Collaborative networks for scientific knowledge commercialisation – A science-to-business marketing approach

Diana Nadine Boehm

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Supervisor: Dr. Teresa Hogan

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Preface

A paper written from chapter 6 entitled “A jack of all trades’ – PIs role in establishing and managing stakeholder relationships and networks” is accepted for presentation at the 2012 Academy of Management Annual Meeting, August 3-7, in Boston, Massachusetts, USA.

A second paper written from chapter 6 entitled “Collaborative networks for innovation: A S2B marketing approach to scientific knowledge commercialisation” is accepted to be presented at the 32nd Babson College Entrepreneurship Research Conference (BCERC), June 6 - 9, 2012, in Fort Worth, Texas, USA.

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B-2-B	Business-to-Business
B-2-C	Business-to-Consumer
CIPSM	Centre for Integrated Protein Science
COTESYS	Cognition for Technical Systems
CRANN	Centre for Adaptive Nanostructures and Nanoscience
CSET	Centre for Science, Engineering and Technology
EI	Enterprise Ireland
HEA	Higher Education Authority
HERD	Higher education Expenditure on R&D
IP	Intellectual Property
IPR	Intellectual Property Rights
LMU	Ludwig Maximilian University Munich
MAP	Munich Advanced Photonics
NCSR	National Centre for Sensor Research
NDP	National Development Plan
NIH-syndrome	Not invented here syndrome
NIM	Nano Initiative Munich
NIS	National Innovation System
PI	Principal Investigator
PR	Public Relations
R&D	Research & Development
RINCE	Research institute focused on engineering technologies
SCA	Sustainable Competitive Advantage
SFI	Science Foundation Ireland
SSTI	Strategy for Science, Technology and Innovation
S-2-B	Science-to-Business
TCIN	Trinity College Institute of Neuroscience
TTO	Technology Transfer Office
TU	Technical University Munich

Abstract

Scientific-knowledge commercialisation has become a primary objective for universities worldwide. Science-industry exchange is a prerequisite for innovation. Collaborations are viewed as key to this objective. Despite government financing, artificially supporting the development of such networks has proved difficult.

This study extends relationship marketing's B-2-B model by using a unique multiple-stakeholder research design to explore why, how and by whom scientific-knowledge-commercialisation networks are established and managed. The study uses qualitative evidence from 82 stakeholders in 17 collaborative projects in Irish and German universities. This approach facilitates an analysis of *the true value* of the stakeholders' roles. This provides for a holistic view, as opposed to prior research which reported findings based on analysis of one or two stakeholders. The study demonstrates how contextual differences impact on scientific-knowledge commercialisation in Ireland and Germany.

The study finds that network capabilities are the main reason that collaborative networks are established. It finds that enduring networks are conduits for innovation and scientific-knowledge commercialisation due to continuously improving capabilities. Stakeholder retention is a catalyst for improving collaborative networks. Stakeholder retention results from stakeholder loyalty. Stakeholders become loyal because they are content with the overall relationship and quality of the commercialisation service. It is fundamental that stakeholders understand each other's roles and motives as incongruities hamper network development.

The findings highlight the central role that PIs play in building and managing relationships. The PI, like the entrepreneur, has to be 'a jack of all trades', taking on the roles of negotiator and project/ relationship manager. These roles are in addition to the traditional role of teaching, researching, acquiring funding, Ph.D. supervision and mentoring and administration. The findings suggest that PIs are better placed than TTO managers to act as boundary spanners between science and industry.

1 Introduction

1.1 Research background

> "The university today finds itself in a quite novel position in society. It faces a new role with few precedents to fall back on . . . We are just now perceiving that the university's invisible product, knowledge, may be the most powerful single element in our culture, affecting the rise and fall of professions and even of social classes, of regions, and even of nations."
> **-- Clark Kerr, The Uses of the University 1963 (2001 p xi-xii)**

It has been recognised that knowledge is central to economic development. Universities play an amplified role in expanding knowledge economies (von Hippel 1988, Etzkowitz et al. 2000, Porter and Van Opstel 2001). This new role involves creating entrepreneurial universities which commercialise scientific knowledge (Clark 1998, Etzkowitz, Webster and Healey 1998, Etzkowitz et al. 2000, Etzkowitz 2001). Scientific knowledge can be transferred to the market in different ways: (a) education and training; (b) contract research; (c) industrial consultancy; (d) licensing; (e) spin-off companies; (f) spin-off joint ventures; and (g) collaborative research (Cripps et al. 1999 p11). These commercialisation channels are considered to be vehicles for entrepreneurial activity at universities (Louis et al. 1989, Klofsten and Jones-Evans 2000, Siegel, Wright and Lockett 2007) and several researchers have elaborated on the effectiveness, performance and success of these. Governments and policy-makers seek direct returns from investment in third-level research by prioritising licensing (Lambert 2003) and spin-out activity (Bray and Lee 2000, Jensen and Thursby 2001).

Industry partners and academics, however, see collaborative research and other forms of industry engagement as more essential (Faulkner and Senker 1994, Cohen, Nelson and Walsh 2002, D'Este and Patel 2007, Perkman and Walsh 2009). Mowery and Sampat (2005) report that industrial R&D managers attach very little importance to measurable performance-metrics, such as licensing and patents. They describe the "economically important 'outputs' of university research" (ibid p212) as soft outputs, those outputs being: (a) scientific and technological information that improves industry R&D efficiency; (b) the use of equipment and instruments by industry; (c) skills or human capital of students and researchers; and (d) networks of scientific and technological competences for the diffusion of new knowledge. "[A]cademic research rarely produces 'prototypes' of inventions for development and commercialization by industry – instead, academic research informs methods and disciplines employed by firms in their

R&D facilities" (Mowery and Sampat 2005 p 224). Considering the importance of collaborative research for academics and industry partners, this study is concerned with collaborative research as a way to transfer scientific knowledge to the market. Collaborative research refers to projects where universities and businesses work together on shared problems (Martinelli, Meyer and von Tunzelmann 2008). Collaborations can be defined as "all forms of agreements between firms, universities, and research institutes whereby two or more organisations share the commitment to research a common goal by pooling their resources and co-ordinating their activities" (European Commission 2002 p15). As collaborative networks, cooperative relationships and, above all, strong prior relationships between organisations impact on the successful transfer of knowledge (Harmon et al. 1997), it is important to study collaborative networks for scientific-knowledge commercialisation.

1.2 Research fields

This study is anchored in two research fields: relationship-marketing theory and university-entrepreneurship theory. Relationships and collaborative networks have enjoyed increased acknowledgement in marketing literature due to its emergent importance and relevance. Relationship marketing is concerned with the mutual benefit that all participating stakeholders gain by being in a relationship and collaborative network (Shani and Chalasani 1992, Grönroos 1997, Gummesson 1996, Parvatiyar and Sheth 2000). The Business-to-Business (B-2-B) literature emphasises the prominence of networks in facilitating shared R&D goals (Håkansson 1982, Möller and Svahn 2003). Network thinking within B-2-B relationship marketing accentuates the salience of previous purchases and mutual evaluation in order to establish satisfying exchange relations (Håkansson 1982). It builds on the idea that the nature of the relationship between two entities may not merely be built up during the course of a single major transaction, but rather through an interactive process within a certain environment. Recurring transactions modify the overall nature of the relationship. Greater attention must be paid to the embedded network context and environment in which relationships occur (Anderson, Håkansson and Johanson 1994). No relationship can be understood without looking at the wider network and environment (Håkansson and Ford 2002). These relationships and resources should be pooled and expanded in order to create chances for novel gains (ibid.). Knowledge-based organisations need to openly engage with their environment in order to facilitate the knowledge creation and potential commercialisation (Achrol and Kotler 1999).

To date relationship marketing research has primarily focused on business relationships (Håkansson 1982, Dwyer, Schurr and Oh 1987, Möller and Svahn 2003) and customer relationships (Mittal and Kamakura 2001, Olsen 2002). Thus, theoretical insights in relationship-marketing theory have predominantly developed from private sector research. While acknowledging the role of science partners, most studies focus on B-2-B networks (Pittaway et al. 2004) and, thus, only look at the benefits for firms. In doing so, current research ignores other collaborating participants such as public sector participants (Plewa and Quester 2008, Rampersad, Quester and Troshani 2010). Additionally, as previous research has focused on the firm, the mutual benefits that relationships with other parties in collaborative networks deliver have been ignored. Similarly, individual benefits for other participants such as benefits for a university have also been ignored. By researching collaborative networks that incorporate the public sector in the form of universities (i.e. science-to-business (S-2-B) networks), this study therefore addresses a literature gap that is relevant to relationship-marketing researchers.

The majority of the B-2-B network literature has focussed on existing networks. There is little research on the establishment of collaborative networks and management of emerging networks (Möller and Svahn 2003, 2009). Thus, studying how and by whom such S-2-B networks are established and managed would offer interesting insights that current research has not yet addressed.

Considering the lack of studies looking at mutual benefits or benefits for universities, there is a need to study relationship dynamics from multiple perspectives in order to avoid restricted or misleading interpretations. Thus, research that aims to understand why S-2-B networks are established is of particular interest not just for industry partners but also public sector organisations such as universities.

University-entrepreneurship literature also highlights interorganisational collaborations. Such collaborations have attracted considerable interest to the role of relationships and networks in facilitating the commercialisation of knowledge (Powell, Kogut and Smith-

Doerr 1996). Most studies within university-entrepreneurship theory have concentrated on the transactional nature of collaborations rather than relational exchange, leaving research on the nature of these collaborations incomplete.

Prior research in the university-entrepreneurship literature outlines the benefits of collaborative networks to firms, but neglected to study the benefits for other network partners (Rothaermel, Agung and Jiang 2007). The value of collaborations for firms has been documented for several sectors, including high-tech industries (biotechnology, telecommunications, robotics, aerospace etc.), manufacturing industries (mechanical engineering, automobile components etc.), service industries (financial services and food) and primary industries (energy, agriculture etc.) (Pittaway et al. 2004). Collaborative networks contribute significantly to firms by exposing them to novel sources of ideas, enabling fast access to resources, and enhancing transfer of knowledge (Powell and Grodal 2005 p79). However, little research has examined the value of collaborations for universities or mutual benefits of such collaborations.

In addition, the issue of multilevel interaction has not been studied in the required depth and a better understanding of the commercialisation context is required. This involves an examination of the enablers and barriers that influence the interplay between different stakeholders, as opposed to prior research which has focused on a single or dyadic analysis. While the understanding of linkages in the university-entrepreneurship literature is growing in terms of how individuals, industry partners, government grants or embeddeddness impact university-industry relationships (Howells 2006, Azgara-Caro 2007, Bozeman and Gaughan 2007, Godama 2008, Wright et al. 2008, Adler, Elmquist and Norrgren 2009, Hoye and Pries 2009, Levy, Roux and Wolff 2009), little emphasis has been placed on the development and management of relationships in order to effectively build networks for scientific-knowledge commercialisation. Instead, collaborative networks have been treated as given and researchers do not study how to effectively build such networks and manage the relationships within those networks (Rothaermel, Agung and Jiang 2007). Considering this, university-entrepreneurship literature also highlights the need to study the establishment of, and the relationship management within, collaborative networks and the benefits that such collaborative networks provide.

In summary, this study aims to address the gaps identified in marketing and university-entrepreneurship literature and to respond to calls for research on: (1) the process of establishing collaborative networks in a science-to-business environment; (2) the management of relationships within these networks; and (3) university or mutual benefits of such networks (Pittaway et al. 2004, Rothaermel, Agung and Jiang 2007, Plewa and Quester 2008, Möller and Svahn 2009). In achieving this aim, the study also responds to the call to study multi-party relationships (Plewa and Quester 2008, Rothaermel, Agung and Jiang 2007, Rampersad, Quester and Troshani 2010). The study's focus is on the university rather than industry which has dominated prior research. Additionally, the study aims to address the need for a better understanding of (a) who enables effective interaction and management of relationships in a S-2-B environment; (b) how S-2-B collaborative networks are established; and (c) why S-2-B collaborative networks are established.

University-entrepreneurship literature has mainly been driven by an empirical agenda which seeks to describe the phenomena in terms of barriers and enhancers, thereby bypassing the need for theory development. Leading researchers in the area support this position (Markman, Siegel and Wright 2008) and call for more inductive research. Relationship marketing is, on the other hand, an interactive approach that is concerned with relationship building and management, and has previously radicalised success within several industry sectors (e.g. retail industry). Relationship marketing, thus, offers a great insight into the process of how collaborative networks are established and managed. Applying relationship-marketing theory to the public sector context of S-2-B relationships offers a theoretical framework. Due to its practical nature it might also offer practical advice for universities. Accordingly, this study puts forward a relationship marketing framework to examine the initiation and management of S-2-B relationships and the establishment of S-2-B collaborative networks.

1.3 Theoretical framework

In this thesis, relationship marketing is defined as (Shani and Chalasani 1992, Grönroos 1997, Gummesson 1996, Parvatiyar and Sheth 2000):

> a proactive endeavour to initiate, manage, intensify and adapt relationships with customers (i.e. industry partners) and stakeholders to identify, sustain, enhance and strengthen a network for the mutual benefit of all participating stakeholders. This is accomplished by an ongoing process of engaging in cooperative and collaborative activities.

The definition shows that collaborative networks are sets of relationships. In this study where the focus is on the university, therefore, a collaborative network can be understood to mean a university's set of relationships with industry partners and other stakeholders. These relationships are strengthened, and networks formed and enhanced, by a continuous process of engaging in cooperative and collaborative activities.

The study builds on several relationship-marketing streams which stress the value of collaborations and significance of networks. Relational-exchange theory emphasises relational interdependence. Contrary to discrete transactions, relational exchanges evolve over time, use formal and informal communication and give rise to personal, noneconomic satisfaction (Dwyer, Schurr and Oh 1987). B-2-B relational exchange "is motivated by the mutual recognition of the parties to the exchange that the outcomes of such exceed those that could be gained from…exchange with a different partner" (Lambe, Wittmann and Spekman 2001 p12). Mutual investments are made as a result of satisfactory relationships (Wilson 1995, Turnbull, Ford and Cunningham 1996, Rao and Perry 2002). These investments in relationships create social bonds (trust, commitment, interdependence) or structural bonds (information and resource sharing, pooled knowledge, contractual arrangements, joint investments and pooled competencies). These bonds, in turn, strengthen the relationship further and are more complicated to terminate. Therefore, the core domain for relational-exchange success is the relationship. These relationships are strategic and organisations form relationships in order to achieve mutual goals (Wilson 1995).

Commitment-trust theory (Moorman, Zaltman and Deshpande 1992, Moorman, Deshpandé and Zaltman 1993, Morgan and Hunt 1994, Pritchard, Havitz and Howard 1999, Hennig-Thurau, Gwinner and Gremler 2002) builds on social-exchange theory and postulates that commitment and trust are the most important aspects for understanding relationship performance and success.

In B-2-B markets, satisfaction is defined as a positive affective condition which does not emerge by virtue of single transactions but rather through business relationships (Werani 2004). This condition is based on the evaluation of all aspects of a business relationship and embraces economic and psychosocial perspectives of satisfaction. Economic satisfaction shows the extent to which economic expectations in relation to business relationships are met. Psychosocial satisfaction concerns positively assessed relational aspects, such as reciprocal support, mutual appreciation or amicable relations. There is theoretical consensus that loyalty primarily results from satisfaction with a product and/or service (Hermann, Huber and Braunstein 2000). Loyalty is the result of a psychological evaluative decision process where different alternatives, in consideration of relevant criteria, are judged (Homburg and Bruhn 2005, Weinberg and Terlutter 2003).

