have made things difficult." (TTM13)* **2. Bringing AEs into Contact with the Right People** • *"I think it has really been helping the academic accessed funding to come up with a solution. It was reviewing a lot more out there with them, and I said okay we try this and that and determine there is no other thing out there. And then getting them the funding to do something that is going to work. (…) It's also about networking. Getting the right people in the right place at the right time." (TTM6)* **3. Pull the University Spin-out Process Together/Guide the University Spin-out Process Forward** • *"I would say that if they didn't have access to the TTO, as a whole, not just to me, then this wouldn't have progressed to where it is now. And I think if they didn't have access to me, then their motivation would have stalled quite some time ago; and I don't think they would have got to the point where we've got a spin-out company. I think they would have lost motivation and potentially lost interest." (TTM1)* • *"Well I am one of those fortunate people who is necessary. I think it is a case of helping make sure that those multiple areas are looked after, but (...) in a way the most important thing is working to identify a commercially valuable technology at the beginning. As long as you have actually got that right and know this is valuable, it is about*

	• *"I don't have any related technical knowledge. (…) Yes, it does limit me in some ways to work with academics because I can't hold technical conversations with them, which is why I'm the commercial projects manager and not a business development manager. Those two roles work closely together because I need to go along with one of them and they can talk technically and understand it, ask questions, and I can't do that." (TTM4)* • *"… but only on commercial things - depending on the technology you don't need to understand in great detail the science. You might need somebody to interpret that for you, and to make sure you're not having the wool pulled over your eyes." (TTM5)* • *"I think you've got to have a general appreciation of what they do. You need to understand the sector they are working in. You need to understand the fundamental principles and process, and the IP rights. (…) Sometimes, the technical aspect I struggled with. If I had a better understanding of the technical part, I might do a better job than I am now. So although I can hold my own I think more in-depth technical knowledge would help." (TTM6)* • *"I think it helps personally if you've got quite a lot of technical understanding of what they are doing. If you don't have any technical understanding of what they are doing at all, how do you know what you are investing a fair amount of your time in, and how do you know that it is not completely a waste of your time? (…) So the more technical knowledge you have which is relevant, that has to help. I can't say it is necessary, but some technical knowledge is helpful." (TTM9)* • *"I think it helps to have efficient technical understanding and to at least be able to have a conversation about the research the project is based on − what is the reasoning behind the company? So to be able to at least have that, maybe not understand in the same depth as when it originated, but to at least have an appreciation of the key points." (TTM12)* *4.* **Understands Spin-out process, Familiar with University System, and has Previous University Spin-out Experience** • *"I would say I am quite new to spin-out company formation really, so some of the information around the way the university functions and what's required within the university for the spin-out company, I'm not so clear on, and that's where I call upon colleagues such as (...) who's had that experience. Around the actual company documentation, I don't have that knowledge, but I think I've got the support network around me that's required, so I can very much help the company, and if I'm in a*	*responding, being slightly reactive going forward. It is also about those multiple things: keeping the team together, keeping people focused and making sure no one is dropping off the list, looking after the university's interest and all those sorts of things." (TTM10)* **4. Making Sure Every Process Follows the University's Procedures** • *"I think it's making sure it follows the university procedure. We have a (...) set of ways of doing it that we know who it works for. And get it to the point of incorporation, investment with the right type of license, the right kind of involvement of the key current scientists, the founders. An investment agreement and association where everyone's responsibilities are right regarding each other, and structure everyone's interests as commonly as possible." (TTM11)* **5. Co-completing All the Paperwork** • *"I co-write all the paperwork and towards the business case as well. I manage the relationship with the consultant, so it's part of my job to write the business case and manage the relationship. I manage our patent portfolio in such a way our position is strengthened. I've procured reports on market opportunities and due-diligence to support the case." (TTM3)*

	position where I don't know the answer then I can just come back to my colleagues and they answer it..." (TTM1) • *"There are some things like understanding the legals [sic] and the way one structures deals and so on, so there is a range of legal knowledge there one has to have or have access to." (TTM2)* • *"I think going back to the understanding in the background of research, very strong management and negotiation skills as well. Legal to a certain degree, but not entirely necessary; we also have a law firm that we can ask for specific support. Making use of specialists in a particular area is important. Management and understanding the skills to work through the process for a spin-out and understanding what requirements within diligence are important." (TTM3)* • *"You need to understand IP, you need to understand company law, you need to understand finances, you need to understand market opportunities and markets, and you need to understand how people work, so you almost need to know, to a degree, a lot about the entire business process." (TTM5)* • *"The key thing is at the start you are not very confident, and that is because it is such an ambiguous process, you don't know where your academics are going to lead you with particular questions. When you have more experience, it is not about the specific technical knowledge, it is about the level of confidence you are doing it in the right way and giving the best advice. That is why it is more like an experiential learning." (TTM11)* • *"All those aspects I have pretty good experience of doing but it would probably be simply because of the volume I dealt with. I haven't had the window of opportunity to actually deal direct with raising venture capital, but that is where we utilise the specialists, such as the business mentors we have who can take on that role." (TTM12)* • *"I think, particularly in the first spin-out, some of the commercial agreements, I was much less familiar with, so my skills and knowledge weren't as good, but that was where I would work more closely with my managers and colleagues to support me in that. You only get experience by doing, as well, so sometimes, the first time you do something you will never know as much as when you have done it 2 or 3 times. But that is where you have to work with your colleagues and work as a team within the organisation. So if you know you don't know enough about a certain area then you work with people who do and can help you." (TTM13)*	

AEs	**1. Personal Skills or Traits** • *"I suppose they have to tolerate academics that don't always answer emails or the phone or have other ideas on how the projects might go." (AE5)* • *"I think the personal enthusiasm of TTM6 works extremely well. I think the approach the university has, to put you in the same room with a potential investor, works very well. Providing academics with good communication is very good." (AE6)* **2. Commercial or Related Process Knowledge, Experience or Skills** • *"I think it is good if they have some business experience, but I think they also need a good understanding of what drives academics because we are not business people. So it is a combination of knowledge about two different types of worlds that somebody needs." (AE2)* • *"I do think these TTMs need to have experience of working with companies, they need to know the constraints of companies, and they need experience of working with business angels and venture capitalists." (AE3)* • *"Past business experience is crucial, because a lot of people haven't done the spin-out process and haven't had the experience so it has taken a bit longer - so experience is vital. You need to know what the market is like and what people expect of the company too." (AE7)* • *"A good knowledge of all business issues that you need to set up a company and run it. Probably a good knowledge of legal implications as well." (AE8)* • *"I do not think TTM11 has the right experience or is business minded. It is a difficult one because what you really want is people who have been through, for example, the CEO process before; to tell us what has happened." (AE11)* • *"TTMs should have business knowledge of commercialisation, and I think they are all very good in this respect." (AE13)* **3. General or Relevant Technical Knowledge** • *"It helps to have technical knowledge as you can spell out everything. In life it's difficult to speak to someone without any experience. So it's good for them to have some understanding of what we do." (AE1)* • *"I think it is helpful if the TTM can understand the science, but it is not essential. I think it is in the exploitation side that you need more direct experience in industrial sectors." (AE3)*	**1. Facilitating the University Spin-out Process** • *"I think it was very positive. They offered us lots of advice about the business plan, marketing and all sorts of things, about how we should develop the business, and all of that was very helpful." (AE2)* • *"Their expertise and their areas. So TTM7 knows about IP and I had never read a patent until we filed for one, and it is a totally different language. If you look at them it is so complex to understand, so it is good to have specialist skills that a normal academic wouldn't have in these areas. I think it isn't just one skill TTMs offer, they have experts in all different regions so whatever problem you face they will have someone who has some knowledge of that area. (…) It wouldn't have happened without them because they do all the patenting, and you have to engage with them to come up with the patent. I think they are valuable at every stage of the process, I mean everything we have done they have given us some sort of assistance along the way." (AE7)* • *"Firstly they were involved in the first step of the evaluation and putting us in contact, supporting the project. Then their knowledge of IP was essential because they had a portfolio of patents and knew what would be good for the company or not, and they helped with the whole IP package which was crucial at this stage as the value of the company was based on that. Their contribution was crucial. We couldn't have done it without the TTM or the TTO for sure, because they put us in contact with funders, so all that wouldn't have been available." (AE10)* • *"TTM13 was excellent with writing a business plan and dealing with investors, lawyers, accountants and that sort of thing, so that saved me a lot of time and energy because I can't do all that." (AE13)*