Relationship marketing also has strong ties with network literature. The network thinking of the IMP group accords with the views of other relationship-marketing scholars, who argue that the relationship is the most important aspect in achieving mutual goals (Dwyer, Schurr and Oh 1987) and that trust and commitment are the most important aspects for relationship success (Morgan and Hunt 1994).

The rationale behind relational B-2-B marketing constructs can be applied to scientific-knowledge commercialisation as participating stakeholders form relationships in order to achieve the goal of transferring and exploiting scientific knowledge. Inherent in this mutual goal is the fact that both parties will make investments in the relationship. These investments will create the above-mentioned social bonds of trust, commitment, interdependence or structural bonds in the form of information and resource sharing, pooled scientific knowledge, contractual arrangements, joint investments in equipment and machinery and pooled academic and industrial competencies. These social and structural bonds in turn will strengthen the relationship further and produces satisfaction with the collaboration.

A study by Becerra, Lunnan and Huemer (2008) shows that high trustworthiness assists the transfer of tacit knowledge. Thus, trust-influencing factors in scientific-knowledge commercialisation could be related to researcher integrity, willingness to reduce research uncertainty, confidentiality, expertise, tactfulness, sincerity, congeniality and timeliness. Other non-interpersonal aspects affecting trust could be the research organisation's power and the extent to which the research can be customised. Commitment is present if a relationship is of importance and valuable. Assuming that relationships with other partners in the commercialisation process are of importance, trust and commitment can be regarded as influential to the relationship outcomes and to the cooperation of different stakeholders within scientific-knowledge commercialisation.

In addition, different stakeholders may have different expectations on the outcome, service they received, transfer and commercialisation process etc. The evaluation of satisfaction within the commercialisation process might, therefore, provide some valuable insights and help identify discrepancies. In scientific-knowledge commercialisation, relationship quality, and not just perceived service quality, has the potential to influence stakeholder loyalty and retention. It is therefore important to consider the evaluation of all aspects of the business relationship when looking at scientific-knowledge commercialisation.

In sum, this study draws on relationship-marketing theory to examine the initiation and management of relationships between universities and their stakeholders. The study proposes that these relationships develop within collaborative networks and are mutually beneficial to all participating stakeholders. Stakeholder retention is considered the most important objective to relationship success. It is suggested that relationship success and stakeholder retention contribute to the success of scientific-knowledge commercialisation due to repeated information, physical or financial transactions and ultimately the formation of collaborative networks.

B-2-B relationship marketing, thus, offers a theory that incorporates several theoretical perspectives, thereby limiting the scope restrictions of a single perspective. It enables the analysis of the embedded context and relationships within this context. In addition, it enables the explanation of the different phases that lead to relationship success, mutual benefits and scientific knowledge commercialisation.

1.4 The research objectives

The study aims to address the gaps identified in the research fields. This study is located where relationship-marketing research and university-entrepreneurship research intersect. Unlike previous studies in both research streams, where the establishment of networks and motives to partner with universities have mainly been researched from an industry perspective, this study looks at these issues from the perspective of all collaborating participants on a project, that is: (a) university researcher (Principal Investigator (PI)); (b) industry partner; (c) Technology Transfer Office (TTO) manager; (d) government agents; and (e) commercialisation or centre manager. In doing so, this study puts forward a B-2-B relationship-marketing perspective to examine the establishment of, and relationship management within, collaborative networks for scientific-knowledge commercialisation. While the various perspectives are looked at, the study's focus is on the university.

In particular, this study examines:

(a) Why collaborative networks for scientific-knowledge commercialisation are established?

(b) How do collaborative networks develop to facilitate scientific-knowledge commercialisation?

(c) Who establishes and manages collaborative networks for scientific-knowledge commercialisation?

By answering these questions using the research methodology (which is summarised Section 1.5) and addressing the research gaps identified, the study establishes a platform which facilitates the university in understanding the process of building collaborative networks and providing recommendations on possible actions.

1.5 Research methodology

This study uses a qualitative case-research approach to examine why, how and by whom collaborative networks for scientific-knowledge commercialisation are established and managed. The research design is based on a critical-realist epistemology and a qualitative case-research methodology. Such an approach helps to identify complex sets of factors and relationships. The approach is believed to be an appropriate approach to study B-2-B relationships in industrial marketing studies (Easton 2010), and can thus be applied to S-2-B relationships. This is the most appropriate method as the analysis of such relationships is best examined within the phenomenon's complex real-life context. In addition, qualitative data will provide deeper insight into S-2-B relationships as they involve complex social processes that quantitative data cannot disclose (Eisenhardt and Graebner 2007). The study is novel both in terms of its theoretical approach and research design. In particular, it deploys a relationship-marketing framework to examine collaborative networks that facilitate the commercialisation of scientific knowledge.

The research process comprises of several steps as prior theory is essential for the design and analysis of case research. "Prior theory can be viewed as some additional evidence that can be used to triangulate on the external reality of case study research's realism paradigm" (Perry 1998 p791). Hence, the first step of the process is a thorough literature review, which reveals the need to study the establishment and management of collaborative networks for scientific-knowledge commercialisation. Reviewing the marketing literature shows the applicability of the B-2-B relationship-marketing constructs such as trust, commitment, satisfaction, loyalty and retention. These constructs are identified as open research issues (Yin 2009). These general, broad research gaps are then examined in a pilot case study at the National Centre for Sensor Research (NCSR) in the form of convergent interviewing. The research issues are used as guidance for the interviews (Carson et al. 2001, Rao and Perry 2003, Williams and Lewis 2005). Broad questions, such as how, why and by whom collaborative networks that facilitate scientific-knowledge commercialisation are established and managed, are asked so as to identify the suitability of the B-2-B marketing constructs. The results of the convergent interviewing show that the B-2-B constructs can be applied as the interviewees referred to them in their answers. In addition, other research issues emerge as a result of the interviews including the use of universities, entrepreneurial activity, applied vs. basic science, barriers and factors, and relationship management. These initial theoretical frameworks are then used to draft the interview protocol for the main study and serve the data analysis (Perry 1998).

The second step is the main study. A holistic perspective on the establishment and management of collaborative networks is derived from interviewing 82 key stakeholders in 17 research-collaboration projects. These 17 research-collaboration projects within 17 research organisations constitute the cases of the study. Following Yin (1984, 2009) and Eisenhardt (1989), these cases are selected considering literal and theoretical replication logic. Replication logic serves to identify root causes of the performance differential and, thus, possibilities for further research. It also serves to identify similar research results to enable theory building (Eisenhardt 1989).

The case selection is based on two aspects. The first aspect involves a comparison between Germany and Ireland. The second aspect compares excellence centres with faculty-based research centres.

Turning firstly to the national comparison, Germany and Ireland have been chosen as their policy initiatives are quite similar with regard to creating centres of excellence. The two countries have, however, different economic and financial infrastructures. Germany ranks among the leading economies of the world and has a strong tradition of university-industry collaboration. It has one of the highest levels of R&D expenditure in Europe, with R&D expenditure of 2.63% of GDP in 2008 (Eurostat 2012). This compares to Ireland's R&D expenditure of 1.43% of GDP in 2008, which, although catching up, is still well below the expected EU target (Forfas 2009). In Ireland, the industry context is primarily based upon multi-national subsidiaries which are generally less embedded in the local economy. The challenge is to encourage multinationals to undertake more research in Ireland. In this respect, one would expect that Ireland could learn some lessons from Germany's long tradition of university-industry collaborations.

Additionally, while Hofstede (2001) shows that Ireland and Germany's cultural tendencies are largely similar, Hofstede observes that Germans tend to avoid uncertainty. The Irish, on the other hand, are more comfortable with uncertainty, and encourage creative and imaginative solutions to problems. One would therefore expect that, notwithstanding the cultural similarities, Ireland would be more inclined towards both innovation and university-industry collaborations. Nevertheless, Germany continues to outrank Ireland in relation to university-industry collaborations as measured by the global innovation index (INSEAD 2011). Given the relatively similar cultures, this anomaly provides an interesting and relevant backdrop to this study's comparison of the two countries' systems.

As mentioned above, the second comparison is of excellence centres, which are promoted by policy initiatives, and faculty-based research-centres. Excellence centres get allocated on average 5 million euro per year for research and administration in order to create multidisciplinary research hubs. Faculty-based research centres have to apply individually for government and EU grants. Therefore, one would expect that excellence centres should outperform faculty-based research-centres. This study, thus, examines research-centre organisations by comparing commercialisation projects in designated centres of excellence with faculty-based research centres in Germany and Ireland. This study does not, however, look at quantitative output-metrics that such centres create. Rather, it looks at the impact of research centre type on the dynamics of a collaborative network.

As noted above, there is a call for research to examine networks from the perspective of multiple stakeholders connected by a shared collaborative project. The stakeholders in each of this study's case studies therefore include the various participants in collaborative projects (i.e. PIs, TTO managers, research-centre managers or commercialisation managers, industry partners and government agents).

It is believed that the a priori selection of cases, based on analytical replication, guides the analysis (Eisenhardt 1989, Yin 2009). Within-case and cross-case analysis enables the research to view evidence from different perspectives. The initial theoretical constructs from the literature review and convergent interviews serve to guide the analysis (Perry 1998). In order to present the empirical evidence and build theory, it is recommended that the study's data should be compared with existing literature (Eisenhardt 1989, Halinen and Tornroos 2005, Eisenhardt and Graebner 2007, Yin 2009). The data should then be analysed, that analysis taking the form of a dialogue between data and theory. The analysis takes various contextual factors identified in the study into account by comparing Irish and German scientific-knowledge-commercialisation ecosystems.

1.6 Thesis findings and contribution

The study finds that the PI plays an important role in the establishment and management of collaborative networks for scientific-knowledge commercialisation. The PI initiates contacts or, where an industry partner initiates contact, the PI is the key reason for the industry partner's initiative. The PI has to show a willingness to collaborate with industry.

The findings show that stakeholder satisfaction is based on both a cognitive and affective evaluation process of technology and service (the commercialisation process) and the relationship quality. Stakeholder satisfaction results from an assessment of economic and/or psychosocial aspects of the business relationship between stakeholders and a university. In particular, industry partners evaluate: (a) professionalism; (b) timing; (c) market and industry awareness of the PI and centre; and (d) realistic evaluation and feasibility of IP and project. While these evaluation factors appear to be peculiar to industry partners, all stakeholders stressed the importance of: (a) communication; (b) research output and quality; and (c) relationship quality.

Relationship quality, as added value, becomes particularly important when other universities are able to provide similar knowledge and competencies. The findings propose that trust, commitment and a favourable attitude deriving from first experiences or past collaborations contribute to the creation of loyalty. Loyalty exists if the stakeholders show the first signs of a lower intention to change and if they consider using the service of the university or working with the industry again. This manifests where industry partners continue to want to collaborate with a certain PI or centre. Indeed, the study finds that industry partners become loyal to PIs. This is also the case for TTO managers who want to continue working with certain PIs. Likewise, PIs are committed and have an enduring desire to maintain valued relationships with industry partners, TTO managers and government agents. The importance of relationships between individuals, rather than inter-organisational relationships, is therefore highlighted in the study.

The transition from stakeholder loyalty to stakeholder retention takes place when the favourable attitude, acceptance of the university (or, more particularly, key university employees), trust and commitment actually result in recommendations or re-use of the service. Stakeholder retention is the most important objective of relationship success. Relationship success and stakeholder retention contribute to scientific-knowledge commercialisation due to repeat information, physical or financial transactions.

A "demonstration effect", whereby previous network success is leveraged, is also evident from the interviews. This effect refers to the ability to build improved collaborative networks where stakeholders show a higher willingness to invest and create new knowledge due to satisfaction with the previous relationship and process. Stakeholder retention thus influences the development of advanced collaborative networks by facilitating repeated collaborations. The findings suggest that stakeholder retention is a catalyst for developing collaborative networks.

The findings also suggest that these improved networks facilitate innovation, thereby creating the potential for further commercialising scientific knowledge. These findings accord with Powell and Grodal (2005) who suggest that, due to trust and cognitive understanding requiring time to develop, the influence of collaboration on innovation depends on previous interactions and relationship building. They further cite examples that more radical innovation is facilitated from close and persistent interaction. Close ties are also believed to overcome cultural differences between academic researchers and industry partners (Mowery and Sampat 2005). One explanation that Powell and Grodal (2005) provide is that such strong ties better enable the transfer of tacit knowledge. Such continuous networks accord with the views of relationship-marketing scholars who argue that the relationship is the most important aspect in achieving mutual goals (Dwyer, Schurr and Oh 1987) and that trust and commitment are the most important aspect for relationship success (Morgan and Hunt 1994). These relationship-marketing scholars further acknowledge that collaborative networks facilitate innovation (Håkansson 1982, Möller and Svahn 2003). On the other hand, there is a stream of literature that argues that lengthy collaborations and participation in a network can stifle innovation. Powell and Grodal (2005), while acknowledging the importance of collaborative networks, point out that if networks are too tight and no new members get access to the network, network participation can hamper innovation and thereby invention and exploitation.

While it is acknowledged, therefore, that lengthy collaborations and continuous networks can inhibit innovation this study indicates the benefits of repeating collaborations. Repeated collaborations allow routines to develop and improve. However, the focus of this study is to show how satisfaction, commitment, trust and loyalty facilitate repeat collaborations thereby establishing collaborative networks. The point at which a network becomes inhibitive to innovation is, therefore, outside of the scope of this study, as are the dynamics that cause such inhibitive effects.

The study supports the view of the existence of boundary spanners in collaborative networks. While the study finds that general principles of the role of boundary spanners hold true, the dominant logic that TTOs are boundary spanners (Siegel et al. 2004, Wright et al. 2008) is not, however, supported. Instead, the PI has the dominant role in initiating and managing contacts and collaborative networks.

In answering the three research questions, the study shows the theoretical importance of relationships and networks for scientific-knowledge commercialisation. The study addresses the research problem by establishing a platform which facilitates the university in understanding the process of building collaborative networks and providing recommendations on possible actions. It is the first to introduce a S-2-B marketing approach to scientific-knowledge commercialisation. The study empirically validates that B-2-B marketing concepts, such as satisfaction, commitment and trust, loyalty and retention, are also important for relationship success in a S-2-B context, thereby contributing to relationship marketing theory. The study extends the current understanding of business relationships in the private sector to a new understanding of business relationships between the public and private sector. It further contributes to relationship-marketing theory by answering the call for research on the establishment and management of collaborative networks. This is achieved by providing a process view of how and why collaborative networks are established for scientific-knowledge commercialisation, thereby offering practical insights for universities.

The methodological approach taken shows the value of context-sensitive research and its theoretical and empirical focus. By providing an empirical enquiry informed by critical realism, a multi-layered embeddedness perspective develops. This perspective allows the contextualising and building of theory. The study is one of the first to develop and employ an ecosystem approach to scientific-knowledge commercialisation based on the St. Gallen Management Model. The strength of this methodological perspective gives rise to strong contextual findings.

Researching the context shows several aspects that impact upon the creation of scientific-knowledge-commercialisation networks. Germany, for examples, continues to outrank Ireland in relation to university-industry collaborations, despite the continued prevalence of 'ivory tower' perception of academia in Germany. While Germany has a long tradition of engagement with existing indigenous companies, the study highlights that the lack of new engagements between academics and industry is preventing the development of personal relationships and poses a barrier to network creation in the future. In contrast, in Ireland industry-academia collaboration is driven by scientists seeking to meet the requirements of government-funded programmes. There is also evidence of short-termism in the Government's approach to investment in the third-mission in Ireland. Current economic constraints in Ireland exacerbate doubts among the stakeholders about the long-term commitment of the Government to building networks for the creation of a knowledge economy.

The importance of PIs as boundary spanners has major implications for how scientific-knowledge commercialisation is structured and organised. The thesis calls for a re-evaluation of the role and structure of TTOs in universities.