	• *"I think also they have to have knowledge of the technology they are trying to spin-out because the academic has the knowledge but the TTM also has to understand the material and the business and the marketplace where the academic wants to take the product. Without that, it is very difficult for the TTM to really find the right investor." (AE5)* • *"They need to know exactly how to exploit technology for a successful business." (AE12)* **4. Translating What AEs Say into Non-technical Language for Investors** • *"Having an understanding and knowing what they are talking about, you need to, because everyone in industry talks in these terms and if you don't know what all the different acronyms are then you are stuck. I think for example the exhibition booth we did, the other TTM4, he came along with us and was on the booth with another person who has been on the project the entire time, and she was making contacts and chatting to all the people about it and had to come up to speed with all the technical knowledge we had in a very short amount of time. TTM4 managed to successfully convey the message to everyone about our technology, so being able to learn everything quickly and understand it is a key feature and necessary in what we do." (AE4)* • *"If you want to try to get funding, then first of all people will ask what the technology is about. You have to attract people by telling them about it in one or two sentences, and without knowing the project very well you can't do that. So I think TTMs have to know your project very well." (AE13)* **5. Understands the University Spin-out Process and is Familiar with University Systems** • *"It's interesting that TTM6's real skill is he knows his way around the university system and he is very good at that." (AE6)* • *"I think in the initial stages they need to know the legalities of how you get patents and what you have to do. They need to have contacts that allow them to get professional advice on the structure of a patent. They need to then follow the patent process through and make sure the academic is allowed to get on with his science and the patenting process is professionally managed." (AE3)*	**2. Bringing AEs into Contact with the Right People** • *"TTM5 came on board pretty quickly. He started doing background work on the markets we thought were there. He seemed to spend quite a lot of time doing some background work, understanding the market place and also what investors were out there. I mean I think he was aware through his everyday work and intelligence which investment companies were out there and who had money. So he had that already so he knew where to start, who to start and contact. That's how TTM5 really came on board. As soon as we started dealing with the IP investment, TTM5 came in with some knowledge about the investors and where money could come from. So that was good, TTM5 knew there was more work to do, but he knew immediately where to start looking. The spin-out couldn't have happened without him, there is no way I could do it myself - I wouldn't know where to start." (AE5)* **3. Pull the University Spin-out Together/Guide the University Spin-out Forward** • *"TTM3 has assisted by making the process within the university straightforward at the minute." (AE3)* • *"TTM4 kept us very organised, because there is a lot of documentation about what we did. We had road maps made of exactly where we needed to go, what our aims were, and what we needed to do, step-by-step milestones. So there was a lot of planning and organisation of what we needed to do at each stage; for example liaising with consultants. Also the time line of things we were very conscious of; if we need to get to here by this point then we need to talk to this person etc. and we need to get information back by this date. So it was an organisational and planning role, keeping us on our toes and keeping their ear out for any potential funding or anything that could benefit us in the long run, or any news articles from*

	• *"I would say they don't have enough knowledge and experience to help with the spin-out. There are several aspects here. One thing is they don't have enough resources and money." (AE9)* • *"They always know what they are doing and are very professional. I feel confused because I don't understand the business part of the project. They try to explain and I understand in the end but at the beginning I was quite lost. But I know they are doing the right thing. I understand the general picture but not the business detail." (AE13)* **6. Networking Skills (Make contact, Introduce, and Set up Meetings with All the Relevant People)** • *"Getting good advice on those is what you need most but it is the hardest thing to find, so in a sense I don't expect someone like TTM2 to have that knowledge, but to have access to people who might point you in the direction of that knowledge." (AE2)* • *"So the knowledge and, even though it was limited, experience on university spin-out stuff, even the knowledge TTM5 did have was vital." (AE5)* • *"I think what TTM8 has brought is a lot of contact with other people because he knows so many other relevant people we need to talk to, and that is something he has really brought to the company that perhaps the other people don't have." (AE8)* • *"I don't think there is any skill gap, but there is a problem with resources. So they have people, but actually putting the right people into the right task... They are doing different jobs, but not on different projects. So getting the right people on to the right project seems to be a problem. I guess it is maybe because they are under resourced or pushed in different directions." (AE9)* • *"They need to know what are the difficulties that the university spin-outs would be facing and what kind of support they can provide or otherwise, and also the contacts they can put forward for the academics." (AE12)*	*potential competitors which we may have missed and may influence what we are doing." (AE4)* • *"I would have thought it was key for getting everything set up, because we certainly didn't have that business knowledge, we were dependent upon TTM8 and whoever was in that role guiding us through the process. So I think his role was crucial." (AE8)*

5.2 The Observed Abilities of TTMs and their Contribution to the Spin-out Process

In the previous analysis, the study has discussed the prior knowledge of TTMs and the perceptions and expectations of the role from both TTM and AE perspectives. From observation of the relationship building, communication, and trust building between TTMs and AEs, it can be seen that the prior knowledge of TTMs also serves as a major component that contributes to the combinative capabilities of a spin-out's AC and has a significant impact on the collaborative relationship with AEs. However, some AEs had doubts about the role of TTMs and what they can contribute to university spin-out and it appears that suspicions about their role and ability can influence their relationship building and communication during the university spin-out process. In this section, the study will look at: the prior knowledge and combinative capabilities required for a TTM to progress a university spin-out; how, in practice, they contribute to the process.

5.2.1 The Knowledge or Skills that Equip TTMs to Contribute to the University Spin-out Process

(1) Personal Skills or Competences

TTMs are considered to have a vital guiding, coordinating and motivational role in the spin-out process (see Section 4.2.2). Therefore, when looking at the TTM contribution to university spin-out, it is not surprising that TTMs and AEs both felt that TTM personal competences or skills were of the foremost importance with regard to performance. TTMs thought that they should have the following abilities (see Table 14), or more precisely, personal competences or skills, and that these equipped them to play the role well, and to improve interactions, relationships, and communications with AEs, thus benefitting the entire university spin-out process and its AC development from the beginning. Table 14 provides an overview of the key personal skills or competencies that TTMs and AEs believe TTMs contribute to the spin-out process.

Table 14 Personal Skills or Competences which enable TTMs to Contribute to the University Spin-out Process, from TTM and AE Perspectives

TTMs	AEs
a) Build up personal relationships and trust with AEs b) Establish a comfortable working relationship with AEs c) Deal with AE egos d) Boost AE confidence and stimulate AE interests about interactions e) Motivate AEs to do things f) Keep track of what AEs are doing g) Manage AE expectations h) Undertake the time, risk and project management for the university spin-out process i) Be a good negotiator, persuader and mediator with different types of stakeholders j) Listen to and understand what the issues are during the university spin-out k) Support AEs in achieving their aims	a) Tolerate the busy AE schedule and the fact that AEs are less knowledgeable about the university spin-out process b) Demonstrate enthusiasm for undertaking university spin-out with AEs c) Be able to communicate well with AEs d) Support AEs in achieving their aims e) Encourage AEs to move forward f) Be flexible and listen to AE concerns g) Establish trust between AEs and themselves

From the AE's point of view, TTMs are expected to be there every step of the way, to fill the knowledge gaps, communicate, move the process forward and then achieve the aims. They also want TTMs to be flexible and listen to their concerns and expect to have a trusting relationship with TTMs. TTMs share the same views as the AEs. On one hand, they feel they provide guidance and encouragement throughout the process, establishing a comfortable and trusting relationship with AEs from the beginning, motivating the AE to disclose their research output, boosting AE confidence, and ultimately supporting them in the achievement of their aims. On the other hand, TTMs also consider themselves to be important coordinators in the spin-out process, undertaking risk and project management, as well as keeping track, negotiating, and mediating with

stakeholders. TTM13 stressed the importance of the TTM's personal skills in a more comprehensive way: "Lots of personal skills, persuasion and negotiation with very many different types of stakeholders, and energy and motivation from the individuals to do things. (…) So we need to understand, we need to be commercial, highly motivated, highly organised, and we need to be aware of what the needs of each of the different stakeholders are." So not only do they need to be skilled in dealing with AEs, they also need to be able to deal with, manage, and coordinate all other stakeholders in the process.

As indicated in Table 14, although the personal skills or competences required for TTMs to contribute to university spin-out are very similar from both TTM and AE perspectives, TTMs feel that they contribute much more than the AEs expect. This may be because AEs lack prior UTT knowledge or have higher expectations and hold very different opinions on whether those expectations have been met by TTMs, as discussed in the previous analysis (see *N3* & *N12*). Also, for various reasons including heavy workload or lack of trust, some TTMs might fail to fill the knowledge gap and push the process forward. Alternatively, might it be that TTMS have unrealistic perceptions or expectations of themselves?

(2) Commercial or Related Process Knowledge, Experience or Skills

Previous research has indicated that there is a need for TTMs to improve their commercialisation skills, especially the necessary business, marketing, negotiation and entrepreneurial skills (Siegel et al., 2004; Lockett et al., 2005; McAdam et al., 2009). It has been widely discussed in this study that there are doubts about whether TTMs all possess the commercial or related process knowledge, experience or skills needed to assist with the commercialisation aspect of university spin-out. TTMs and AEs both considered that this was one of the most important attributes of a TTM; they should be able to contribute commercial knowledge and knowledge about the process and most importantly to fill the knowledge gap for AEs and improve communication. This could greatly affect the whole of the spin-out process and the development of its AC.

Given the nature of their job, TTMs should be commercially minded. As TTM6 mentioned, “It should be the TTMs who bring the commercial knowledge or just the knowledge about the process. A commercial mind is required for TTMs, but not a strong commercial track record − just knowing when to bring people in.” This is consistent with arguments by McAdam et al. (2009), which emphasise that it is important to have TTMs who possess a solid understanding of commercialisation processes. TTMs should also be familiar with the economic climate for business and capable of developing ideas towards a strong commercial position (TTM12). TTM12 said, “I think that’s a very important skill to be able to get that balance right between technical appreciation and commercial knowledge.” TTMs also considered it important that they had the knowledge to obtain access to available funding opportunities.

It can be observed that AEs rely on their TTM’s commercial knowledge/skills during the university spin-out process since they lack such knowledge/skills and experience themselves. Most AEs considered the TTM’s business/commercial experience valuable, as described by AE2: “I think they also need a good understanding of what drives academics because we are not business people. So it is a combination of knowledge about two different types of worlds that somebody needs.” AEs also expected TTMs to have experience of working with investors.

(3) General or Relevant Technical Knowledge

In order to help AEs with the commercialisation of their research output, TTMs firstly have to understand what exactly they are trying to commercialise. This brings out the important question of whether TTMs need technical knowledge related to the AE’s idea (especially when most university spin-outs are science related). TTMs and AEs agree that TTMs require only general or relevant, rather than detailed, technical knowledge, which is helpful, but not essential. Initially, the contribution of a TTM’s prior technical knowledge is mainly to the development of spin-out AC (especially PAC). As the importance of shared language has been addressed with regard to both prior knowledge and combinative capabilities (Cohen and Levinthal, 1990; Kogut and Zander, 1993), it could also be of crucial

assistance to connecting/closer communication with AEs internally, and could speed up the exploratory learning capacity of university spin-out (RAC).

Despite this, TTMs are able to communicate and better arrange access to the right market place, customers or investors if they understand the technology they are selling. Such an understanding could therefore help to develop a more extensive and dense network with the external environment which may possibly enhance the spin-out RAC (Cohen and Levinthal, 1990; Jansen et al., 2005). TTM12 said, “I think it helps to have efficient technical understanding and to at least be able to have a conversation about the research the project is based on − what is the reasoning behind the company?”. As AE5 argues, “also they have to have knowledge of the technology they are trying to spin-out because the academic has the knowledge but the TTM also has to understand the material and the business and the marketplace where the academic wants to take the product. Without that, it is very difficult for the TTM to really find the right investor.” AEs generally thought this helped with the communication with TTMs. AE1 commented, “In life it’s difficult to speak to someone without any experience. So it’s good for them to have some understanding of what we do.” TTMs might also do their job better with more understanding of the technology. For example, TTM6 said, “Sometimes, the technical aspect I struggled with. If I had a better understanding of the technical part, I might do a better job than I am now. So although I can hold my own I think more in-depth technical knowledge would help.”

(4) Translating What AEs Say into Non-technical Language

Whether or not TTMs had related technical knowledge, AEs strongly agreed that TTMs should be able to help them interpret pure technical language into non-technical, more commercial language: “being able to translate sometimes quite complex scientific formulations into a business” (TTM8). This is especially important to spin-out RAC when TTMs are helping AEs to make their idea commercially ready, market ready, and investment ready and when AEs are developing the ability to pitch their idea to find funding for the university spin-out (e.g. *N10* & *N12*). AE13 said: “If you want to try to get funding, then first of all people will ask what the technology is about. You have to attract people by telling them about it in one or two sentences, and without knowing the project very well

you can't do that. So I think TTMs have to know your project very well." From the AE perspective, this ability is more important than the technical knowledge required. As mentioned, TTM4 felt that his lack of technical knowledge limited his working relationship with AEs. However, AE4 said: "TTM4 managed to successfully convey the message to everyone about our technology, so being able to learn everything quickly and understand it is a key feature and necessary in what we do".

(5) Understanding of the University Spin-out Process and Familiarity with University Systems

As discussed and well-acknowledged, one of the most important duties of a TTM is to help AEs go through the university spin-out process in accordance with university systems (e.g. *N15*), simply because, after all, university spin-outs are co-owned by the university and the AEs. There are some key aspects on which TTMs should focus when building their process related abilities.

First, the accumulation of university spin-out experience could be helpful (e.g. *N3*). As discussed in the previous chapter, since each university spin-out process is unique, previous university spin-out experience cannot provide much help with future university spin-out activity. However, TTM11 felt that "When you have more experience, it is not about the specific technical knowledge, it is about the level of confidence you are doing it in the right way and giving the best advice. That is why it is more like an experiential learning."

Second, many TTMs considered the legal aspects to be significant while forming a university spin-out under a university system. TTM2 mentioned: "There are some things like understanding the legals [sic] and the way one structures deals and so on, so there is a range of legal knowledge there one has to have or have access to." Most TTMs seek assistance from the law firm with which they usually work, therefore they just need to make sure they can find legal support when they need it. TTM5 also argued that, other than legal support, "You need to understand IP, you need to understand company law, you need to understand finances, you need to understand market opportunities and markets, and you need to

understand how people work, so you almost need to know, to a degree, a lot about the entire business process."

As for AEs, it is important that they can tell whether or not their TTM is familiar with the whole process or university system. It could significantly impact upon their relationship and trust building and indeed the whole collaboration and the spin-out PAC and RAC. TTM13 explained, "They always know what they are doing and are very professional. I feel confused because I don't understand the business part of the project. They try to explain and I understand in the end but at the beginning I was quite lost. But I know they are doing the right thing. I understand the general picture but not the business detail."

(6) Networking Skills

To complete the university spin-out process, a great deal of knowledge is required and more people need to be involved. It is not possible for a TTM to have all of the necessary knowledge and experience. Therefore, there is one final important skill set which the TTM must have every time – networking skills.

TTM1 acknowledged that he was relatively new to university spin-out formation, but that he was confident that he could access all the support he needed from his colleagues; the team at the TTO. "I think I've got the support network around me that's required, so I can very much help the company, and if I'm in a position where I don't know the answer then I can just come back to my colleagues and they answer it..." AEs especially emphasise the importance of networking skills for TTMs. AE2 thought that "Getting good advice on those is what you need most but it is the hardest thing to find, so in a sense I don't expect someone like TTM2 to have that knowledge, but to have access to people who might point you in the direction of that knowledge." "They need to know what are the difficulties that the university spin-outs would be facing and what kind of support they can provide or otherwise, and also the contacts they can put forward for the academics," said AE12. AE5 considered TTM5's prior knowledge and university spin-out experience to be both important and helpful because TTM5 always knew who to talk to or what to do next and was able to immediately take action or contact the appropriate people. "So the knowledge and, even though it was limited, experience on university spin-out stuff, even the knowledge TTM5 did have was

vital," he said. Networking skills that contribute to the boundary spanning role of TTMs are again seen to be crucial at all stages of the university spin-out process, as well as to the development of its AC as a whole. For example, in the exploratory learning stage, TTMs could bring in professionals to help with due-diligence. In the exploitative stage, it is important that TTMs help AEs to connect with all the necessary contacts in commercial exploitation.

5.2.2 The Observed Contribution of TTMs to the University Spin-out Process

After analysing the knowledge or skills required for TTMs to contribute to the university spin-out process, the study examines the actual contribution TTMs make to the process. From the TTM perspective, TTMs and the TTO as a whole provide the access and resources to motivate AEs throughout the university spin-out process. TTM7 commented that, "Spinning out a company requires such a complicated mix of skills and experience that you need at least one person, and in this case it was me." The majority of TTMs and AEs considered that the university spin-outs in which they were involved would not have happened, or not have been viable, without TTM contributions. Such contributions included:

Table 15 The Observed Contributions of TTMs to the University Spin-out Process from the Perspectives of TTMs and AEs

TTMs	AEs
a) Providing assistance with due-diligence, dealing with patents and IP agreements, legal support, fund raising, identifying a CEO for the company etc. and keeping all the pieces in a university spin-out together (TTM5 and TTM13) b) Managing relationships between AEs and all the necessary contacts (TTM6) c) Keeping everyone involved motivated and focussed, making sure that no one 'drops off the list', and keeping the university spin-out in progress (TTM1 and TTM10) d) Making sure the university spin-out follows university policy and procedure (TTM11) e) Co-completing all the paperwork − business plans, market opportunity assessments and analyses, investment agreements and shareholder agreements − all sorts of company formation documents (TTM3)	a) Contributing their expertise and experience to provide advice about business plans, marketing, fund raising, IP agreements, and many other assorted things (e.g. AE2, AE7 and AE10) b) Helping AEs to liaise with the right people at the right time, always knowing what work to do next and knowing immediately where to start looking (AE5) c) Setting everything up in accordance with university procedure (e.g. AE8) d) Keeping AEs organised, and guiding them through the process, to reach milestones and achieve their goals (e.g. AE3, AE4 and AE8)

The key to completing a successful university spin-out is that TTMs have to believe in the technology and the outcome and also be proactive during the process (for example, Cases 1, 6 and 13). TTM13 said: "it probably wouldn't have happened without me or without a manager who believed in the technology or who believed, or had the time and energy to put into it, because I guess TTMs can be much more passive in the role, and just do things that require doing. Whereas for a university spin-out to succeed you need to be proactive, and I think I was very proactive throughout the whole thing." However, TTMs sometimes felt that some AEs appreciated neither their contribution, nor how difficult some aspects of the university spin-out process (for example, raising funds) can be (e.g. Cases 7, 9, 11).