Implications for both Ireland and Germany include the need to focus on collaborations and partnerships instead of spinning out companies. Ireland needs to recognise it has a relatively young ecosystem. Consequently, short-termism is not the way to approach the establishment of collaborative networks. Ireland may consider reconfiguring the participation and connectedness of the different government agencies. Collaborations between Ph.D. students and industry can increase interaction between firms and academia (Mangematin 2000). Taking the engineering sector as an example, German Ph.D. students traditionally work in sectors such as the automotive industry and are therefore integrated into industry from an early stage. Mangematin (2000) also finds that this is particularly true for the engineering sector, and observes that if collaborations with industry are not encouraged during the Ph.D. phase, contacts between academia and industry will be reduced. Mangematin and Robin (2003) suggest that Ph.D. involvement should also be encouraged in the life sciences. The promotion of industry Ph.D. programmes might, thus, help to reduce the disconnect between industry and academia. In order to enable collaborative research, Ph.D. programmes should, therefore, be introduced in Ireland and extended in Germany.

Additionally, the study supports the general idea that excellence centres are established to create internationally visible, competitive research facilities. The study proposes that excellence centres have an advantage over faculties as an aggregation effect is created by virtue of the concentration of a number of PIs in one location. This is not to say that faculties cannot compete and the study cautions against generalising this finding. A single PI can be the critical determinant.

1.7 Thesis structure

The study comprises eight chapters. Following this chapter, Chapter 2 outlines the literature on university entrepreneurship, focusing on aspects relevant to scientific-knowledge commercialisation. In Chapter 3, two theoretical views on stakeholder relationships are outlined, namely entrepreneurship theory and relationship-marketing theory. These two theories are then evaluated and applied to the scientific-knowledge-commercialisation framework. Following the theoretical overview, Chapter 4 elaborates the case-study methodology. The fifth chapter presents findings on the contextual environment (i.e. the ecosystem of scientific-knowledge commercialisation). Chapter 6 elaborates the findings on how, why and by whom collaborative networks are established and managed when commercialising scientific knowledge. Chapter 7 provides a discussion on the three research questions. Chapter 8 concludes the study by setting out policy and managerial implications and outlines the study’s contributions.

2 The existing body of knowledge

2.1 Introduction

Research and teaching as premier activities in academia have steadily changed as new perspectives on the role of universities knowledge creation, increased globalisation, reduced government funding and growing awareness of opportunities for the practical use of academic knowledge emerge. This chapter outlines the existing body of knowledge on scientific-knowledge commercialisation in order to identify the need for further research and is structured as follows. In Section 2, the knowledge economy and its trends and changes are discussed. Section 3 outlines the nature of scientific knowledge. This is followed by an overview of the different roles of stakeholders in the scientific-knowledge-commercialisation process. Sections 5 and 6 outline the barriers and factors of scientific-knowledge commercialisation. The chapter concludes by summarising the literature and identifying the need for further study.

2.2 The knowledge-based economy: Trends and implications

> "Transferring university-developed knowledge to the private sector fulfils a goal of federally funded research by bringing the fruits of research to the benefit of society" **(Duderstadt 2004 p69).**

The term 'knowledge economy' was coined by Peter Drucker (1992). Knowledge, seen as human capital and technologies, is central to economic development and is one of the most important factors for a country's international economic strength and competitiveness. It is not just the US that has tried to change from an economy of goods into a knowledge economy (Drucker 1992), but rather all OECD economies are now more reliant upon the production, distribution and utilisation of knowledge. New growth theory or endogenous growth theory, as opposed to the neo-classical model, tries to incorporate knowledge as an important factor in economic development, by incorporating human capital and new technologies more directly into traditional production functions (Romer 1990, Grossman and Helpman 1994, Aghion, Howitt and García-Peñalosa 1998). New growth theory serves to understand the shift from an economy of goods to a knowledge based economy. In addition, it underlines the importance of the economic processes, which produce and diffuse new knowledge, in forming the growth of nations. In this theory investments in education and training, as well as R&D, are of great significance.

As scientific knowledge seems increasingly important for new business development and innovation, governments are requiring universities to take a more active role in national and regional economic development (Mansfield and Lee 1996). “The commercialisation of scientific and technological knowledge produced within publicly funded research institutions…is increasingly considered by policymakers as raw material for developing and sustaining regional economic growth”(Ndonzuau, Pirnay and Surlemont 2002 p281). Commercialisation of knowledge it is not only a matter of national concern but also a central issue for universities in the US and in Europe.

2.2.1 Paradigm shift of knowledge production and innovation

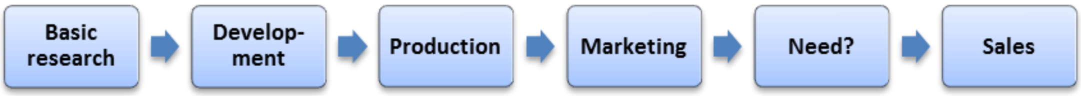
According to Schumpeter (1934 p66), innovation is:

> “(1) The introduction of a new good – that is one with which consumers are not yet familiar – or of a new quality of good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market (…) (4) The conquest of a new source of supply of raw materials or half-manufactured goods (…) (5) The carrying out of a new organisation of any industry (…)”

Schumpeter’s definition introduced the distinction between product and process innovation. It also highlights that innovation can be technologically or commercially driven. The latter differentiations reflect that innovation can either be led by ‘technology push’ (a scientific discovery is pushed into the market, whether it is needed or not) or ‘market pull’ (a specifically expressed need is satisfied). These concepts of ‘innovation push’ or ‘innovation pull’ are of both linear and sequential in nature (Rosenberg 1982, Kline and Rosenberg 1986, Coombs, Saviotti and Walsh 1987, Martin 1994).

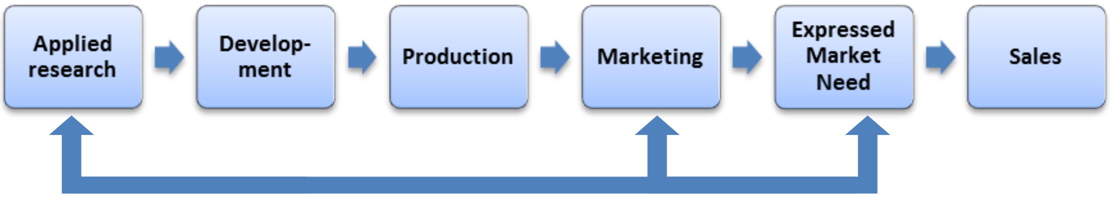
Ruivo (1994) distinguishes three paradigms or phases of science development, namely science as ‘motor of progress’, ‘problem solver’ and ‘a source of strategic opportunity’. The first two paradigms ‘science as motor of progress’ and ‘science as problem solver’ can be compared with the technology strategies of ‘innovation/technology push’ or ‘innovation/market pull’ (see Figure 1 and 2). The linear process of innovation starts with either a scientist doing basic research (motor of progress) or applied research (to solve a problem) and progresses then through the different stages of development, production, marketing and/or sales.

Figure 1: Innovation/Technology Push



Source: own conception based on (Rosenberg 1982, Kline and Rosenberg 1986, Coombs, Saviotti and Walsh 1987, Martin 1994)

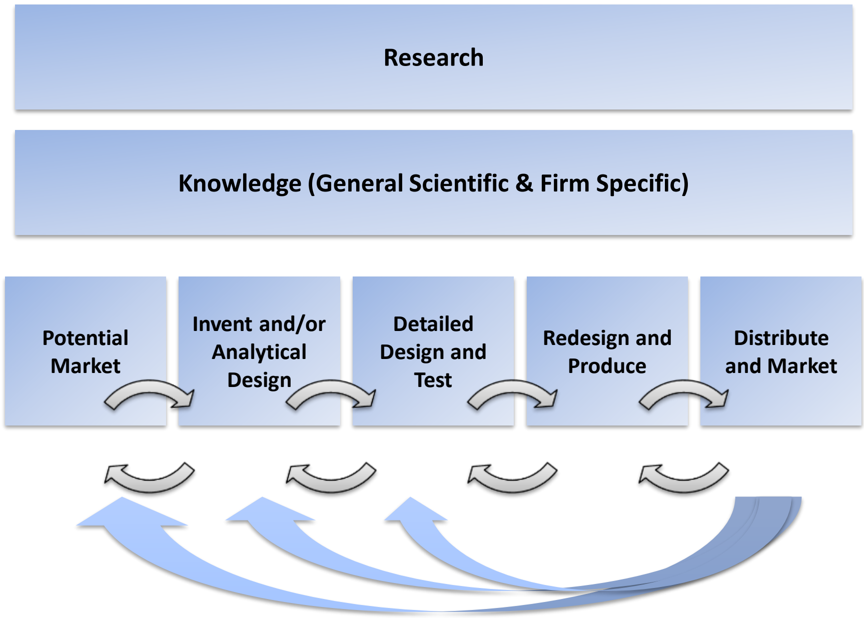
Figure 2: Innovation/Technology Pull



Source: own conception based on (Rosenberg 1982, Kline and Rosenberg 1986, Coombs, Saviotti and Walsh 1987, Martin 1994)

'Science as a source of strategic opportunity' combines the two technology strategies, forming a new innovation system that involves the interaction and communication among different actors with feed-back loops between research, engineering, product development, manufacturing, marketing and customers. The 'chain-link' model (Kline and Rosenberg 1986, Myers and Rosenbloom 1996) provides a good overview of how innovation occurs within a framework of networks and relationships with participating actors (Figure 3). The authors point out that a potential market has to be identified and that at each stage of the process an interaction of technology capabilities and market needs is inevitable for a successful market entry.

Figure 3: The chain link model of innovation

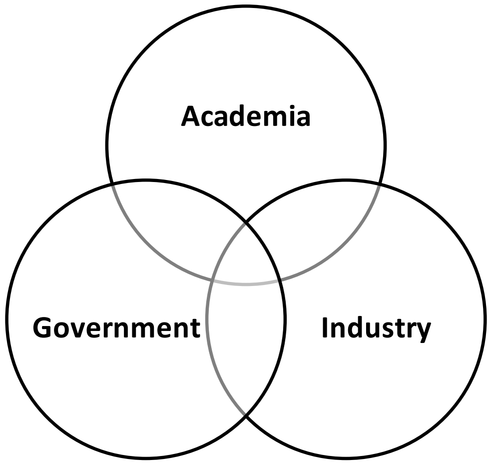


Source: Adapted with minor changes from Kline and Rosenberg (1986) and Meyers and Rosenbloom (1996)

The ‘new mode’ or ‘mode 2’ of knowledge production, as opposed to the ‘old mode’ or ‘mode 1’ where knowledge was created through basic research in the university, was coined by Gibbons et al. (1994 p4) who argue that the creation of knowledge is “always produced under an aspect of continuous negotiation and it will not be produced unless and until the interests of the various actors are included.” They further allege that: “Such knowledge is intended to be useful to someone whether in industry or government, or society more generally and this imperative is present from the beginning.” (Gibbons et al. 1994 p4) It seems that ‘science as a source of strategic opportunity’ and pari passu the mix of a ‘technology push’ (Figure 1) and ‘market pull’ (Figure 2) process of innovation can be seen as ‘mode 2’, where knowledge is produced in a transdisciplinary manner with a diversity of actors. The ‘chain link’ model of innovation is a good framework to understand how innovation takes place, but it focuses more on the creation of innovations and not as such on the exploitation. In comparison, Chesbrough’s (2003) ‘open innovation’ approach is an example that shows that the sub-results of the innovation process can also be commercialised.

Innovation as an evolutionary continuous procedure, which involves different institutional areas, or sectors, in society was taken further in the ‘triple helix’ model of Etzkowitz and Leydesdorff (1997, 2000) (Figure 4).

Figure 4: Triple Helix



Source: (Etzkowitz and Leydesdorff 1997, 2000)

In recent years this non-linear recursive interaction of helixes has become an alternative mode, where the different 'overlapping' institutional spheres – Academia, Government and Industry – generate a knowledge infrastructure and form tri-lateral networks and hybrid organisations (ibid. 1997, 2000) The 'triple helix' is a useful approach that shows that internal and external partners are integrated and are able to network within the knowledge infrastructure. In order to form a working innovation system the three institutional spheres, and the relationships between them, are changing worldwide. The triple helix, however, fails to provide a holistic understanding of the surrounding environment; a wider, more complex (eco)system of knowledge commercialisation that influences the formation of the knowledge infrastructure, scientific knowledge exploitation and commercialisation processes respectively. The triple helix approach does not, therefore, provide a systemic approach for policy-making. This systemic approach to policy-making is required to compete in global markets, as postulated by Tödtling and Trippl (2005).

While acknowledging that an ecosystem approach is consistent with a National Innovation System (NIS) or systems of innovation approach, NIS focuses mainly on overall industrial capabilities in innovation and does not take the commercialisation of scientific knowledge and universities per se into consideration. Edquist (2005) claims that it is necessary to develop the approach further to conceptualise and formalise the work more in order to get new insights into the operations of the system. Research has shifted from NISs to Sectoral (SIS) and Regional Innovation Systems (RIS). These approaches offer a more detailed view on how innovation happens. It is argued, however, that innovation policy should not just target high-tech industries but several sectors (Tödtling and Trippl, 2005, Tödtling, Lehner, and Kaufmann, 2009) and that for these reasons a differentiated policy approach is required. Stemming from the work of these authors, each of the system of innovation approaches may be viewed as not ideal to apply in the same way across different areas in order to enable specific policy-making. "Policy makers should also deal with the organisational, financial, educational and commercial dimensions of innovation" (Tödtling and Trippl, 2005, p.1211).

Furthermore, policy researchers commonly agree that the relationship between innovation, technology and science is of an interactive nature (Morlacchi and Martin, 2009). They believe that the innovative power of countries rests upon relations between actors and not just on the ability of the individual. They further believe that absorptive capacity, and not just internal R&D, is vital for firms to produce new technologies.

2.2.2 The changing role of the university

Traditionally, academia's undertaking in society has been teaching and research. Many authors now note that universities play an amplified role in innovation and in growing economic clusters in expanding knowledge economies (von Hippel 1988, Etzkowitz et al. 2000, Porter and Van Opstal 2001). With respect to the recognition that knowledge is central to economic development and is one of the most important factors for a country's international economic strength and competitiveness, society has become progressively knowledge intensive and increasingly dependent upon knowledge-producing universities. This new role refers to creating entrepreneurial universities which commercialise scientific knowledge and partake in 'entrepreneurial science' (Clark 1998, Etzkowitz 1998, Etzkowitz, Webster and Healey 1998, Etzkowitz et al. 2000, Etzkowitz 2001). The university is no longer considered just an institute of teaching and basic research, but is now a source of commercial value. Elements common among entrepreneurial universities (Clark 1998) are as follows:

(1) a strengthened steering-core that promotes and enforces an entrepreneurial spirit and the process of commercialisation (the third mission) alongside traditional concerns of teaching and research;
(2) an expanded developmental periphery. Universities link up with outside organisations and groups such as industrial liaisons offices, outward research centres etc. to bridge the gap between the university setting and the outside world;
(3) a diversified funding base in the form of second and third stream income;
(4) a stimulated academic heartland where traditional academics accept new managerial points of view; and
(5) an entrepreneurial academic culture; a culture where the new perspectives and beliefs of the university are anchored.

The tension between the traditional role and the entrepreneurial university is provoking increasing debate. Some scholars (Bok 2004, Nelson 2004) argue that the objectives of the university should not be profit related and that the commercialisation of IP could damage the university's standing in society. Other scholars (Fairweather 1990, Mansfield and Lee 1996, Etzkowitz et al. 2000, Larédo and Mustar 2001) see universities as key sources of innovation and partnerships with industry as beneficial to economic growth. Commercialisation activities may also bring some benefits in terms of increasing the public image due to aiding economic development, which in turn can cause an increase in public funding (Fairweather 1990). Etzkowitz et al. (2000) suggest, however, that the 'ivory tower' role (i.e. teaching and basic research) can conciliate with the 'entrepreneurial paradigm'. In addition, Van Looy et al. (2004) propose that the two roles may actually reconcile and complement each other.