Most AEs valued the TTM role as helpful, positive, even crucial, especially when contributing to university spin-outs. Compared to the perceptions and expectations of the TTM role and the knowledge and skills required of TTMs discussed in the previous analysis (see Section 4.2.2 and Section 5.2.1), it can be seen that the TTM's actual contribution is consistent with what they are expected to do. The exception to this is that AEs still felt TTMs were not proactive enough in exploring the commercial opportunity of their innovative research, which has been discussed several times in the previous analysis. It is interesting to note that, when they were asked about the TTM contribution, ten of the thirteen AEs said that their university spin-out would not have happened without TTM/TTO assistance and support. As AE13 mentioned, "Without them [TTMs] it wouldn't have happened. That is the simple answer."

Summary

In this section, we look into the actual contribution of TTMs to university spin-out and the knowledge or skills required for them to make that contribution. It can be seen that the part TTMs play, given their prior knowledge and experience of university spin-out, is highly valued and acknowledged by AEs, and that their contribution is generally consistent with the perception and expectations of their role and the knowledge and skills which are required to assist with the process. TTMs and AEs both note the complementary functions of TTMs; that they should fill the knowledge gaps of AEs, network with appropriate contacts, and help AEs to translate their ideas into more commercially understandable language during a university spin-out. They also highlighted the importance of having close communication and a trusting relationship with their TTMs. All of these elements help to construct a strong basis for the combinative capabilities needed for university spin-out PAC and RAC (Cohen and Levinthal, 1990; Kogut and Zander, 1993; Jansen et al., 2005). A more in-depth discussion of the contribution made by the entire analyses and discussion in Chapters 4 and 5 will be presented in Chapter 6.

CHAPTER 6

Conclusions

Based on the findings of the thirteen case studies, this research reveals the prior knowledge and combinative capabilities that constitute university spin-out AC and how these determinants affect different dimensions of AC development. The results provide us with a better and more comprehensive understanding of the role and importance of TTMs and AEs in the university spin-out process, and how their collaborative and synergistic relationship contributes to the development of spin-out AC. Therefore, this concluding chapter: outlines the author's theoretical reflections and the study's contribution to the AC and UTT literature in Section 6.1; points out the limitations of the work in Section 6.2; draws out the practical implications and recommendations for practitioners in Section 6.3; and makes recommendations for future research in Section 6.4.

6.1 Theoretical Reflections and Contribution to Knowledge

The general aim of this study, as addressed in Chapter 3, is to reduce the ambiguity of the knowledge transfer process by monitoring the antecedent factors and the interactions of the participants involved. The study looks at two key identities which are both involved in the spin-out process from the beginning – TTMs and AEs – to see how they work together and transfer knowledge from pure academic research output into something which is commercially viable, and also to see how they fit into the context of university spin-out companies. The study therefore developed a process model (see Figure 8), which was first introduced in Chapter 2, in an attempt to understand the key determinants of university spin-out AC, and their impact upon its creation. This novel process model combines individual and organisational level perspectives on AC development, which have never been conceptualised in this way before. The central research question is as follows:

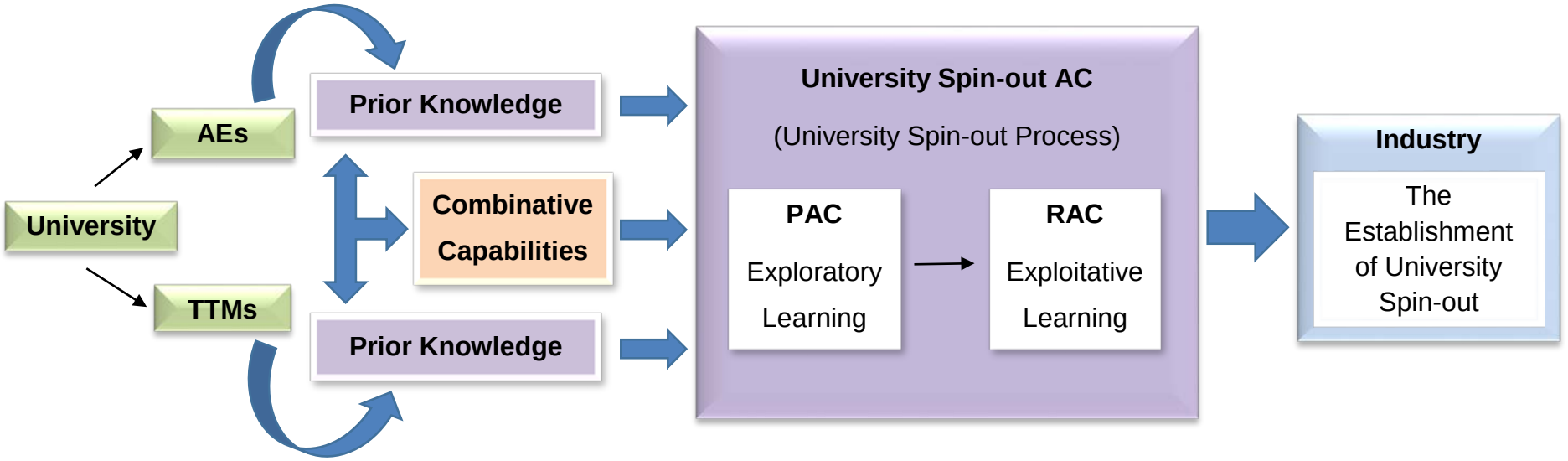

Figure 8 A Process Model of University Spin-out AC, its Determinants, and its Impact
(Re-printed from Section 2.3.3 for the reader's convenience)

RQ. How does the interaction between AEs and TTMs contribute to the development of AC within university spin-outs and how does this affect the commercialisation process?

Two research objectives were addressed in order to answer the research question. First, the determinants that constitute university spin-out AC, shape the role of AEs and TTMs, and facilitate their collaboration in the university spin-out process were identified. Second, the impact of the roles of AEs and TTMs and their collaborative and synergistic relationship on different dimensions of the spin-out process were revealed. The findings contribute greatly to our appreciation of current UTT development, considering that spin-out creations have been scarce in recent years. The results of this study are a novel contribution to AC and UTT related research, as shown below.

6.1.1 Contribution to the Absorptive Capacity Literature

AC refers to an organisation's capability with regard to knowledge acquisition, assimilation, transformation, and exploitation (Cohen and Levinthal, 1990; Zahra and George, 2002). The present study looks specifically at how knowledge is generated and employed by TTMs and AEs in the university spin-out process.

Prior knowledge has been discussed in some previous studies (see Chapter 2) in terms of the knowledge, skills, and experience needed in order for TTMs and AEs to contribute to UTT, and all hold different opinions on the purpose of the knowledge required and how it will affect UTT (e.g. Siegel et al., 2003; Lockett and Wright, 2005; McAdam et al., 2010; Muscio, 2010; Link et al., 2015). Adopting an AC perspective allows the study to take a closer look at the knowledge or experience necessary for the learning process of university spin-out PAC and RAC. Thus this investigation first looks at the prior knowledge of AEs and TTMs that allows them to contribute to university spin-out AC on an individual level.

Prior technical knowledge seems to be the key requirement for TTMs to contribute to UTT, as addressed in previous studies (Siegel et al., 2003; Siegel

et al., 2004). This study goes beyond the existing literature by examining in greater detail the need for TTMs to have such knowledge. The findings show that prior technical knowledge is indeed valuable to TTMs and contributes by establishing a shared language with AEs. It helps TTMs to work more close with AEs and to contribute to the spin-out in various ways, which include establishing an ability to understand or see the value of the AE's research output, communicating effectively with AEs, and gaining credibility, respect, and even trust from AEs regarding their capacity to assist with the process. In contrast with the findings of McAdam et al. (2010), the study participants consider a general technical knowledge to be sufficient, as external professional assistance is usually sought to complete due-diligence and to examine the potential of an AE's research output.

The role of TTMs in raising awareness and encouraging AEs to disclose innovations, and in confirming the potential of commercialisation opportunities has also been recognised. However, the findings of this study also indicate that, even with limited industrial experience and no prior business/commercial experience, commercial opportunities were first identified, in most cases, by the AEs. Whilst most TTMs do have industrial experience and half had business/commercial experience, only one proactively discovered the commercial potential of an AE's research output. Although previous research also indicates that the discovery of opportunity is mainly left to AEs (Lockett et al., 2005), the lack of initiative on the part of TTMs to discover opportunity certainly limits the development of spin-out PAC as identification and disclosure are two of the TTM's key functions in UTT. Under such circumstances, exploratory knowledge and prior knowledge are not fully employed in the spin-out process.

TTMs are also particularly well placed to support the AE role and to complement the limited prior business/commercial/UTT knowledge or experience and personal relationships/social networks of AEs in the university spin-out process. This counteracts the weaknesses of AEs with regard to the exploitation of research output and enhancing the RAC of the spin-out. With regard to industrial/business experience, most TTMs had experience in either or both areas and considered it to be a great help in their role. The prior knowledge of TTMs helps them to facilitate the university spin-out process, whilst also ensuring that university procedure is followed. This allows TTMs to contribute to spin-out AC

using their prior learning experience and problem-solving skills (Cohen and Levinthal, 1990). The research results, however, also suggest that TTMs should not focus exclusively on adherence to official university guidelines and procedures. The main focus should be on facilitation of the process, adding value through knowledge and experience. Failure to do this can affect an AE's perception of a TTM's fulfilment of their responsibilities. This could lead to miscommunication and distrust which delay the spin-out process.

The results reveal that technical knowledge, personal attributes, and personal motivations are the three key aspects of prior knowledge that contribute most to the role of AEs in university spin-out and underpin the PAC and RAC of spin-out. The superior technical expertise of AEs, complemented by that of TTMs, is the foundation stone of university spin-out and allows AEs to serve as CTOs/CSOs in charge of the technical support that is needed throughout the process (DTI, 2003; Lockett, 2006). The study reveals personal attributes and personal motivations of both TTMs and AEs, that trigger the increased commitment of AEs to spin-out. It shows also that AE commitment to spin-out could largely be inspired by the encouragement or support received from TTMs. This addresses a previous research gap concerning our understanding of the AE's willingness and attitude toward participating in UTT activities. Similar factors influence the attitudes and responses of TTMs. Meanwhile, as the majority of TTMs hold technical related degrees (some with PhDs), they exhibit the same strong aspirations as AEs to turn basic science into commercialised products, because they recognise both the social and academic benefit of the process. It appears that personal attributes and personal motivations not only motivate them to engage in spin-out but also support them throughout the process. Commitment and engagement are of great value in sustaining university spin-out AC from beginning to end. The antecedent factors that inform TTM and AE behaviour are not dealt with in the extant literature, but are identified in this study as integral to the successful development of spin-out.

The findings of this study show that the prior knowledge of both TTMs and AEs is complementary, or to a certain degree overlapping, which allows them to work more closely together, affecting the accumulation of combinative capabilities and contributing to the development of a university spin-out's AC (both PAC and RAC).

This study reveals also how TTMs and AEs initiate and maintain collaborative relationships with each other, something which is key to accomplishing a university spin-out. The results show that creation of as tight a relationship as possible from the beginning of the university spin-out process is crucial and that the establishment of trust can lead to the maintenance of that relationship. When miscommunication barriers occurred, TTMs and AEs involved in good working relationships had greater confidence that the problems could be solved, based on their positive working relationship and trust. This is consistent with the findings of Jones and George (1998), that the transfer of tacit knowledge requires unconditional trust between people and this strengthens the collaborative and synergistic team relationship. This study goes further, and explores what happens when TTMs fail to build up good and trusting relationships: the spin-out process and development of AC become rather problematic and prone to delay; it is difficult to resolve problems; and there is more miscommunication over the lifetime of the project. A form of path-dependency behaviour with regard to relationship building during the development of university spin-out has been discovered in the course of this study which has never been discussed in previous literature. In those cases where TTMs and AEs begin their relationships more interactively or with close communication (formal or informal meetings), the relationship tends to develop positively during the spin-out process and the barriers and problems that occur are more likely to be overcome through communication or via the trust that has evolved. Where cases fail to build up a trusting relationship, this tends to have a negative influence on the entire process and can lead to miscommunication, misunderstandings and considerable delay in any stage of spin-out AC development.

The study also substantiates the view that the combinative capabilities of university spin-out AC, contributed by TTMs and AEs, are vital to the support of trust building. For example, TTMs can establish credibility with AEs through shared language and overlapping/complementary expertise based on their prior knowledge, and hence create trust which lasts throughout the university spin-out process. Previous studies also suggest that trust between parties possibly affects the outcome of knowledge transfer and could be considered as a basis for collaboration (Van Den Bosch et al., 2003; Chen, 2004). Meanwhile, the TTM's previous UTT experience and networking skills are considered to be crucial

because they give TTMs the confidence to guide AEs in the right direction with appropriate resources and people at every stage. Whilst these aspects of prior knowledge contribute to combinative capabilities and help to shape the cross-functional boundary role of TTMs in facilitating effective communication between the various individuals involved in the spin-out (Cohen and Levinthal, 1990; Kogut and Zander, 1993; Siegel et al., 2003; Siegel et al., 2004), the findings of this study show that prior knowledge can enhance both spin-out PAC and RAC. This is especially important to AEs, as most of them have limited UTT experience, and heavily rely upon, and expect, TTMs to direct them to the right contacts and to help them every step of the way. The study shows that even those TTMs without related technical backgrounds can still make a great contribution to spin-out through their strong personal/networking skills.

By uncovering the determinants of university spin-out AC and their impact upon different stages of AC development, this study makes a notable contribution to the current AC literature and the linkage with UTT; it also provides guidelines for future research (see Section 6.4). Prior knowledge (including educational background, industrial/business experience, UTT experience, personal relationships/social networks, personal attributes, and personal motivation) has been shown to shape the role of TTMs and AEs and brings about the combinative capability of university spin-out AC through relationship building, communication and trust building. It thus contributes to the development of university spin-out AC in a number of ways. The research findings show that the prior knowledge of AEs mainly supports spin-out PAC and that of TTMs is more supportive of RAC. However, neither could contribute solely to either PAC or RAC, so their complementary role is critical. The combinative capability, amalgamated from TTMs and AEs, has an important impact on spin-out AC as a whole (both PAC and RAC).

The trust established by TTMs and AEs is mutual. AEs are more concerned about whether TTMs are competent and reliable, and TTMs would like AEs to be more open and engaged which covers all key dimensions of trust mentioned in previous research (Mishra, 1996). This study provides empirical evidence which was absent from earlier studies that address the development of AC.

Overall, the results propose a novel perspective on AC within the context of identifying the importance of prior knowledge and how it helps TTMs and AEs to establish combinative capabilities. The findings contribute to a better understanding of the spin-out process; from raising AE awareness, to TTMs and AEs working together and complementing and benefitting from each other's role in the process. A mutual trusting relationship between TTMs and AEs could also benefit AC development. This all leads us back to the process model developed by this study which is illustrated in Figure 8. The research results show that the prior knowledge of TTMs and AEs enables them to contribute to university spin-out AC at an individual level. It is believed that AEs mainly dominate spin-out PAC and TTMs add more value to RAC. However, it is also noticeable that their prior knowledge and roles need to be complementary for the spin-out to achieve optimal AC development. Combinative capabilities, amalgamated from AEs and TTMs at the individual level, grant the organisation strength by contributing to organisational AC, greatly benefitting both spin-out PAC and RAC.

6.1.2 Contribution to the University Technology Transfer Literature

The complexity of tacit knowledge transfer and UTT have been widely discussed in previous studies, and the need for TTMs/TTOs to fill the knowledge gaps in different stages of the development of spin-out has also been identified (e.g. Lambert, 2003; Siegel et al., 2003; Siegel et al., 2004; Lockett et al., 2005; Markman et al., 2005a; McAdam et al., 2009; McAdam et al., 2010). This study makes a novel contribution to the theory concerning the UTT process and our understanding of the two-way interaction and communication (of personal knowledge, skills and experience) between key stakeholders – AEs and TTMs – involved in the university spin-out (Lubit, 2001; Siegel et al., 2004; Lockett, 2006; Hughes et al., 2007; Abreu et al., 2008).