Empirical evidence shows that university entrepreneurship is emerging as an important academic field in its own right. The literature, however, continues to be rather fragmented (Rothaermel, Agung, and Jiang, 2007). Due to this fragmentation, Rothaermel, Agung and Jiang (ibid.) conducted a systematic review of the literature for the period between 1981 to the end of 2005, which is summarised in Table 1 below.

Table 1: State of the art in university entrepreneurship (between 1981 and 2005)

Topic	Influences on entrepreneurial activity and key aspects/findings	Authors	Conflicting Findings	Lack/Weakness
Entrepreneurial university	**Internal factors**		**Role of the university** • academic or entrepreneurial **Incentive structure** • provide incentives/rewards to faculty or personnel **Effects of policies** • positive (patent quality increase) or negative (patent quality decrease)	Complexity in models and richness in data to understand the interdependent processes across different stakeholders
	Organisational design of university influences the commercialisation of scientific knowledge			
	Incentive system • Faculty • TTO • Departments	e.g. Friedman and Silberman 2003		
	University status • Public/private • Prestige • Departments	e.g. Thursby et al. 2001		
	Location • Proximity to high-tech firms/industry	e.g. Mansfield 1995		
	Culture • Historical context • Differences	e.g. Jacob et al. 2003		
	Intermediary agent • TTO availability/age • Incubator	e.g. Collins and Wakoh 2000		
	Experience • University learning	e.g. Owen-Smith and Powell 2001		

	Characteristics and roles influence research commercialisation			
	Faculty •Motivation •Quality •Background •Disclosure decision	Chrisman et al. 1995		
	External factors			
	Government policies •Bayh Dole	e.g. Mowery and Sampat 2001		
	Industry conditions •Resources •Opportunities •Concentration	e.g. Harmon et al. 1997		

Productivity of TTO	**TTO internal factors**		**Role of TTO** • Establishing link between University-Industry or scientists are already part of network and therefore limited role of TTO **What constitutes TTO performance** • Licensing agreements/revenues or invention disclosure and sponsored research agreements	Understanding the variety of TTO strategies (not just IP strategy) and how characteristics and processes influence performance. TTO staffing practices and training
	TTO system •Degree of self-sufficiency •Resources •Incentives for staff	e.g. Jensen et al. 2003		
	TTO structure •Reporting relationship •Age •Autonomy	e.g. Bercovitz et al. 2001		
	TTO staffing •Market experience •Admin experience	e.g. Markman et al. 2005		

	TTO external factors			
	Mechanisms of TT • Licensing strategy • Financial returns of licensing vs. equity • Evaluation and selection of project • Effectiveness of patent	e.g. Bray and Lee 2000		
	Technology • Nature and stage	e.g. Thursby and Thursby 2001		
	Faculty • Propensity to disclose • Shift of research focus • Disclosure	e.g. Thursby and Thursby 2002		
	University system • IP protection • Culture • R&D intensity • Departments • Public/private	e.g.Siegel,Waldmand and Link, Siegel et al. 2003a,b		
	Environmental factors • Industry research support • R&D activity of local firms • State-level economic growth	e.g. Feldman et al. 2002		
New firm creation Spin-off as entrepreneurial activity	**University policy** • Attitude to surrogate entrepreneurs • Equity investments • IP • Incubation models	e.g. Franklin et al. 2001	**Involvement of university with newly created firm** • Beneficial (higher survival, performance and reputation effects) or dependency, negative reputation effects and delayed graduation from incubators	Performance of university ventures over time and multiple cases – not just a single university
	Faculty • Time • Role • Experience • Location • Quality strengths of ties	e.g. O'Shea et al. 2005		

	TTO • Experience • Age • Expectations	e.g. Lockett et al. 2003	**Attitude towards entrepreneurs** • Surrogate entrepreneur or coaching entrepreneur
	Technology • Quantity • Quality	e.g. Shane and Stuart 2002	**Founding team** • Heterogeneity (diversity of expertise to assess opportunities and threats) or homogeneity (as diversity increases self-sufficiency which negatively correlates with networking and thereof resource allocation)
	Investors • Info gap • Availability • Relationship • JVC arrangement	e.g. Wright et al. 2004	
	Founding teams • Social capital • Evolution of team • Team homogeneity • Scientific excellence	e.g. Clarysse and Moray 2004	
	Networks • Strengths of ties • Formality of ties/collaboration	e.g. Johansson et al. 2005	
	External conditions • Market opportunity • Industry R&D funding • Industry attractiveness	e.g Powers and McDougall 2005	

Environmental context including networks of innovation	**Direct factors**		**Innovation networks** • Impact or no impact on firm's R&D output **Science park membership** • Effect or no effect on research productivity	Deeper understanding of diverse linkages Effectiveness of various types of linkages How to effectively build and manage networks and linkages
	Innovation networks •Link with HEI •Collaboration with university scientists •Coverage and scarcity of participants/research area	e.g. Medda et al. 2005		
	Science parks •Growth •Membership •Added value	e.g. Lindelöf and Löfsten 2003		
	Incubators •Types •Services •Added value •Knowledge flows	e.g. Mian 1996		
	Geographic locations •Proximity to university •Clusters	e.g. Van Dierdonck et al. 1990		
	Mediating factors			
	Science and faculty •Type of research •Role founder/advisor	e.g. Audretsch and Stephan 1996		

Source: Derived from Rothaermel, Agung and Jiangv (2007)

The literature review is based on 173 articles published worldwide in a number of refereed scholarly journals and offers a detailed analysis and synthesis of the state of the art in university entrepreneurship. As outlined in the above table, the review reveals that there are several conflicting findings. Researchers question the role of the university or TTOs and what influences these have on scientific-knowledge commercialisation. In addition, they disagree about incentive structures rewards, the effect of policies on patent quality and whether surrogate entrepreneurs or coached investors and homogenous or heterogeneous founding teams have an impact on the success of new firm creations. Furthermore, there are contradicting findings with regard to the environmental context in the form of innovation networks and science park memberships on R&D performance.

Rothaermel, Agung and Jiangv (2007) find that, although university entrepreneurship is a recent field of research, the majority of research is atheoretical and quantitative in nature. Only a few scholars apply sociology, network or strategic management theory to the university entrepreneurship phenomenon, thus limiting the progression of the research field in question. In addition, they point out that the unit of analysis was mainly the university (50 %) followed by the firm (23 %), individuals (10 %), incubators/science parks (9 %), TTOs (5 %) and regions (3 %). Only a few studies focus on the dyadic interplay of actors and even fewer studies consider a multiple view of interaction.

2.2.3 University-industry collaboration

The Lambert review (2003) revealed that there are two major worldwide trends that are responsible for the change in the way businesses are carrying out research. Primarily they prescind themselves from undertaking research in their own laboratories in favour of a new system of collaborating with other institutions in order to facilitate innovation. This trend is documented in the work of Chesbrough (2003) in what he calls ‘open innovation paradigm’. Companies can no longer rely solely on their internal innovation capabilities, particularly in technology sectors where the pace of the product life cycle is shortening. Companies have to supplement internal capabilities by ‘in-sourcing’ product or process innovations through both acquisition and collaboration (Chesbrough, 2003).
He suggests that businesses, that want to be innovative, “can and should use external ideas as well as internal ideas, and internal and external paths to market” (Chesbrough 2003 pXXIV). The other trend is that R&D by companies is going international. Companies’ habitual preference in R&D investments is no longer the country they are located in, but rather the international market. These changes have major implications for the way universities collaborate (Lambert 2003). Universities are required to become entrepreneurial universities which transfer and commercialise scientific knowledge (Clark 1998, Etzkowitz 1998, Etzkowitz, Webster and Healey 1998, Etzkowitz et al. 2000, Etzkowitz 2001). Governments increasingly see university-industry collaborations as a requirement for economic success.

The reality, however, is different. Only a few world-class universities – most of them located in the US – generate considerable revenue from licensing fees and royalties (Lester 2005). In addition, universities are not the most important source of knowledge to the private sector. They are even ranked behind customers/users, competitors, technical conferences and workshops and other sources (Cosh, Hughes and Lester 2006, Giuri et al. 2007). Aside from that, the relationship between industry and academia does create tensions due to differing interests which yield problems and barriers to the commercialisation process. Universities collaborate in order to finance their research, create royalties and generate good PR and reputation. Businesses want to get access to new technologies and ideas, substitute or reduce their R&D costs and accelerate their time to market (Benneworth 2001, Decter, Bennett and Leseure 2007).

There are tensions at both the individual and organisational level. The individual level is more prominent as individual researchers "are bound by their experiences and socialised into specific work environments" which make them repellent to change (Ambos et al. 2008 p1428). Nevertheless, academia is able to reconcile the tensions through what Ambos et al. call creating 'ambidexterity' or 'dual structures'. These 'dual structures' could be, for example, the establishment of TTOs or the appointment of designated faculty tasks (teaching, entrepreneurial faculty etc.). These findings correlate with the studies of other scholars who state that intermediaries bridge the gap between academia and industry (Wright et al. 2008, Yusuf 2008). Referring to bias in academic and commercial interests, the literature also suggests that academia and industry should recognise their abilities and synchronise their distinctive roles (Rosenberg and Nelson 1994, Hall 2004, Siegel et al. 2004) i.e. universities should engage more in basic research and industry should focus on the short-term problems.

2.2.4 Changes in government policies

University-industry relations and the commercialisation of university-generated knowledge have become a common and widely accepted phenomenon. This is evidenced in governments' interest in investing in the research base and responding with public policy programmes. With respect to the whole of Europe, it still lags behind the United States and Japan in research and innovation performance. On average, European Gross Expenditure on R&D (GERD) in 2008 was 1.77% of GDP, compared to 2.77% in the United States and 3.44% in Japan (OECD 2010). Indeed the current debate about the benchmarking of Europe with the United States may soon be overshadowed by the challenges Europe faces from fast developing Asian nations such as Korea where GERD exceeds 3% of GDP. China's GERD increased from 0.9% in 2000 to 1.44% in 2007 showing the increasing importance of R&D (OECD 2010). Whilst investment in R&D in the United States is proving fruitful from a commercialisation point of view, the 'European paradox' describes the poor returns to R&D investment in Europe.

In Europe policies have been implemented to capitalise knowledge and protect IP in order to address this dilemma. To be competitive, the European members set a target to increase R&D performance to 3% of GDP by 2010 in the Lisbon strategy. The target has not been met to date, partly due to low economic growth of national economies and the recent global economic crisis. Governments have been trying to improve R&D performance for several years by embracing public policies on innovation and science. Larédo and Mustar (2004) note that Europe exhibits significant diversity in terms of research organisation. Most European countries have centralised R&D systems (for example UK, France, Ireland, and Netherlands) but a few (Sweden and Belgium) have decentralised systems. Germany, however, has multi-level R&D systems, where higher education and research policies are shared between the Federal Government (Bund) and the Regional Government (Länder). This approach enables regional specialisations. In addition, EU 'Technological programmes' such as the 'Industrial and Materials Technology' programme and the 'Information and Communication Technology' programme, as well as current debates about direct EU funding for large research facilities like CERN and ESF are examples that indicate a transfer of national responsibilities to the EU. This has emerged alongside a rising interest in 'problem-solving' policies of both the EU and national governments in the form of the framework programmes (ibid.). The European Research Area (ERA) was established to advance the co-ordination of national and international policy issues (OECD 2008). An initiative to meet the Lisbon agenda objective, i.e. to boost universities contribution to the formation and distribution of knowledge within Europe, was created by European stakeholders European Industrial Research Management Association *(*EIRMA), Association of European Institutions of Higher Education (EUA), European Trade Association (EARTO) and the European Knowledge Transfer Association (ProTon Europe). 'Responsible Partnering' is a programme designed to create a platform and guidelines for transnational co-operations between public research organisations and industry (EUA et al. 2008, 2005). Another innovation policy stimulant is the focus on tax incentives in the form of tax reliefs (Rammer 2006). It is important, however, to remember that, with regard to research, national systems differ and that there are still different national policies with regard to IP rights, initiatives etc. in operation.

Goldfarb and Henrekson (2003) point out that there are two different policy approaches to commercialisation of university IP. One form of doing this is 'top-down' from the government and its agencies. The other form comprises initiatives promoted through a 'bottom-up' policy, from the individuals and entities inside academia. In the US the Bayh-Dole Act is legislation that deals with the IP generated by publicly funded research. It awards the property rights to universities. The US system is highly focused on creating incentives for academics to commercialise their scientific knowledge and allowing them to find the best way of doing that (Council on Governmental Relations 1999). Scholars, however, question the impact and effects of the Bayh-Dole Act. While some (Mowery et al. 2001) argue that this Act has little effect on patenting output, others assign no effect to it (Coupé 2003). With regard to the quality of patenting output, findings are also mixed. Mowery and Ziedonis (2002) as well as Sampat, Mowery and Ziedonis (2003) find an increase in quality, whereas Henderson, Jaffe and Trajtenberg (1998) assert a decrease. Part of the strength of the US innovation system is the favourable IP system, a scenario which is juxtaposed to that in some European countries where IP protection for academia is still quite weak and incoherent.

Although the European Commission is promoting open innovation in order to improve knowledge transfer between research institutions and industry (European Commission 2007) and recommending management of IP in the form of a code of practice (European Commission 2008) there is no common intellectual property right (IPR) strategy. IPRs are still handled individually at national legislative level. There is no agreement on ownership rights for the employed inventor vs. 'professor's privilege', the compensation of inventors or joint ownership regimes. This inconsistency is making the effective exploitation of scientific knowledge more difficult. In some European countries the IP is still the 'professor's privilege'. Professors hold exclusive right to their inventions (pertain to academic freedom). Some countries have laws which grant the university the right to exploit the IP, while others leave it to each university to decide it (Kilger and Bartenbach 2002, Wright et al. 2007). There is consensus in several reports of the European Commission that ownership of the IP should belong to the public research institution or higher education institute where the scientific knowledge has been created (European Commission 2002, 2004, 2008). Given these results and the lack of European consensus on ownership, it may be necessary to revisit the topic in order to simplify the management of international university and business collaboration.

2.3 Commercialisation of scientific knowledge

The commercialisation of scientific knowledge is one of the major goals in knowledge-intensive societies in order to sustain economic growth and prosperity. Lundvall (1992 p18) underlines this subject matter as follows: "Knowledge does not decrease in value when used. On the contrary, its use increases its value." The foundations of this approach will be shown in this section. The nature of scientific knowledge and the commercialisation process will be examined a priori. In addition, strategies to capitalise knowledge will be outlined and barriers and enablers of the commercialisation process will be discussed.

2.3.1 The nature of scientific knowledge

Science comes from the Latin word 'scietia, -ae' and means knowledge, understanding or expert knowledge (Morewood 1994). The Oxford English Dictionary (Stevenson 2010) defines knowledge as:

(1) Facts, information, and skills acquired through experience or education;
- the theoretical or practical understanding of a subject;
- the sum of what is known;
- information held on a computer system;
- (philosophy) true, justified belief; certain understanding, as opposed to opinion.

(2) Awareness or familiarity gained by experience of a fact or situation.