Of importance to their relationship building and communication is the need to fill the knowledge gaps between TTMs and AEs. Reflecting back on the TTM and AE roles in the university spin-out process, as discussed in the previous chapter, AEs are expected to focus on technical development and TTMs are expected to concentrate on and develop commercialisation aspects. This study has produced

important insights into how TTMs and AEs overcome the barriers to cooperation as follows.

Based on their relationship building and communication, it is apparent that some AEs have doubts about the ability of their TTMs (whether they have the skills or experience) to support the university spin-out process. McAdam et al. (2010) stressed that the problem may be due to a lack of knowledge amongst AEs about commercialisation and the steps involved; they may assume that the process is relatively straightforward (Chapple et al., 2005). The study shows that most AEs have either no, or high, expectations of TTMs because, prior to their own UTT involvement, they had no knowledge of TTMs or of their role in UTT. TTMs handle this in various ways, some feeling that regular face-to-face meetings are essential in order to fill the knowledge gap. As mentioned, some AEs have high expectations of their TTMs. Although TTMs are sometimes too busy to deal with what is required of them, and can even delay spin-out, they try to address this through trust building, and suggest that the AE's lack of understanding of spin-out procedure may be at the root of the problem. In a few cases, however, even though the TTMs had strong backgrounds and experience, their abilities were still questioned and dismissed by the AEs. Such relationships were usually not close from the start and were characterised by communication problems caused by busy schedules, geographical barriers, or trust issues. This study shows the importance of filling the knowledge gap, establishing a tight relationship, close interaction, and trusting collaboration between TTMs and AEs. Distrust or doubt can also stem from TTMs who feel that AEs are not revealing the actual status of their invention. The result can be severe, as the TTM may decide to freeze the case.

Even though it is claimed in this study, and also in previous research, that TTMs can be trained whilst working on UTT commercialisation (Wright et al., 2007; McAdam et al., 2010), the lack of business and commercial knowledge or skills was persistently noticed, commented upon, and led to issues with trust building and the credibility of TTMs. Many TTDs also acknowledged the need to recruit TTMs from outside academia. Although only half of the TTMs in this study had prior knowledge/experience of commercialisation or of university spin-out procedures, the majority of AEs were confident about their TTM's ability to assist

them, based upon their good working relationship, communication and trust building.

This study also highlighted that UTT related knowledge could be vital to both TTMs and AEs and might influence their communication, expectations, and the confidence of AEs in the contribution of TTMs to spin-out, hence affecting their synergistic relationship and the entire spin-out process.

The findings indicate that the majority of TTMs had strong technical backgrounds, but only half of them had business and commercial related expertise, and this is consistent with the research of Siegel et al. (2003) and Siegel et al. (2004) which points out that TTOs usually place greater emphasis on technical background than on business or commercial skills when recruiting TTMs. However, AEs reported that they had no problem communicating with TTMs who had no technical or commercial background or experience, and were in fact able to endorse the ability of their TTMs to contribute to university spin-out. This was because, they said, TTMs had been able to quickly learn about and understand their ideas at a later stage, and had also been able to assist with preparing the technology for commercialisation and translating the technological language into commercial language to attract funding. The results substantiate the findings of Muscio (2010), who indicates that TTMs can still contribute to UTT without an academic background, as long as they can understand, and have the respect of, AEs. However, the results suggest that if related technical knowledge/experience is too low, this may limit the ability to work efficiently with AEs.

This study also fills an important research gap in the current UTT and university spin-out related literature, as follows. First, the quality of TTOs has been questioned in previous research (Siegel et al., 2003). Although the majority of AEs acknowledged that their TTMs were helpful and met their expectations in this study, some of them felt that the small size of the TTOs and the heavy workload of the TTMs limited the extent to which they were able to contribute to the spin-out process. Second, Siegel et al. (2003) and Siegel (2004) addressed some of the barriers to UTT and made suggestions to improve the UTT process, including developing mutual understanding and overcoming the informational and cultural barriers between university and industry, and increasing networking between scientists and practitioners. The findings of the present study show that the prior

knowledge of TTMs makes a marked contribution to, filling the knowledge gap for AEs and thus to developing a shared language and mutual understanding, to overcoming barriers, and to enhancing networking, as mentioned above. However, the study also indicates that TTMs sometimes failed to utilise their prior knowledge efficiently and that they could have contributed to these aspects of spin-out more proactively. For example, some experienced TTMs considered it normal for AEs to lack knowledge of spin-out, be unfamiliar with procedures, and to want to rush things, but instead of filling the knowledge gap, supporting and encouraging them, and dealing with the miscommunication that existed within their relationship, they chose to keep the process rolling forward, following university procedures. Third, in the university spin-out related literature, Rasmussen and Wright (2015) point out that there is no clear pattern indicating that historical success leads to the future success of spin-out creations. The findings of the present study show, by looking at the years of UTT experience of TTMs and the university spin-outs they have successfully incorporated, that a TTM's prior UTT or spin-out experience is of limited relevance to the success of subsequent spin-out creation. TTMs indicate that this is due to the uniqueness of university spin-out cases.

In summary, this study provides a deeper understanding of the mechanisms through which AEs and TTMs work together in the university spin-out process. It identifies tensions and doubts and provides insights into how most of these could be dealt with by filling the knowledge gaps, managing AE expectations, and promoting effective communication and trust.

6.2 Limitations

This study discovers the key constituents of university spin-out AC, the role AEs and TTMs play, and their contribution to the spin-out process from both of their perspectives. Among various UTT activities, university spin-out is the most time consuming and the only activity which allows TTMs and AEs to work together for years. TTMs are expected to contribute to the process with a wide range of abilities and to serve different functions at different stages. AEs may be more critical with regard to their expectations and perceptions of TTMs where spin-out

is concerned. Therefore the research findings of this study may not apply to other UTT activities. Also, each university spin-out case is unique, but this research result may still be of use when considering how to improve collaboration with AEs and to encourage UTT activities in general.

All the case studies were collected from different universities in the UK. Due to the different approaches to development and application of government policy with regard to UTT, the research findings may not apply to university spin-out in other countries. Even within the UK, there has been restructuring in many universities' TTOs. TTMs can serve different functions across TTOs in the UK and there may not be one specific TTM responsible for a university spin-out case, but a team of TTMs (such as a commercialisation team) which takes care of all cases. In such a situation, the team as a whole, and therefore each TTM, benefits from the collective gathering together of knowledge and resources, and the need to rely upon an individual TTM network no longer exists. Finally, the majority of the university spin-out cases in this study are technological and science related. The results may differ for non-technical university spin-out.

Furthermore, methodological limitations may exist in the interview method or process of the study. First, although the researcher tried to control the interview time at an hour for every interview (which was also the time most of the interviewees could spare), given this time pressure, and the varied pace with which the interviewees answered the questions, sometimes not all of the topics could be investigated in great detail. Second, although the university spin-out cases were either currently under development or had recently been completed at the point of data collection, most cases had been developing their spin-out for at least a year, sometimes far longer. Thus, the interviewees' recall of historical events may not have been perfect. All of the above might limit the achievement of the study goal, which was to reveal the complete story and history of relationship building during the spin-out process.

6.3 Practical Implications and Recommendations for Practitioners

This study makes several suggestions with regard to what TTMs are required to contribute to the spin-out process, how they can work more closely and efficiently with AEs, and finally how they might work with AEs to overcome the barriers encountered. These might be expected to improve knowledge and also the UTT process and spin-out creation in the present and the future.

All AEs in this study had strong technical backgrounds, but most did not have direct industrial/business experience, only industry-business collaboration experience, and only half had prior (limited) UTT experience (two had university spin-out experience). There is an obvious gap between TTMs and AEs with regard to business/commercial knowledge and experience and UTT experience (especially in relation to university spin-out). This study suggests TTMs could fill the knowledge gap between themselves and their AEs in various ways. First, as TTMs all have some forms of competence, due to their background and experience, they should demonstrate their abilities to AEs in these areas (technical, commercial, and UTT or spin-out related), and let them know what they can provide as a TTM and what they are capable of doing. Second, TTMs could provide AEs with help in gaining business/commercial related knowledge or skills, and also UTT related knowledge, to narrow the knowledge gap. This could start from the very early stages of technology transfer, or even before, when TTMs should proactively encourage and motivate AEs to participate in UTT, and TTMs could develop the AE's awareness by working closely with them or by holding sessions to advertise and promote their services. Third, it is crucial to have regular face-to-face formal or informal meetings to ensure that the UTT knowledge gaps are filled, especially for AEs.

Although TTM responsibilities are summarised in some studies (Siegel et al., 2003; Siegel et al., 2004; Wright et al., 2004; Muscio, 2010), this project is the first to look into their contributions to the UTT process from both TTM and AE perspectives, together with the background, experience, and skills that support them in making such contributions. The TTM responsibilities and the role they should play in UTT, especially in the spin-out process, are considered to be as follows: first, facilitating the UTT process, including providing AEs with information,

advice and support, arranging meetings with/for AEs, providing AEs with decision making choices, guiding AEs in the right direction, letting AEs know what needs to be done to make their idea commercially ready, market ready, and investment ready, ensuring evaluation/due-diligence is completed, assisting with patenting, providing commercial or business guidance (including development of business and marketing plans), helping AEs to search for funds and make investment decisions, providing legal document services (e.g. contracts), and talking with the AEs and negotiating with them about how the process will work; second, co-ordinating and pulling the university spin-out process together by managing the relationship between AEs and themselves and arranging for them to meet the necessary contacts; third, encouraging AEs to disclose their innovations and clarifying the commercialisation opportunity; fourth, making sure every process follows the university's procedures; and fifth, being encouraging and supportive and managing AE expectations.

The findings are generally consistent with those of previous studies (Siegel et al., 2003; Siegel et al., 2004; Debackere and Veugelers, 2005; Muscio, 2010; Link et al., 2015), but this research differs in that it contributes to current knowledge by providing detailed empirical evidence of the mechanisms by which TTMs contribute to the facilitation of UTT. It is noteworthy that, the study repeatedly mentions how AEs felt that TTMs were not sufficiently proactive in encouraging and spotting commercial ideas from academics/departments. This is the main difference between this and previous studies which considered such proactivity to be one of the main responsibilities of a TTM (Siegel et al., 2003; Wright et al., 2004). However, as discussed in Section 6.1, working together as a team, TTMs and AEs could complement each other and develop their explorative learning capacity (PAC) with regard to the transfer of tacit knowledge. Also the findings show that TTMs feel that they contribute much more than the AEs expect. This may be because AEs lack prior UTT knowledge or have higher expectations and hold very different opinions on whether those expectations have been met by TTMs. Also, for various reasons including heavy workload or lack of trust, some TTMs might fail to fill the knowledge gap and push the process forward. Alternatively, it might be that TTM have unrealistic perceptions or expectations of themselves.

The study demonstrates that, in order to fulfil their multifunctional role in university spin-out, TTMs are expected to have wide ranging knowledge (including both technical and business/commercial related backgrounds) and experience, and an extensive skill-set. Although such backgrounds and experience are considered to be beneficial, but not essential, it can still be seen that they are expected to add value to the process in many different ways.

University TTM recruitment advertisements[1] (see table in Appendix C) show that TTOs do recruit TTMs with a wide range of knowledge, experience, and competencies, and also expect them to be capable of multitasking so that they can handle a variety of UTT related activities at the same time. In reality, the recruitment advertisements are more detailed and precise than indicated by the table. On average, they pay between £35,000 and £50,000 (dependent on experience). However, as discussed in Section 4.1, TTMs do not receive any specific reward for working on spin-outs; spin-out activity is treated as a part of their job. Bearing in mind that over half of the TTMs in this study held a technical related PhD degree, if they worked as a grade 7 or 8 lecturer, they could earn between £37,000 and £50,000 (dependent on experience).[2] Those who held a technical related PhD degree and also had a few years' industrial experience could take up jobs in senior roles in industry and be paid £40,000 to £55,000 (dependent on experience).[3] Clearly, work as a TTM requires much more knowledge, experience, and skill, yet post-holders are not being paid or rewarded for this.

This highlights two issues. First, it seems that the majority of TTMs in this study were more than qualified to play the role in the university spin-out process for which they were paid. Second, since they were not rewarded for undertaking complex and time consuming spin-out, maybe this is the main reason why TTMs were usually not proactive in initiating the process; they had too many other duties to manage. This might limit the potential for spin-out opportunities to be taken up.

Although the creation of university spin-outs has declined dramatically over the past few years, due to lack of funding for early stage spin-outs, the UK government still considers that UTT plays a significant role in wealth creation and

[1] Data retrieved on 05 Sep 2014, from http://www.job.ac.uk
[2] Data retrieved on 05 Sep 2014, from http://www.job.ac.uk
[3] Data retrieved on 05 Sep 2014, from http://www.technojobs.co.uk/

in boosting the economy. This study makes several recommendations for practitioners and believes they could improve the current state of UTT and assist universities to reinvigorate their knowledge transfer and their contribution to both the public and the economy.

The importance of entrepreneurial education for AEs has been discussed in previous studies (Gómez et al., 2002; Gómez et al., 2008; Prodan and Drnovsek, 2010); this study agrees with this view, and also confirms that such education is not sufficiently well promoted in the universities. Moreover, this study has stressed the significance of filling the knowledge gaps between AEs and TTMs from the beginning of the spin-out process. It is suggested that UTT related knowledge/courses/seminars are equally important to AEs. The key is not only to give AEs a comprehensive understanding of UTT and to raise awareness about the disclosure of research output, but also to inform them of how TTMs are responsible for and could contribute to the process. TTMs would then be able to better manage AE expectations of the process by reducing the knowledge gaps.

This study also pointed out that, in general, TTMs do not proactively seek out the commercial potential among the research output of AEs and fail to see this as one of their responsibilities, as addressed in previous studies (Siegel et al., 2003; Wright et al., 2004). AEs support this argument and feel that TTMs usually wait passively until AEs initiate the relationship or the UTT process, especially with regard to university spin-out. This is considered to significantly limit the development of many potential UTT opportunities. However, TTMs often have more than enough to do and are usually handling a range of UTT activities simultaneously. Given the time constraints, their heavy workload, the pay they receive, and the absence of a reward structure for undertaking complex and time consuming university spin-outs, they are certainly not inspired to explore or take over more UTT activities. As discussed in Section 6.1, however, most AEs and TTMs engaged in UTT were motivated by seeing university research output applied outside academia in order to achieve great social and academic benefit. Therefore, if policy makers or universities want TTMs to perform such functions as spotting or exploring commercial opportunities, a clear reward structure or other incentives should be provided and the workload assigned to TTMs needs to be reconsidered.

To improve their relationship with AEs, TTMs should aim to fill the knowledge gaps which exist between them (in particular with regard to business, commercial, and UTT related knowledge), they should better manage AE expectations, and establish a friendly and trusting environment − and all of the above needs to happen from the beginning of the UTT process. It is also important to demonstrate care and encouragement while working with AEs. AEs are experts in their professional field, so it is understandable that they may feel uncomfortable when participating in UTT – of which they have no knowledge – having to learn from TTMs and to understand the entire process from scratch. Therefore, it is suggested that TTMs should serve in a strong supportive role. AEs must be assured that TTMs will be there, every step of the way, and will patiently handle any situation about which AEs have doubts. They should not be allowed to perceive that TTMs are university employees who are simply responsible for looking after the university's interests. Many of the TTMs in this study held a PhD degree, thus they understand and are passionate about applying academic research output outside academia, improving research, and benefitting both the public and the economy. They should share this passion with their AEs in a positive push to improve cooperation and relationship building in UTT.

Overall, as can be seen from the recommendations for practitioners outlined above, there is still much that could be improved and further developed in the UTT process. It appears that TTMs and AEs could progress their involvement and contribution on their own, but will contribute more to university spin-out if they complement each other, simply by being more proactive. AEs, for example, could seek education on business, commercial, and UTT related knowledge from TTMs, whilst TTMs could be even more proactive in raising AE awareness of UTT, initiating and maintaining the relationships with their AEs, filling knowledge gaps for AEs, and establishing credibility and gaining trust. Since both have full-time jobs and responsibilities within the university, however, policy makers could give considerable assistance by providing them with incentives or reward structures to encourage their actions.

6.4 Recommendations for Future Research

AC has proven to be of great value to this exploratory study, as part of a qualitative approach to researching the university spin-out process and the collaborative relationship between AEs and TTMs. More empirical research which adapts the AC approach to other knowledge transfer, technology transfer, or UTT activities, such as licensing, is required. Due to the complexity of the development of university spin-outs, the study mainly focuses on the key determinants that shape AE and TTM roles, the initiation and maintenance of their collaborative relationship building, and how these impact upon the development and efficiency of different dimensions of university spin-out AC. It is suggested that more empirical work is needed to evaluate the relevance of AC in the ultimate success or failure of spin-out activity, or even its future performance. Also this study only contributes to our understanding of how the determinants affect the PAC, RAC or AC as a whole of the university spin-out, but the transfer from explorative capacity (PAC) to exploitative capacity (RAC) still remains vague, and the same is true of the transfer from tacit knowledge to explicit knowledge. The study looks mainly at the two stakeholders involved in the spin-out process, and further research should look at all stakeholders, to see how a variety of prior knowledge, and the combinative capabilities amalgamated by all stakeholders, contribute to AC at the organisational level.