Ergo scientific knowledge refers to a systematic study to gain an understanding or a status of understanding. There is burgeoning literature about the theory of knowledge (epistemology), its impact on economies, firms' competitiveness and different frameworks for differentiating between the existing knowledge. The creation of scientific knowledge is complex and a much discussed issue. Some scholars argue that scientific knowledge can be developed through scientific methods and hence research per se. There are different views as to whether knowledge creation is attributed to individuals or to collective, social-embedded communities or networks (Popper 2002, Heilbron 2003). Several authors (Polanyi 1967, Nonaka and Takeuchi 1995) argue that it is important to understand the nature of knowledge (tacit or explicit) and that the interaction between the two types of knowledge is significant for the creation of new knowledge. Explicit knowledge can be codified, is easier to transfer and can be used without participation of the person or group. Conversely, tacit knowledge is personal, difficult to explain or articulate and can only be created through experience and not through study. "We can know more than we can tell" (Polanyi 1967 p4) indicates that tacit knowledge has a cognitive perspective which makes it difficult to imitate if key individuals are not hired or key organisational processes transferred. 'Appropriability regimes' for knowledge assets are used to describe how easy or difficult it is to imitate or replicate a scientific discovery. The most important parts of appropriabiliy regimes are IPRs (such as patents, trade secrets, trademarks, copyrights or registered designs) and the degree of replicability.

A discovery has a strong appropriability when it is difficult to replicate and there are tight IPRs in place to protect it from imitation. Conversely, economists speak of weak appropriability when replicability is non arduous and the protection of the IP is loose or not possible (Lowe 1993, Teece 2002).

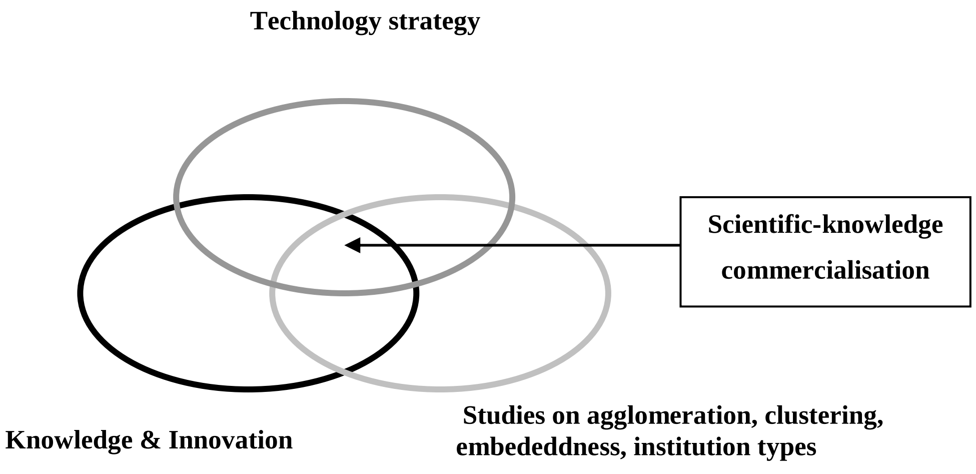
Technologies from universities are usually classified into stages i.e. early stage, proof of concept, reduction to practice and prototype. These technologies are categorised based on the uncertainty of the potential market, legal protection (Markman et al. 2005) as well as on uncertainty about the technology (Brockhoff 2005). Early stage discoveries are generally not yet protected, the market potential is difficult to predict and insecurity of the technological appropriation is inherent. As a result, there is a high level of uncertainty about success. In contrast, a prototype has a higher legal protection, clearer market perspectives and technical uncertainty might have already been minimised.

Most scientific discoveries from academia are embryonic in nature and therefore involve a high proportion of tacit knowledge (Thursby, Jensen and Thursby 2001, Yusuf 2008). As tacit knowledge is difficult to codify the transfer and commercialisation is deemed to be difficult. In order to absorb scientific knowledge from external created knowledge, industry has to have the ability of 'absorptive capacity' (Cohen and Levinthal 1989, 1990). This refers to the firm's ability to realise the economic value of new knowledge created by others and to understand, commercialise and market it successfully. This success is based on internal R&D, access to complementary assets (Teece 1986) and protection of the IP. In addition, Polanyi states that “all knowledge is *either tacit* or *rooted in tacit knowledge*. A *wholly* explicit knowledge is unthinkable” (Polanyi 1966 p7). Drawing on Polanyi and the assumption that tacit knowledge is embodied and embedded in individuals and social networks, the sole transfer of explicit knowledge in technology commercialisation is not possible without communication and the interaction of all participating parties. Zucker, Darby and Armstrong (2002) argue that the inherent transfer difficulties can only be solved in joint projects where firms can access and adapt tacit knowledge. Achieving effective knowledge commercialisation and transferring the discoveries from academia to industry is a difficult task to undertake involving important competencies of all participating stakeholders and continued collaboration.

2.3.2 Scientific-knowledge-commercialisation process

As illustrated in the Figure 5 below, from a theoretical perspective scientific-knowledge commercialisation is positioned on the overlap of three existing paradigms: (a) knowledge and innovation; (b) technology strategy; and (c) studies on agglomeration, clustering, embeddedness and institution types.

Figure 5: Theoretical position



Source: Own conception

There is literature on innovation via patenting, licensing and coherent theoretical and empirical evidence on the processes that guide commercialisation across institution types (Markman, Siegel and Wright 2008). Literature on technology strategy only addresses new product development and market entry issues rather than the transfer and commercialisation of the technology. Furthermore, the authors (ibid.) refer to Siegel (2003) who points out that studies on agglomeration, clustering, embeddedness and institution types do not cover the factors that influence the commercialisation processes and the interplay of the different stakeholders. Markman, Siegel and Wright (2008) note that knowledge and innovation literature highlights that knowledge has become a core competitive advantage but that the literature does not include issues with regard to organisational processes. The concept of commercialisation and the concept of innovation do overlap to some extent (Jolly 1997). Jolly argues that commercialisation has only been seen as a part of product innovation – the final stage of product launches – and that there are significant differences between technology commercialisation and product innovation. The main differences are summarised in Table 2 below:

Table 2: The main differences between product innovation and technology commercialisation

Characteristics	**Product**	**Technology**
1. Object to be commercialised	Singular design	Multifaceted capability
2. Start of commercialisation (and time scale)	Product conception (1-5 years)	As soon as a potentially valuable technology concept is proposed (10-20 years)
3. Stakeholders to whom to demonstrate value	Customer as end-users	Several, whose mix and interests evolve with the technology
4. Nature of demand	Final for the segment targeted	Derived from the product(s) made possible
5. Competition	Other products for same function	At different levels against other technologies for same product or function
6. Marketing challenge	Exploiting unique selling proposition (USP) of finished product	Exploiting whatever the technology can achieve at the point of time
7. Timing	End-user market opportunity	The time line of competing inventors, adopters and resource providers
8. Opportunity for value creation and appropriation	Revenue from making and selling products competitively	Product sales and/or collateral benefits over life of technology

Source: (Jolly 1997 pxvi)

The literature discussed above reveals that there are several theoretical approaches to commercialisation but there is no general consensus about the meaning of the commercialisation of university research. In the broadest perspective, commercialisation can best be described as a process. This commercialisation "process usually occurs through a complex interplay between different actors and mechanisms" (Waagø et al. 2001 p119) and can be identified as a procedure of transferring and transforming theoretical knowledge into commercial value. The process of exploiting includes:

> "all stages of commercial development, application and transfer, including the focusing of ideas or inventions toward specific objectives, evaluating these objectives, downstream transfer of research and/or development results, and the eventual broad based utilization, dissemination and diffusion of the technology-based outcomes" (Roberts 2007 p36).

Jolly (1997) defines the process of technology commercialisation as a sequence of distinct sub-processes involved in bringing new technologies to market:

> "*imagining* a techno-market insight; *incubating* the technology to define its commercializability; *demonstrating* it contextually in products and/or processes; *promoting* the latter's adoption; and *sustaining* commercialization" (Jolly 1997 p3).

In order to overcome the problems of commercialisation, including links between technological discoveries and opportunities, demonstration of technology to opinion leaders, incubation of technology, resources for successful demonstration, market acceptance and transfer of benefits as well as selection of proper business tools, one has to satisfy and mobilise stakeholders at each stage of the process.

A popular approach amongst researchers in the field (Roberts and Malone 1996, Jolly 1997, Ndonzau, Pirnay and Surlemont 2002, Siegel et al. 2003a, Siegel et al. 2004, Spilling 2004, 2008, Ryan and Kelly 2007) is to present the commercialisation process as a stage model, as presented in Table 3 below. Spilling (2004, 2008) argues that a stage model implies some form of linearity for an easier understanding, but that interaction happens between the stages and that it will always start at the point of the existing knowledge base.

Table 3: Stage models of commercialisation

Stages	Roberts & Malone 1996	Jolly 1997	Ndonzuau, Pirnay, Surlemont 2002	Siegel et al. 2003a, 2004	Ryan & Kelly 2007
I.	Invention	Imagining	Generate Business Ideas from Research	Scientific Discovery	Recognise the Opportunity
II.	Disclosure	Incubating	Finalise New Venture Projects out of Ideas	Invention Disclosure	Assess the Commercial Value
III.	Evaluation	Demonstrating	Launch Spin-Offs from Projects	Evaluation of Invention for Patenting	Assess Patentability
IV.	Protection	Promoting	Strengthen the Creation of Economic Value by Spin-Offs	Patent	Develop a Commercialisation Strategy
V.	New Venture Creation	Sustaining		Marketing of Technology to Firm	Implement the Strategy
VI.	Product Development			Negotiation of License	
VII.	Incubation			License to Firm (Existing Firm or Start Up)	
VIII.	Business Development				
IX.	Initial Public Offering				

Given the range of process approach variations which exist in the literature (mainly focusing on spin-offs rather than different commercialisation options) no uniformity can be identified hitherto. To distinguish commercialisation of inventions in general and commercialisation of scientific knowledge within academia, the term scientific-knowledge commercialisation will be used. Scientific-knowledge commercialisation can be defined as the process of commercialising university created scientific knowledge, where the produced knowledge is promoted to the business world in order to generate commercial value (Waagø et al. 2001). It covers IP transfer/development and is a complex and heterogeneous process, requiring complex interactions between research suppliers, the businesses who want to exploit the research and the investors (Australian Research Council 2000, Zhao 2004).

Commercialisation success however, is not guaranteed. In order to sustain commercialisation ‘after sales’ activities should be put in place. Such activities could contribute to both the sustainability of the product and the relationships with the stakeholders. Some of these activities could be of a supporting nature, as well as mobilising researchers. In the literature there is strong consensus that collaboration of original researcher and ‘customer’ are of great importance in the development phase and afterwards (Jolly 1997, Roberts 2000, Thorburn 2000, Jensen and Thursby 2001, Zucker, Darby and Armstrong 2002, Knockaert et al. 2009). Sustaining commercialisation could, therefore, be one factor to accelerate the performance of the commercialisation process.

2.3.3 Commercialisation strategies

The question of which commercialisation route to take is a difficult and complex endeavour for universities and TTOs. It is a keep-or-sell decision (Bullinger and Renz 2005) that has to be well thought out. Lowe (1993 p29) points out:

> “the issue of which route to follow for academic commercialization depends crucially on an understanding of the alternative routes to *appropriability*, i.e. the way in which a university can maximize the value of its research to either the organization or the individual inventors. Discussions of appropriability usually consider the exogenous factors, e.g. the technological and market opportunity, and endogenous factors, i.e. complementary assets and protection afforded to the invention.”

According to this, the choice has to be made based upon several concerns including (a) the knowledge itself and the way it is protected; (b) the market potential and practices; and (c) the availability of resources. Sufficient funding has to be available to enable the realisation of a proof of concept or the development of a working prototype to show to potential licensee, business angels etc. Additional resources for the IP protection phase plus commercial competence and market intelligence also have to be accessible (Yencken 2008). Other important factors that have to be taken into account are entrepreneurial drive/initiative (Lowe 1993, Hindle and Yencken 2004), information transfer mechanics (Roberts and Malone 1996), access to tacit knowledge and original researcher (Roberts 2000, Thorburn 2000, Jensen and Thursby 2001, Zucker, Darby and Armstrong 2002, Knockaert et al. 2009), and supply of venture capital (Wright, Vohora and Lockett 2004, Wright et al. 2006).

The IP produced in academia can be transferred to the market in different ways. It can include, for example, collaborating with business on research projects, agreeing at the outset on rights relating to any IP created, as well as dealing with businesses to exploit IP that is already developed (Lambert 2003). The Scottish Enterprise study quoted by Cripps et al. (1999 p11) identified several options for exploiting and commercialising university research: (a) education and training; (b) contract research; (c) industrial consultancy; (d) licensing; (e) spin-off companies; (f) spin-off joint ventures; and (g) collaborative research.

These commercialisation channels are considered to be vehicles for entrepreneurial activity at universities (Louis et al. 1989, Klofsten and Jones-Evans 2000, Siegel, Wright and Lockett 2007) and several researchers have elaborated on the effectiveness, performance and success of these. Policy-makers place emphasis on the creation of new companies, such as spin-offs, as this enables growth, creates higher income and generates more employment than other channels (Bray and Lee 2000, Jensen and Thursby 2001). Some researchers suggest the reconsideration of these policies and point towards licensing (Lambert 2003) and soft activities such as consulting and contract research (Klofsten and Jones-Evans 2000). This view is reflected in the work of Siegel et al. (2004) who find that not all stakeholders involved in university technology transfer consider start-ups as being a critical output. Industry and academics prioritise collaborative research and other forms of industry engagement over licensing or academic spin outs (Faulkner and Senker 1994, Cohen, Nelson and Walsh 2002, D'Este and Patel 2007, Perkmann and Walsh 2009). It is believed that collaborative networks, cooperative relationships and, above all, strong prior relationships between organisations impact on the successful transfer of knowledge (Harmon et al. 1997). Collaborative research refers to projects where universities and businesses work together on shared problems (Martinelli, Meyer and von Tunzelmann 2008). An expert report under the 5th Framework Programme describes collaboration as "all forms of agreements between firms, universities, and research institutes whereby two or more organisations share the commitment to research a common goal by pooling their resources and co-ordinating their activities" (European Commission 2002 p15). The commercialisation then depends on the type of knowledge and different types of knowledge require different strategies.

2.4 The role of stakeholders in the scientific-knowledge-commercialisation process

The commercialisation of scientific knowledge involves several stakeholders. In order to enable successful transfer, stakeholders have to have relevant competencies. It is important that the transferor has (a) the technological know-how, (b) method competence, (c) relationships, (d) cooperation experience, (e) motivation and (f) market orientation (Walter 2003, 2005). In the literature these competencies are attributed to different stakeholders. Different stakeholders will also have different motives for taking part in the commercialisation process.

The transfer partners can be distinguished as the transferor and transferee. The transferor is usually a higher education institution, such as a university, institute of technology, college, research centre or public research institution. The transferee is the body who receives the technology. Transferees could be anybody who is interested in obtaining the scientific knowledge in question. The transfer process can be done indirectly through an intermediary such as the TTO (Walter 2003, 2005). Siegel, Waldman and Link (2003) and Siegel et al. (2003a, 2004) classified university scientists, university technology managers within the TTOs and firms/entrepreneurs as the key stakeholders in the commercialisation process, notwithstanding that other stakeholders are involved as intermediaries (Walter 2003, 2005). Such intermediaries are chambers of commerce, public agencies, incubators, technology centres and science parks. Accordingly, intermediaries which enable and contribute to the transfer of knowledge can be classified into the following categories (Wright et al. 2008, Yusuf 2008):

Internal intermediaries:

- The general purpose intermediary i.e. the university; or
- The specialized internal intermediary e.g. the university's TTO.

External intermediaries:

- The specialised external intermediary e.g. incubator or science park;
- The financial intermediary e.g. a venture capitalist or an angel investor; or
- The institutional intermediary e.g. a public agency.

External intermediate organisations can also act as boundary spanners (Wright et al. 2008) and facilitate commercialising scientific knowledge through bringing additional knowledge into the process (e.g. management skills, risk assessment skills) or offering incentives and services (Yusuf 2008). These external options fill expertise and skill gaps of the TTO and may facilitate mid-range universities in getting access to commercialisation skills that might otherwise be hard to gain (Siegel and Wright 2007). Science parks and incubators are intermediaries "that provide the social environment, technological and organizational resources, and managerial expertise" (Phan, Siegel and Wright 2005 p170) to enable the exploitation of scientific knowledge.

The roles of the various stakeholders in the scientific knowledge collaboration are not very well defined in existing literature. There is some prior research on the roles of scientists/PIs and TTOs, which is examined in this section.

2.4.1 The role of PIs

According to research, scientists' and PIs' major motive for pursuing commercial opportunities is recognition within the scientific community (Siegel 2003, Siegel et al. 2003a, Siegel et al. 2004). For some scientists personal satisfaction and solving societal problems are considered to be more important than financial rewards (Goktepe-Hultèn 2008). Yet, Jensen and Thursby (2001) argue that there is a moral-hazard problem when inventors endeavour to collaborate in commercialisation processes which can only be solved if the inventor's income is connected with licence revenues. Lockett et al. (2005) argue that incentives should be offered to TTO personnel, and not to the scientist to encourage more commercial activity. Goldfarb and Henrekson (2003) argue that a top-down policy (as in Sweden) discourages commercialisation and that the US policy is a much more favourable as there is competition among universities for funding and scientists.

As people who produce commercial results differ from those who generate academic ones (Ambos et al. 2008), several authors argue (Jones-Evans 1995, Radosevitch 1995, Dickson, Coles and Smith 1998, Fontes 2001, Birley 2002, Goktepe-Hultèn 2008, Spilling 2008) that an entrepreneurial mind-set differentiates inventors from other academics as presented in Table 4 below.

Table 4: Entrepreneurial roles of academics

Author	Type of Entrepreneur	Roles/Activities
Spilling (2008)	- Entrepreneurial professor	Continued focus on developing new commercial activities based on a high scientific commitment
	-Industrial Entrepreneur	Main task to organise and develop the new business, strong focus on market opportunities and industrialisation
	- Research based entrepreneur	Main focus on research and disciplinary activities in the new firm, involvement in business activities is balanced with academic career
	- Production Manager	The role in the company mainly devoted to manage routine tasks no R&D activity involved. Keeps the main position in the university or research institute
Goktepe-Hultèn (2008)	- Serial-active inventor	Commercialisation by forming spin-offs; high patenting activity; mainly seniors with high scientific status, credibility and reputation;
	- Serial-passive inventor	Commercialisation through licensing; high patenting activity; mainly seniors with high scientific status, credibility and reputation; strong industrial networks and participation in U-I collaboration projects
	- Occasional–active inventor	Commercialisation by forming spin-offs; Lower patenting activity; mainly junior; lack of social networks, reputation, credibility and financial means; need assistance from TTO or other actors
	- Occasional-passive inventor	Commercialisation through licensing; Lower patenting activity; senior or mid-level researcher; one-time inventors or member of large research group; 'hands-off' attitude towards commercialisation
Fontes (2003)	- Insider conducted commercialisation	Insiders of the research organisation exploiting knowledge of the research organisation
	- Outsider conducted commercialisation	Outsiders who establish relationships to gain access to research organisations to assist development of business ideas
	- Intermediary conducted commercialisation	Outsiders or (not so often) insiders who have specialised in TT
Birley (2002)	- Orthodox spinout	Scientists leave to form new firm – 'clean break'
	- Technology spinout	Outside actor organises the knowledge commercialisation
	- Hybrid spinout	Combination of inside and outside actors
Dickson et al. (1998)	- Academic entrepreneur	Scientists who engage in entrepreneurial endeavour, but maintain their identity as academic scientist
	- Entrepreneurial scientist	Scientists operating full-time in the new business essentially dedicated to scientific interests
	- Scientific entrepreneur	Integration of scientific and business interests, utilising a high level of scientific intelligence to identify new business opportunities
Jones-Evans (1997)	- Research technical entrepreneur - Producer technical entrepreneur - User technical entrepreneur - Opportunist entrepreneur	Terminology based on the background of the entrepreneur
Radosevitch (1995)	- Inventor entrepreneur model	Scientists/inventors organise the new venture
	- Surrogate entrepreneur model	External actor with entrepreneurial experience organises the new venture

Source: Derived from (Spilling 2008)

This leads to discussions about whether academics are entrepreneurial academics or academic entrepreneurs. The former are described as a pioneering faculty member and the latter are described as the exemplary start-up entrepreneur (Martinelli, Meyer and von Tunzelmann 2008). Audretsch, Aldrige and Oettl (2006) find that 70% of the scientists who received grants from the National Cancer Institute take the TTO route to licensing whilst 30% take the entrepreneurial route by spinning out to commercialise their research. The lower proportion opting for the entrepreneurial route reflects D'Este and Perkmann's (2010) finding that most scientists take part in commercialisation to further their research. The choice to either take the entrepreneurial route or TTO/collaborative route depends on commercial motives (entrepreneurial route) or research related motives (collaborative projects and TTO route). Entrepreneurial accomplishments are only likely to succeed if the entrepreneurs are "integrated into diverse networks of interactive relationships and partnerships" (Meyer 2003:109). Affiliation with a network and personal relationships are particularly important when taking the entrepreneurial route through spinning out a company (Roberts 1991, Meyer 2003, Goktepe-Hultèn 2008), but social capital can also increase the tendency to commercialise research through the TTO route (Audretsch, Aldrige and Oettl 2006). Oliver (2004) finds that scientists involved in collaboration with industry are more likely to submit patent applications than scientists who are not. Research on different commercial routes across scientific disciplines indicates that scientific knowledge collaboration is dependent on network participation by scientists but also highlights the necessity of diverse incentives.

2.4.2 The role of the TTO

While a few TTOs were established before the mid-20th century in the US (University of California TTO 1926) and Germany (Frauenhofer Society TTO 1952), most TTOs were founded quite recently. In the US the creation of TTOs rose significantly in the aftermath of the Bayh-Dole Act of 1980 (OECD 2002). Europe is somewhat different. In Germany, public research organisations had TTOs from the late 1980s and the early 1990s. TTOs in universities followed after that. In the Netherlands and Switzerland, most of the TTOs were established in universities before 1997 and public research organisation TTOs were founded after 2000 (ibid.). The TTO's remit is "to manage the transfer or sale of IP from universities to third parties" (OECD 2002:37) through proactive activities (IP scouting, building links with scientists and industry) and reactive activities (handling IP agreements, patent applications and negotiations) (Siegel et al. 2004). TTOs act per procurationem of the university to protect and market its scientific knowledge. The TTO behaves as the guardian of the IP portfolio (Siegel, Veugelers and Wright 2007) and endeavours to secure additional funding. It also assists the commercialisation process by providing appropriate business experience.

There is a common consensus, however, that in many cases the capabilities of the TTOs and the business skills and expertise of their personnel need to be enhanced (Siegel, Waldman and Link 2003, Chapple et al. 2005, Siegel, Veugelers and Wright 2007, Siegel, Wright and Lockett). The rise in the prevalence of TTOs shows that they are believed to be of importance for successful knowledge transfer and commercialisation. In many cases governments provide direct and indirect support funds for TTOs (OECD 2002, Forfas 2010). As the social networks of the various stakeholders often do not intersect (Wright et al. 2008), several authors argue that the role of the TTO is to bridge the gap between university and industry (Siegel et al. 2004, Wright et al. 2008). Some researchers suggest that the role of a boundary spanner could be assigned to the TTO manager and "could involve relationship or network building that helps to facilitate effective communication with both stakeholder groups and forges alliances between scientists and industry" (Siegel et al. 2004:121). The ability of TTOs to market the IP and to establish the links to do so can, however, be questioned as a consequence of a study by Colyvas et al. (2002). They find that TTO marketing activities are only needed where existing links are weak and all participants are not already rooted in personal or broader scientific networks. The efficiency and acceptance of TTOs vary from country to country. TTOs in the US seem to be more successful than in the UK (Chapple et al. 2005). In Germany, TTOs and regional patent agencies do not appear to be widely accepted by academia and industry (Kienbaum 2006, Sellenthin 2009). In Ireland, a recent survey found that the TTOs do not normally have adequate time to build network relationships. While the number of personnel employed by the TTOs was generally found to be sufficient, the survey concluded that those personnel needed to be up-skilled (Forfas 2010).

The TTO's role as boundary spanner has been researched with conflicting findings. The role of the academic as the bridge between industry and academia is, however, not clearly set out. Given the importance of networks in the theoretical frameworks, there is a need for a better understanding of (a) who enables effective interaction and (b) how stakeholder relationships are managed in scientific knowledge collaboration networks.

2.5 Barriers to scientific-knowledge commercialisation

Although prospective benefits may be recognised, there are several barriers which hinder the creation of lasting relationships between stakeholders and the commercialisation of university research. Four categories of barriers to scientific-knowledge commercialisation can be identified: (1) cultural, (2) individual, (3) operational and (4) contextual barriers. The individual barriers exhibit a great deal of convergence and impact significantly on the process of scientific-knowledge commercialisation and the relationship of the stakeholders. A few studies (Martin and Etzkowitz 2001, Rasmussen, Moen and Gulbrandsen 2006) have investigated how universities can adjust to new requirements of governments. Universities face several challenges including: (a) increasing the scope of commercialisation; (b) visualising the contribution of economic development; and (c) managing the relationship between teaching, research and commercialisation. These challenges may cause some conflicts for universities.

2.5.1 Cultural barriers

Cultural barriers include different missions, interests, time scales and languages of stakeholders. Commercialisation is not a key undertaking of the research university and any shift of resources may undercut the strength on which the national system of innovation depends (Lee and Gaertner 1994). Researchers are beginning to evaluate the traditional university missions – teaching and research – and the new entrepreneurial, or third, mission. Some argue that the objectives of the university should not be profit driven and that, unlike businesses, the commercialisation of IP could damage the university's standing in society (Bok 2004, Nelson 2004). Hence, commercial activities can be seen as a threat to traditional academic freedom and basic research, a strain on independence and differing interests (Etzkowitz 1998, Etzkowitz, Webster and Healey

1998, Polt et al. 2001, Nelson 2004,). Ndonzuau, Pirnay and Surlemont (2002) point out that a 'publish or perish' driven university is disinterested in academic research commercialisation by nature and that the relationship to money is entirely different in the 'publish or perish' driven environment. Researchers want to publish their scientific knowledge as it is connected to prestige and higher financial rewards (Goldfarb and Henrekson 2003) while industry researchers are rewarded for new product innovation (Jones 2006). Published results contribute to the overall goal of increasing the university's scientific reputation (Cyert and Goodman 1997). Lockett, Kerr and Robinson (2008) point out another obstacle to businesses and university researchers understanding of each other. Businesses see the university as an 'ivory tower' where academics are separated from 'the real world' and believe that universities do not take the research businesses' require seriously. The short-term oriented mission of industry partners (i.e. the aim of making money) does conflict with the long-term research oriented goals of academia (Cyert and Goodman 1997, Polt et al. 2001, Jones 2006, Lockett, Kerr and Robinson 2008). In addition, different language and jargon are used by different stakeholder (Cyert and Goodman 1997). In sum, the lack of a more commercial, corporate culture in universities is perceived as a major obstacle that must be confronted.

2.5.2 Individual barriers

Human impediments are individual or interpersonal barriers that can exist between different stakeholders (Mital et al. 2004, O'Shea et al. 2004). These involve different problem-solving styles, character traits, stereotyping, prejudices and other inaccurate perceptions. All of these barriers refer to overall communication obstacles that affect the climate of collaboration or the autonomy of teamwork. Furthermore, the attitude of the employee such as motivation or personality can be another impediment (Mital et al. 2004, O'Shea et al. 2004). In academia many faculty members do not disclose their research to the university efficiently and hence the knowledge either does not leave academia, or exits via the 'back door' (Siegel, Wright and Lockett 2007). Besides that, motivation impacts upon whether a project goes beyond the prototype stage or not (Cyert and Goodman 1997). In addition, a lack of qualified personal (i.e. missing competencies) can cause problems and inhibit the transfer of scientific knowledge (Polt et al. 2001, Walter 2003, Vohora, Wright and Lockett 2004, Walter 2005). Such competencies can be insufficient market or business knowledge amongst researchers (O'Gorman, Byrne and Pandya 2008) or insufficient technology knowledge amongst industry partners.

Moreover, a reluctance to engage in collaborations or lack of entrepreneurial behaviour is mentioned in several studies (O'Shea et al. 2004, Vohora, Wright and Lockett 2004, Zhao 2004, O'Shea, Chugh and Allen 2008).

2.5.3 Operational barriers

Several scholars (Australian Research Council 2000, Goldfarb and Henrekson 2003, Siegel et al. 2004, Lockett, Kerr and Robinson 2008) have debated the impact of (a) insufficient incentive structures, (b) university reward system, (c) preconceived notion of incentives in favour of teaching and publishing, and (d) the lack of recognition of research commercialisation. A widely discussed barrier is the bureaucratic and inflexible nature of universities and civil servant laws which hinder an efficient and rapid commercialisation process (Polt et al. 2001, Walter 2003, Siegel et al. 2004, Walter 2005, Berman 2008). In addition, universities hamper IP exploitation by unsatisfactory allocation of resources to the TTO (Siegel et al. 2004) or by allocating staff with unsuitable skill sets (Forfas 2010).

Capitalisation of scientific knowledge is also obstructed by the poor project management skills of universities (Berman 2008). Furthermore, a lack of management skills in TTOs (Spilling 2004, Wright et al. 2008), a lack of business experience of individuals (Polt et al. 2001, Walter 2003, Vohora, Wright and Lockett 2004, Walter 2005), insufficient IP, market and entrepreneurial experiences in TTOs (Lambert 2003, Hall 2004, Zhao 2004) and bad staffing practices (O'Shea et al. 2004, O'Shea, Chugh and Allen 2008) can be seen as operational barriers and reflect quality issues within the TTO. Industry partners see a lack of professionalism in university TTOs as an inhibiting factor (Lambert 2003). Poor marketing and negotiating skills (Lambert 2003, Siegel et al. 2004) plus overly aggressive behaviours in exercising IPRs (Siegel et al. 2004, Ryan, Wafer and FitzGerald 2008) are mentioned as hindering the presentation and commercialisation of scientific knowledge. In sum, it can be noted that the governance of higher education institutes, as well as TTO interaction with the stakeholders, are major obstacles for the whole commercialisation process.

From an industry perspective a lack of absorptive capacity and innovation management capabilities (Polt et al. 2001), the Not-Invented-Here (NIH) syndrome and an unwillingness to use external science (Gupta and Govindarajan 2000, Polt et al. 2001) are regarded as barriers. Moreover, industry partners are afraid of losing secret knowledge to the partners (Polt et al. 2001) because of the lack of secure and/or conforming laboratories and communication resources in universities (Ryan, Wafer and FitzGerald 2008). In addition, businesses have difficulties in identifying suitable specialists in the field they operate within (ibid. 2008). In general, lack of knowledge about potential collaboration partners (Walter 2003, 2005) and communication barriers can cause discrepancies between the stakeholders. Clear communication and consultation is regarded as useful. The frequency of contact should depend on the nature of the research, the phase of the project and the demands of the participants (Decter, Bennett and Leseure 2007, Berman 2008). Furthermore, all stakeholders have different levels of risk aversion that affect the desire to participate in scientific-knowledge commercialisation (Polt et al. 2001). Additionally, a lack of venture capital is regarded as a hindrance to commercialising university IP (O'Shea et al. 2004, Wright, Vohora and Lockett 2004, Zhao 2004). Financial barriers are, however, more than just venture capital concerns. Other financial barriers are the lack of informal investors, business angels, seed capital and R&D budgets (Spilling 2004). It has also been observed that venture capital firms regularly lack the competencies to act as intermediaries (Wright et al. 2008).