This study has shown the responsibility assumed, and contribution made, by TTMs during university spin-out and also the importance of various antecedent factors which impact upon the process. It is interesting to discover that their personal attributes can contribute to spin-out, become the key motivator for AEs and TTMs to participate in UTT, and even constitute the foundation of the relationship and trust building that benefit the spin-out process. More extensive research on the motivation behind UTT and the impact of trust building upon spin-out creation could be undertaken and could be expected to improve the effective development of UTT in the future. Finally, as mentioned repeatedly in this study, as university spin-out activities are generally more time consuming and demanding than other UTT activities, the requirements of the spin-out process, in terms of prior knowledge, are also more complicated. Spin-out requires diversity and multitasking and can result in a variety of perceptions and expectations on the part of TTMs and AEs. This study can only represent TTM

contributions to spin-out. The requirement for prior knowledge and the perceptions and expectations of the TTM role and contribution in other UTT activities should be investigated and compared to the findings of this research.

Appendices

Appendix A

Interview Questions (for TTMs)

1. Background and past related experience
- **Can you talk about your background and the motivations which led you toward participating in UTT activity?** ✓ What is your educational background? ✓ Did you have any industrial, start-up, or business experience before working in UTT? ✓ Does your past industrial, start-up, or business experience help you with UTT activity? How? ✓ What is your role in the TTO? ✓ What motivated you to become a TTM? ✓ How did you become involved with UTT? ✓ How long have you been working as a TTM? - **What is your attitude towards the commercialization of research?** ✓ Do you have any university technology transfer experience (e.g. licensing or spin-out)? How much? ✓ Does your past UTT experience help you with the current spin-out activity? How? ✓ What are your aspirations for the TTO and for spin-out? ✓ Do you consider that spin-out activity benefits your future career? How? ✓ What reward(s) do you receive for participating in or accomplishing spin-out activity? - **What are your perceptions of academia and the academic process? What are the pros and cons of working with academics?** - **What are your perceptions of TTO and the UTT process?**

2. Initial relationship between you and the AE

- **Can you talk about how the relationship is initiated with the academic from the beginning?**

  - ✓ Who initiated this relationship? How?
  - ✓ How did you initiate and develop your connections and relationships with the department?
  - ✓ How many academics in this department have you worked with? How about other academics within the department?

- **What is your role in the process of spin-out? What do you consider the academic's role to be during the process of spin-out?**

- **How would you describe the relationship between you and the academic?**

  - ✓ How do you usually communicate with each other? How often?
  - ✓ How much time is spent on this activity?
  - ✓ Does it interfere with other work? Does your, or the AE's, workload interfere with this spin-out activity?

- **What knowledge and skills do you think are required in the technology transfer process? Do you have all the knowledge and skills required?**

  - ✓ Are there any areas where you feel you do not have such knowledge or skills?
  - ✓ Are there any knowledge or skill gaps which limit your opportunity to work with the academics?
  - ✓ Could the transfer of technology be conducted more effectively? How?

3. Start-up of the spin-out company (spin-out process)

(Please answer the following questions with regard to the spin-out activity you are currently working on.)

- **Can you discuss the spin-out process?**

- ✓ Can you describe the process of working with this academic, from starting up the spin-out (finding the idea and discovering the commercial potential) to the point where you transfer the idea to the company?
- ✓ At what stage of the spin-out process did you and the academic start working together?

- **How exactly did you and the AE(s) contribute to the spin-out process? What are the expectations?**

- **How would you evaluate the process of spin-out? What has worked and what has not? Can you give examples?**

4. What affects the process of spin-out?

(Please answer the following questions with regard to the spin-out activity you are currently working on.)

- **How do you view your contributions to the spin-out process? How do you impact upon the process?**

- **How has your relationship gone during the process of spin-out? How do you feel about your relationship? How does it impact upon the process?**
  - ✓ Have there been any barriers or miscommunications between you and the academic? What happened, at what stage, and how did you resolve the problem(s)? Did it affect the process of spin-out?
  - ✓ Do you think that you and the academic have gradually built up some kind of trust or common consensus in your relationship which benefits and makes the process more efficient? Can you give examples that illustrate this?

- **Do you think you will be able to work with the academic more effectively in the future, and is so, why? Any suggestions?**

- **Where do you see the future of spin-out activity within UTT?**

Appendix B

Interview Questions (for AEs)

1. Background and past related experience

- **Can you talk about your background and the motivations which led you toward participating in UTT activity?**

  - ✓ What is your educational background?
  - ✓ What is your current research area?
  - ✓ Did you have any industrial, start-up, or business experience before working with UTT?
  - ✓ Does your past industrial, start-up, or business experience help you with UTT activity? How?
  - ✓ What is your role in the department?
  - ✓ How is your research funded?
  - ✓ How did you become involved with UTT?

- **What is your attitude towards the commercialization of research?**

  - ✓ Did you have any university technology transfer experience (e.g. licensing or spin-out)? How much?
  - ✓ Does your past UTT experience help you with the current spin-out activity? How?
  - ✓ What are your aspirations for participating in UTT activities and for spin-out?
  - ✓ Can you allocate percentages to the value you place on each of teaching, research and UTT activity?
  - ✓ Do you consider that spin-out activity benefits your academic career? How?
  - ✓ What reward(s) do you receive for participating in or accomplishing spin-out activity?

- **What are your perceptions of TTO and the UTT process? What are the pros and cons of working with TTMs?**

2. Initial relationship between you and the TTM

- **Can you talk about how the relationship is initiated with the TTM from the beginning?**

  - ✓ Who initiated this relationship? How?

- **What is your role in the process of spin-out? What do you consider the TTM's role to be during the process of spin-out?**

- **How would you describe the relationship between you and the TTM?**

  - ✓ How do you usually communicate with each other? How often?
  - ✓ How much time is spent on this activity?
  - ✓ Does it interfere with other work? Does your, or the TTM's, workload interfere with this spin-out activity?

- **What knowledge and skills do you think TTMs should be required to have in the technology transfer process?**

  - ✓ Are there any areas where you feel they do not have such knowledge or skills? Are there any knowledge or skill gaps?
  - ✓ Could the transfer of technology be conducted more effectively? How?

3. Start-up of the spin-out company (spin-out process)

(Please answer the following questions with regard to the spin-out activity you are currently working on.)

- **Can you discuss the spin-out process?**

  - ✓ Can you describe the process of working with this TTM, from starting up the spin-out (finding the idea and discovering the commercial potential) to the point where you transfer the idea to the company?
  - ✓ At what stage of the spin-out process did you and the TTM start working together?

- **How exactly did you and the TTM(s) contribute to the spin-out process? What are the expectations?**

- **How would you evaluate the process of spin-out? What has worked and what has not? Can you give examples?**

4. What affects the process of spin-out?

(Please answer the following questions with regard to the spin-out activity you are currently working on.)

- **How do you view TTMs' contributions to the spin-out process? How do they impact upon the process?**

- **How has your relationship gone during the process of spin-out? How do you feel about your relationship? How does it impact upon the process?**

  - ✓ Have there been any barriers or miscommunications between you and the TTM? What happened, at what stage, and how did you resolve the problem(s)? Did it affect the process of spin-out?
  - ✓ Do you think that you and the TTM have gradually built up some kind of trust or common consensus in your relationship which benefits and makes the process more efficient? Can you give examples that illustrate this?

- **Do you think you will be able to work with the TTM more effectively in the future, and if so, why? Any suggestions?**

- **Where do you see the future of spin-out activity within UTT?**

  - ✓ Will you consider starting up another spin-out company in the future? Will you continue your relationship with the TTO for your next UTT activity? Alternatively, are you more likely to proceed alone or make contact with the industry or business by yourself? Could you explain why?

Appendix C

The Requirements in Recent TTM Recruitment Advertisements of Different University TTOs

	Recent TTM recruitment advertisements
Background	• A degree in science or technical field (PhD is desirable but not essential) • Technology exploitation related commercial or industrial experience • Business/commercial knowledge or experience (desirable but not essential) • IP, fund raising, university procedure and UTT related knowledge (essential) • Project management related experience (essential)
Responsibilities	• Working with academics in science and technology field • Transferring, commercialising, and marketing technology from research to industry • Negotiating contracts • Managing the formation of spin-out companies • Supporting post-deal activity
Competence	• Grasping technical concepts quickly, and translating these into commercially viable proposals • Working effectively with key stakeholders • Deploying excellent interpersonal and communication skills • Ability to establish good working relationships, and team worker • Able to work under pressure, prioritising and organising own and others' workload effectively to meet deadlines and achieve high standards of performance • Managing a large and growing portfolio of projects to a successful commercial conclusion • Willingness to work longer/flexible hours as necessary to meet deadlines

Source: Summarised by the researcher from advertisements on http://www.job.ac.uk, data retrieved in 05 Sep 2014

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