2.5.4 Contextual barriers

According to Spilling (2004), there are barriers created by the environment in which the university and other stakeholders function. These barriers include the industrial structure and the relationships within this structure. A support structure where universities have sufficient and qualitative access to financial resources and to all relevant actors is crucial as substantial relationships between industries, universities and other stakeholders have an important influence on the research environment and commercialisation opportunities.

Moreover, different legal frameworks (O'Shea et al. 2004, O’Shea, Chugh and Allen 2008, Wright et al. 2008) and other environmental aspects (Siegel, Wright and Lockett 2007) can constrain the formation of partnerships to exploit knowledge. Legal frameworks, such as the Bayh-Dole Act in the USA or polycentric IPRs in Europe, as well as different options on equity stakes, can influence transparency and therefore hamper international collaboration. In addition, several authors (Lambert 2003, Hall 2004, O'Shea et al. 2004, Soboll 2006, O’Shea, Chugh and Allen 2008, Wright et al. 2008) mention the lack of clarity of ownership of the IP as a major hindrance. The embeddedness in different environmental contexts requires universities to adjust to the needs of the region. Government issues such as recession or job losses are also critical to the commercialisation system not just on regional, but also on national and international levels. These issues can result in shortages of funding for agencies or services (Zhao 2004) or the university itself (Johnson 2006) and affect the support structure needed for successful knowledge exploitation.

There are barriers that limit the university access to potential business partners or are creating market entry issues. These barriers to entry can be either technology or system specific (Polt et al. 2001, Spilling 2004, Spilling and Godoe 2007).

Barriers to the relationship between stakeholders are regarded as major constraints to commercialising knowledge. The development of strong, personal relationships is important as most projects are long-term endeavours (Wright et al. 2008). Other barriers that pose risks for partnerships are differing cultures, information asymmetries, opportunistic behaviour (Polt et al. 2001, Fulop and Couchman 2006) and the impersonal character of relationships (Kirby 2006). It is therefore of the utmost importance that all participating stakeholders actively try to overcome these barriers.

2.6 Drivers of scientific-knowledge commercialisation

There are several factors that influence participation in commercialisation and the interplay of the different stakeholders and contribute towards the elimination of barriers. Some of these factors have a direct influence on the researcher's personal surroundings, motivation and objectives as well as the researcher's interest and commitment to the commercialisation of technologies (Goktepe-Hultèn 2008). Other drivers affect the commercialisation performance in general by overcoming specific organisational, cultural or external environmental barriers (O'Shea et al. 2004, O'Shea, Chugh and Allen 2008).

Intermediaries play an essential part in supporting and providing contacts to external resources. This assists in broadening external networks and creating links for individuals to participate with e.g. potential investors (O'Gorman, Byrne and Pandya 2008). The presence of government support programmes is often regarded as the sine qua non of commercialisation. These can be either initiatives with the purpose of progressing institutional capacities at university level (e.g. TTOs, incubators, entrepreneurship centres, university funds and entrepreneurship education) or direct support initiatives for particular projects (e.g. funding agencies) (Rasmussen, Moen and Gulbrandsen 2006, Rasmussen 2008). Furthermore, policies such as patent legislation that enable the ownership of patents are widely viewed as having a positive impact on scientific-knowledge commercialisation (Rasmussen, Moen and Gulbrandsen 2006). It is suggested that the right combination of these policies can accelerate the commercialisation process.

The creation of a 'standort' (communities, cities, states or nations) as an entrepreneurial society is considered to be a new public policy approach to generate economic growth (Audretsch 2006a). The regional infrastructure is another influential factor for spin-off activity (O'Shea 2007, O'Shea, Chugh and Allen 2008) and commercialisation of scientific knowledge in general. This is because it "can influence the propensity for scientists to engage in commercialization activities by providing access to spatially bounded knowledge spillovers and by shaping the institutional setting and behavioural norms and attitudes towards commercialization" (Audretsch, Aldridge and Oettl 2006 p29). Greater proximity between firms and research institutions has a positive influence on the accomplishment of cooperative agreements (Mora-Valentin, Montoro-Sanchez and Guerras-Martin 2004). Furthermore, the availability of financial resources for different stages of the commercialisation process is considered to be a significant factor (Degroof and Roberts 2003, 2004). These resources include R&D financing, innovation grants, seed financing, early-stage venture capital and growth-stage venture capital. In addition, tax incentives can stimulate the acquisition of scientific knowledge from third parties (Rammer 2006).

Previous links with stakeholders and previous cooperative experience have a positive influence on the success of university and industry relationships (Mora-Valentin, Montoro-Sanchez and Guerras-Martin 2004). From an industry perspective the clarification of objectives is fundamental. The objectives have to be well formulated, unambiguous and flexible. Responsibilities and tasks for participants should be well defined and circulated. This contextual factor impacts on the responsiveness to potential conflicts and hence improves the basis for optimal commercialisation (ibid.).

Certain aspects or characteristics of the university influence knowledge commercialisation. As Clark (1998) points out, universities have to take an entrepreneurial pathway in order to be prepared for the future. The creation of ambidexterity within research institutions is a possibility to consider for achieving scientific excellence and bridging the gap between academic and commercial enquiries (Ambos et al. 2008). This could potentially be achieved by providing dual structures, such as TTOs. Research on the role of TTOs, however, shows conflicting findings. Other factors which are important to the research organisation and have an influence on the outcome of scientific-knowledge commercialisation are commitment, communication as well as trust and the partner’s reputation (Mora-Valentin, Montoro-Sanchez and Guerras-Martin 2004). These factors allude to close networking activities between stakeholders.

2.7 Conclusion

Knowledge, seen as human capital and technologies (OECD 1996) is central to economic development and is one of the most important factors for a country's economic strength and competitiveness. All OECD economies are trying to change into knowledge economies (Drucker 1992) so as to achieve economic growth by virtue of commercialising scientific knowledge.

The review shows that the literature on scientific-knowledge commercialisation is still developing. Whilst there is plenty of research on university entrepreneurship, firm creation and university-based technology transfer in terms of TTOs (Rothaermel, Agung and Jiangv 2007), little emphasis is placed on the insight of what influences and hinders the commercialisation of scientific knowledge. There is a lack of complexity in models and richness in data to understand the interdependent processes across different stakeholders.

Research commercialisation is a multifaceted and heterogeneous process. It requires complex interactions among stakeholders. Following Polanyi (1967) and Nonaka and Takeuchi (1995) scientific knowledge transfer is only possible with communication and interaction between all stakeholders, as tacit knowledge (embodied and embedded in individuals and social networks) is needed to transfer the explicit knowledge.

In addition, literature on scientific-knowledge commercialisation states that society has become progressively knowledge intensive and increasingly dependent upon knowledge producing universities. This new role refers to creating entrepreneurial universities which commercialise scientific knowledge and do 'entrepreneurial science' (Clark 1998, Etzkowitz 1998, Etzkowitz, Webster and Healey 1998, Etzkowitz et al. 2000, Etzkowitz 2001). Drawing on the 'entrepreneurial paradigm', entrepreneurial accomplishments are regarded to be successful only if the entrepreneurs are "integrated into diverse networks of interactive relationships and partnerships" (Meyer 2003 p109) e.g. individual relations, networks with firms or relationships with other external stakeholders (Goktepe-Hultèn 2008). Technology transfer occurs through established relationships between stakeholders (Harmon et al. 1997) and therefore requires a focus on the initiation and management of those relationships. When all of the foregoing is tied together, the need for effective interaction and stakeholder relationships becomes obvious. A deeper understanding of the following issues is required:

1. The effectiveness of diverse linkages and how they impact scientific-knowledge commercialisation.
2. Why and how are these networks of linkages established, developed and managed?

The literature to date shows that there is research on the factors influencing university-industry interaction and how linkages impact scientific-knowledge commercialisation. This includes research focusing on how individuals (Azagra-Caro 2007, Hoye and Pries 2009), industry partners (Levy, Roux and Wolff 2009), networks (van Rijnsoever, Hessels and Vandeberg 2008) or government grants (Bozeman and Gaughan 2007) impact linkages between university and industry. Another contribution to knowledge on linkages constitutes the performance of collaborations. It answers questions on the costs of the coordination and the output of university and industry interaction (Cummings and Kiesler 2007, He, Geng and Campbell-Hunt 2009). Furthermore, the role of intermediaries and intermediation on university-industry linkages has been elaborated by other authors (Howells 2006, Kodama 2008, Wright et al. 2008). The embeddedness in geographic areas in terms of proximity (science parks, communities, networks) is another area that researchers have considered (Hussler and Rondé 2007). In addition, scholars started to published articles on policy issues in relation to university-industry linkages (Woolgar 2007), university research centres (Boardman 2008, Boardman and Corley 2008) and tried to identify how the success of collaborations is perceived (Butcher and Jeffrey 2007).

It is noteworthy that most of the studies still look at dyadic relationships between university and industry (Plewa and Quester 2008). While some of the studies take the government into account (Boardman and Corley 2008, Boardman 2009), only a few try to incorporate diverse actors to study multilevel interaction (Adler, Elmquist and Norrgren 2009).

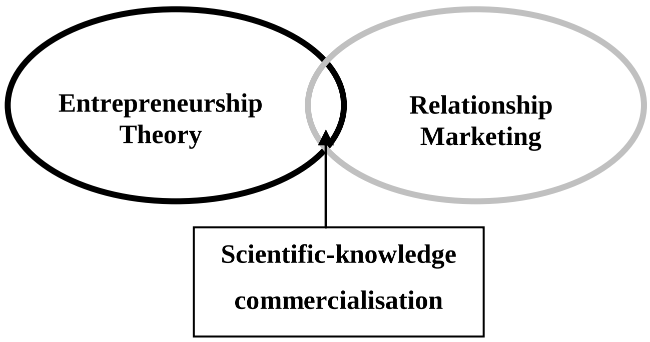
In sum, theoretical perspectives and empirical research on scientific-knowledge commercialisation, as well as commonly agreed ideas among policy researchers, posit further study in the field of stakeholder relationships and the ecosystem in which they are embedded. The issue of multilevel interaction has not been studied in the required depth. A better understanding of the commercialisation context is required. This will involve an examination of the factors and barriers that influence the interplay between different stakeholders as opposed to prior research that focused on a single or dyadic analysis. While the contribution to the understanding of linkages is growing little emphasis is placed on the development and management of relationships in order to effectively build networks of scientific-knowledge commercialisation. Accordingly, this study puts forward a relationship marketing and entrepreneurship framework to examine the initiation and management of stakeholder relationships and collaborative networks. Relationship marketing grants an insight into how these relationships could be developed and treated. Furthermore relationship marketing is considered to be important for the development of new technology innovation (Mohr 2001). The applicability of entrepreneurship theory, as well as, relationship marketing perspectives will, thus, be discussed and evaluated in the following chapter.

3 Theoretical perspectives on stakeholder relationships in the scientific-knowledge-commercialisation process

3.1 Introduction

Chapter 3 evaluates theoretical perspectives of stakeholder relationships in the scientific-knowledge-commercialisation process (see Figure 7 below). Following this introduction, Section 2 discusses entrepreneurship theory on stakeholder relationships and applies it to the process of commercialising knowledge. Section 3 provides an overview of relationship marketing and the theoretical perspectives that contributed to the development of relationship marketing. The section then evaluates and applies relationship marketing to scientific-knowledge commercialisation. Section 4 summarises and concludes the chapter.

Figure 6: Perspectives on scientific-knowledge commercialisation



Source: Own conception

3.2 Entrepreneurship theory perspectives

Consent has been reached that investment in new knowledge itself will not, however, guarantee economic growth. Audretsch, Keilbach and Lehmann (2006 p33) acknowledge "entrepreneurship as the driving force of economic growth because it is an important conduit of knowledge spillovers and commercialisation".

Entrepreneurship theory is a multidimensional theory; this is reflected by the lack of a uniform definition (Audretsch, Keilbach and Lehmann 2006). The disciplines that predominantly influenced entrepreneurship theory are summarised in the following Table 5 below:

Table 5: Contributions of different disciplines to entrepreneurship research

Disciplines	Economics	Management	Psychology	Sociology
Contributions	Entrepreneurship plays a crucial role in economic development; Development of public policy	Differentiation of entrepreneurs and managers	Significance of Individual	Influence of environmental attributes
Defining the entrepreneur	Innovator, Risk-taker, Profit maximiser	Organising leadership, Planning	Personality traits	Context background, Groups, Networks
Examination	Effects	Behaviour	Cause	Cause
Main Questions	What	How	Why	Why
Representatives	Cantillon Say Schumpeter Knight Kirzner Schulz	Gartner Stevenson and Jarillo	McCelland Collins and Moore	Reynolds Thornton Aldrich

Source: Adapted from (Stevenson and Jarillo 1990)

Each of these disciplines makes a contribution by focusing on a different unit of analysis[1]: namely the firm (Di Gregorio and Shane 2003, Lockett, Wright and Franklin 2003), the individual (Gartner and Carter 2003, Shane and Eckhardt 2003), the environment in which entrepreneurs operate (Thornton 1999, Hoang and Antoncic 2003, Thornton and Flynn 2003) and public policy (Siegel et al. 2003b). Most of these current studies build upon earlier work of Knight (1921), Schumpeter (1934) and Kirzner (1973). The latter sees the entrepreneur as an individual that operates on opportunities that arise out of new technologies. That is the alertness to opportunities; the discovery of opportunities. Kirzner's entrepreneur is an equilibrating agent in the economy who moves the market from disequilibrium to equilibrium by finding arbitrage opportunities due to incomplete information. Schumpeterian theories of the entrepreneur view the entrepreneur as an innovator who develops new technologies, new methods of production, resources, or opens up new markets or organisations. Schumpeter's concept of creative destruction refers to the entrepreneur as the disequilibrating factor. Authors such as Audretsch, Aldridge and Perry (2008) commonly refer to the Schumpeterian view as the creation of opportunities. Knight's contribution to entrepreneurship is the differentiation of uncertainty and risk where risk,

[1] For a thorough review of the literature see (Audretsch and Kayalar-Erdem 2005)

unlike uncertainty, is calculable. For Knight the entrepreneur is characterised by his or her attitude to take on the unpredictable uncertainty. Therefore, entrepreneurs for Knight can be considered as the evaluation of opportunities.

Recent works draw on the research of the above mentioned economists. There is, however, no uniform definition of the term entrepreneurship to date. Shane and Venkataraman (2000 p218) allege that possibly “the largest obstacle in creating a conceptual framework for entrepreneurship has been its definition”. Entrepreneurship incorporates an aspect of action (Koppl and Minniti 2003) and one view defines it as the creation of organisations (Gartner 1989). In contrast, Shane and Eckhardt (2003), while acknowledging that venture creation can be an entrepreneurial activity, do not view the establishment of a new organisation as the sine qua non for entrepreneurship. They see “entrepreneurship as the interaction between individuals and…opportunities” (ibid p163). In this light, Eckhardt and Shane (2003 p336) define “entrepreneurship as the discovery, evaluation, and exploitation of future goods and services” and the individuals which engage in this entrepreneurial process. They believe that it is not the same individual or institution that engages in all stages of the entrepreneurial process but rather a set of individuals. Similarly, Hisrich, Peters and Shepherd (2005 p8) define entrepreneurship as “the process of creating something different with value, by devoting the necessary time and effort, assuming the accompanying financial, psychic and social risks, and receiving the resulting rewards of monetary and personal satisfaction”. Taking a scientific-knowledge-commercialisation into account, where the exploitation of knowledge is not just starting a new venture but rather one of many commercial options (see section 2.3.3), this study draws upon Hisrich, Peters and Shepherd (2005) in defining entrepreneurship, to the extent it applies to scientific-knowledge commercialisation, as follows:

> Entrepreneurship is the processes of recognition, evaluation and exploitation of opportunities. Entrepreneurship involves a combination of individuals who identify, evaluate and exploit these opportunities by devoting the necessary time and effort, assuming the associated financial, psychological and social risks, and receiving the consequential rewards of monetary and personal satisfaction.

With respect to the commercialisation process of scientific knowledge, as well as the entrepreneurial process, predominant theoretical perspectives of entrepreneurship theory will be examined and discussed in further detail.

3.2.1 Resource-based view

The resource-based view of the firm has gained considerable attention in recent years, not just in strategic management studies but also in entrepreneurship (Barney, Wright and Ketchen 2001). Resource-based theory argues that Sustained Competitive Advantage (SCA) originates from valuable, rare, not substitutable and hardly imitable heterogeneous resources and capabilities that a firm possesses (Barney 1991). It further alleges that firm performance is primarily a result of heterogeneity. Although heterogeneity is necessary, it is not the sine qua non to derive a SCA. As such, it seems important to examine how resource-based theory informs the exploitation of complex technologies and how universities obtain significant resources to create a SCA.

Alvarez and Busenitz (2001) examine the entrepreneurship element of resource-based theory. They state that heterogeneity is a common factor to both theories. While resource-based theory looks at the heterogeneity of resources, entrepreneurship theory studies the entrepreneur's perception of the value of these resources. Thus, the resource-based theory of entrepreneurship views the resource as the primary unit of analysis. Alvarez and Busenitz's entrepreneurial resource-based view shows that, although resource-based theory sees the firm as the principal unit of analysis, the entrepreneurial resource-based view can theoretically inform both the firm in industry as well as research organisations within academia.

Alvarez (2003) postulates that a competitive position, which is defined by a bundle of unique resources and relationships, has to be adjusted and renewed to prevail against competitive pressure. She further acknowledges that entrepreneurship can assist in expanding and sustaining resource heterogeneity. This is achieved through the entrepreneurial process of cognition, discovery, considering market opportunities and coordinating knowledge (Alvarez and Busenitz 2001). Entrepreneurial opportunities appear when people have insights into the value that others do not (Kirzner 1979). Alvarez and Busenitz (2001 p772) conclude that "entrepreneurial alertness, insight, entrepreneurial knowledge and ability to coordinate resources [are viewed] as resources in their own right.” As people who produce commercial results vary from those who generate academic ones (Ambos et al. 2008), several authors argue that an entrepreneurial mind-set differentiates inventors from academics. Considering the work of Kirzner, Alvarez and Busenitz (2001) point out the differences between entrepreneurial knowledge and knowledge experts. The latter have specialised knowledge at their disposal; this is the technical knowledge that scientists possess. The knowledge expert is not entirely aware of the value of the technical knowledge and how to exploit it. Conversely, the entrepreneur who is proficient in recognising value and entrepreneurial opportunities does not have the specialised knowledge to generate exploitable opportunities. Thus, it is only through the combination of both types of knowledge that opportunities can be fully commercialised. Alvarez and Busenitz argue that in the resource-based view of entrepreneurship, entrepreneurial ability is regarded as socially complex and that the commercialisation of technologies depends on the use of socially complex resources (i.e. entrepreneurial alertness, insight, entrepreneurial knowledge and ability to coordinate assets are entrepreneurial) to make them inimitable. Thus, complex technologies require entrepreneurial knowledge to commercialise specialised knowledge and maintain heterogeneity.

3.2.2 Knowledge-spillover theory of entrepreneurship

The knowledge-spillover theory of entrepreneurship contributes to the understanding of innovation and knowledge creation. Knowledge-spillover theory of entrepreneurship sees knowledge and ideas as the source of entrepreneurial opportunities (Audretsch and Aldridge 2008). The theory tries to bridge the gap between entrepreneurship literature and economic growth literature. While entrepreneurship literature focuses on the idea that opportunities are exogenous or given, endogenous growth theory views opportunities as endogenously created through investment in knowledge and that this knowledge spills over automatically (Acs et al. 2005, Acs et al. 2009).

Considering these aspects, knowledge-spillover theory of entrepreneurship postulates that entrepreneurship is an endogenous response to opportunities generated by investments in new knowledge made by incumbent organisations, but left uncommercialised due to uncertainty inherent in knowledge. It is only through the entrepreneurial activity of starting a new venture that the knowledge spills over from the incumbent organisation to the new firm (Audretsch and Keilbach 2007). Although investment in knowledge creates opportunities for the incumbent organisation the knowledge filter determines which knowledge will be exploited (Acs et al. 2006). The knowledge filter differentiates between what the incumbent firm perceives as ‘normal’ knowledge and economic or exploitable knowledge. It is the exploitable knowledge that can be transferred. The knowledge filter then either recognises the opportunity for the incumbent organisation or creates an entrepreneurial opportunity to spill over.

The more pronounced the gap between ‘normal’ knowledge and commercial knowledge (exploitable knowledge), the more opaque the knowledge filter will be. Thus, the more pronounced the gap is, the more likely it is that that gap will generate differences of opinion in the evaluation of new knowledge among agents and the decision-making hierarchies of incumbent organisations. While, for example, the scientist might perceive the opportunity as extraordinary, the university might not value the opportunity as being of specific importance. If this gap becomes large enough and the costs to start a new venture are not too high, the scientist might decide to leave the university and start his or her own new company. The created knowledge may not, however, simply result in new venture creation by the univerity’s scientist, which would still carry a yield for the university, but it can also spill over for the use of third party businesses (Acs et al. 2005).

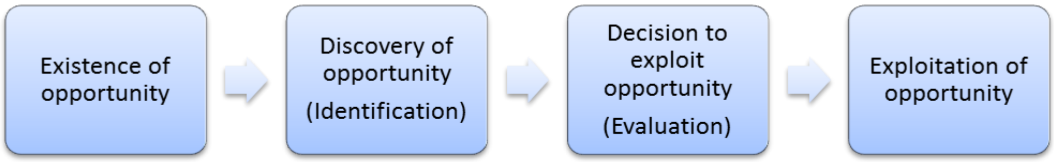
O’Gorman, Byrne and Pandya (2008) state that commercialisation of new knowledge via entrepreneurship will occur, according to the knowledge-spillover theory of entrepreneurship, when scientists are aware of personal benefits of commercialisation, are able to identify the economic value of new knowledge and if external bodies with resources and market knowledge invest in the new knowledge. They further allege, however, that it is nearly impossible for a scientist to meet all those requirements. This is due to the fact that most universities are not equipped with the necessary elements of an entrepreneurial university.[2] O’Gorman, Byrne and Pandya (ibid.) propose that it is important for scientists to be able to recognise and identify commercial value. This is most efficiently achieved if the necessary market knowledge is embedded within the research of scientists and/or that scientists get access to external contacts.

[2] For a thorough overview of entrepreneurial elements see Clark (1998)

3.2.3 Opportunities in entrepreneurship: Existence, discovery and exploitation

The 'heart' of entrepreneurship is the search for and exploitation of opportunities (Stevenson and Gumpert 1985, Krueger 2003). Entrepreneurship "involves the study of *sources* of opportunities; the *processes* of discovery, evaluation, and exploitation of opportunities; and the set of *individuals* who discover, evaluate and exploit them" (Shane and Venkataraman 2000 p218). Therefore, entrepreneurship encompasses a directional process as indicated in the following figure:

Figure 7: Entrepreneurship process



Source: Adapted with minor changes from (Shane 2003) and (Shane and Eckhardt 2003)

This entrepreneurial process outlines a stage model in order to imply a form of linearity for an easier understanding but it is acknowledged that interaction and feedback loops happen between all stages. Thus, "[o]pportunities exist prior to the discovery and opportunities are discovered before they are exploited" (Shane and Eckhardt 2003 p163). Shane and Eckhardt (2003) perceive that variances may exist regarding the involvement of stakeholders contingent on the process stage.

Existence

A key puzzle for researchers is where do opportunities come from? The two main explanations, though, are derived from the work of Kirzner and the Schumpeter. Kirzner (1973, 1985, 1997) argues that opportunities are exogenous or given and it requires differences among individuals in order to discover opportunities. Conversely, Schumpeter (1934) argues that opportunities are endogenously created and that new information is necessary to explain why opportunities arise. They also have different views on the impact of entrepreneurial activity on the economy. While Kirzner views entrepreneurial activity as having an equilibrating effect where entrepreneurs are aware of undiscovered opportunities due to their differing alertness, the Schumpeterian perspective postulates that opportunities are a result of disequilibrating influences. In sum, "Kirznerian opportunities involve the recognition of opportunities largely through discovery processes, whereas Schumpeterian opportunities involve the creation of new knowledge, as well as its recognition" (Shane 2003 p22). Taking a more contemporary perspective, Shane and Venkataraman (2000) state that both theories may coexist in the same market.

Discovery and the decision to exploit

The process of discovery illustrates how individuals perceive a new opportunity. Shane (2003) and Shane and Eckhardt (2003) postulate that some opportunities are not present because price systems balance supply and demand. Prices do not always provide for effective resource allocation and thus do not correctly guide the discovery of opportunities. They argue that prices fail to provide all the important information for accurate decision-making as they do not transmit information to serve a market or, as yet, a non-existing market or information about competitor actions. They further elaborate that, although prices are important to make decisions within known means-ends frameworks, entrepreneurial decisions have to be made where prices allocate resources inefficiently. The limits to the use of prices result in entrepreneurial decision-making which, in turn, either leads to entrepreneurial success or failure.

Saravathy et al. (2003) differentiate between three entrepreneurial opportunities based on the reasons for their existence. Opportunities exist where either (1) supply and demand exist i.e. the exploitation of existing market (arbitrage and franchise); (2) where supply or demand exists i.e. the exploration of existing and latent markets (application for new technologies or cure for diseases); or (3) neither supply nor demand exist i.e. the creation of a market (ground-breaking innovation). Complementing Shane and Shane and Eckhardt, Saravathy et al. (2003 p 159) further postulate that "it require[s] not only the ability and alertness to recognize, and the perception and perseverance to discover opportunities […], but also necessitate[s] decisions and actions based often only on human imagination and human aspiration" in the form of entrepreneurial decisions.

Entrepreneurial decisions are made where there are limits to the use of prices and new decision-making frameworks arise. These frameworks occur due to other market partakers making mistakes which create surpluses and shortages (Kirznerian perspective) or exogenous shocks generating new information (Schumpeterian perspective) (Shane 2003). According to Shane (2003) entrepreneurs identify opportunities and make entrepreneurial decisions that other people do not perceive because of the following two rationales: (1) They have better access to information about the existence and source of the opportunity due to previous life experience, social networks and information search or; (2) They can simply recognise opportunities better, given the same amount of information. This is attributable to absorptive capacity or cognitive processes (ibid.). Absorptive capacity is higher if knowledge about markets or knowledge of how to serve those markets is available. Cognitive processes that are related to entrepreneurial success are intelligence, perceptive ability, creativity and not 'seeing' risks (i.e. seeing opportunities rather than risks).

The decision to exploit is further influenced by individual, industrial and environmental factors (Shane 2003, Shane and Eckhardt 2003). Differences among individuals include non-psychological and psychological differences. Non-psychological factors are education, career experience, age, social position (status and ties) and opportunity costs. "People make decisions to exploit an entrepreneurial opportunity,…because they believe that the expected value of exploitation (both monetary and psychic) exceeds the opportunity cost for alternative use of their time plus the premiums that they would like for bearing uncertainty and illiquidity" (Shane 2003 p62). Social ties, embedding within networks and status enhance the tendency to become an entrepreneur and help to gather valuable information and mobilise resources. Psychological factors are differences in motivation (extraversion, need for achievement, risk-taking and desire for independence), core evaluation (locus of control and self-efficacy) and cognition (overconfidence and intuition). Similarly, Krueger (2003) considers the cognitive processes as a factor that lead to opportunity identification and entrepreneurial decision-making. Opportunities are identified due to exogenous factors such as personal desirability, social norms, self-efficacy and collective efficacy (sense of competence). Comparing university entrepreneurs with other entrepreneurs Audretsch (2000) finds that academic entrepreneurs are usually older and have more experience in their field. Moreover, there is evidence that social norms and norms in general influence individual entrepreneurship (Roberts 1991, Clark 1998).

Shane (2003) outlines that industrial and environmental context also impact the decision to exploit opportunities. He states that differences among knowledge, demand, appropriability conditions, industry structure and industry life cycles determine opportunity exploitation in the form of firm formation. Additionally, he argues that the economic, political and socio-cultural environments play an important role in opportunity exploitation. He does not, however, discuss the interplay between them; instead the influences are discussed in isolation.

Exploitation

In the process of the exploitation of opportunities individuals must mobilise resources. The acquisition of capital is obstructed by information asymmetry in the form of disclosure difficulties, opportunism/moral hazard, excessive risk taking and adverse selection. Furthermore, uncertainty in the form of inability to evaluate, bargaining problems and the need for collateral create barriers (Shane 2003). Shane and Eckhardt (2003) identify three important factors which facilitate the exploitation of opportunities: financial capital (self-financing), social capital (social ties) and contracting solutions (ownership rights and control rights). While self-financing overcomes problems with information asymmetry and uncertainty among investors, it is not necessarily available to all people. In this respect, social ties (indirect and direct) ameliorate the chances of resource acquisition. With respect to resource mobilisation Kim, Aldrich and Keister (2006) explore in their research whether access to resources (financial, human and cultural capital) affects entrepreneurial entry. They find that financial and cultural resources are not the sine qua non for entrepreneurial entry. Latent entrepreneurs might benefit, however, if they are equipped with enough human capital in the form of work and managerial experience, as well as education. While acknowledging that diverse resources influence entrepreneurial entry differently, their work advocates that the external environment impacts entrepreneurial decisions and exploitation.

The identification of a feasible commercialisation strategy is of great importance. There are several channels through which scientific discoveries can be exploited (see Section 2.3.3). Given the heterogeneous nature of the research commercialisation process a strategic decision has to be made based on an individual assessment of the scientific discovery. Once the strategy is selected then decisions have to be made whether and how scientific knowledge can be brought to the market. Again this is a multifaceted endeavour.

3.2.4 Evaluation of entrepreneurship theory and application to scientific-knowledge-commercialisation

Resource-based theory of entrepreneurship (Alvarez and Busenitz 2001) can inform both the firm in industry, as well as research organisations within academia. Several authors (Ambos et al. 2008) argue that an entrepreneurial mind-set differentiates inventors, who pursue commercial opportunities, from other academics. Alvarez and Busenitz (2001) draw on the work of Kirzner to highlight the difference between the entrepreneur and the knowledge expert. The latter have specialised knowledge at their disposal, this being the technical knowledge scientists possess. The knowledge expert is not entirely aware of the value of the technical knowledge and how to exploit it. In contrast, although proficient in recognising value and entrepreneurial opportunities, the entrepreneur may not have specialised knowledge to generate exploitable opportunities. Thus, it is only through the combination of both types of knowledge that opportunities can be fully commercialised. Alvarez and Busenitz (2001) argue that in the resource-based view of entrepreneurship, entrepreneurial ability is regarded to be socially complex and that the commercialisation of technologies depends on the use of socially complex resources (i.e. entrepreneurial alertness, insight, entrepreneurial knowledge, and ability to coordinate assets are entrepreneurial) to make them inimitable. Complex technologies require entrepreneurial knowledge to commercialise specialised knowledge and maintain heterogeneity. While this study acknowledges that it is possible for academic entrepreneurs to be exemplary entrepreneurs, it is believed that entrepreneurial activity has a greater chance of being successful if scientists are integrated into stakeholder networks where other stakeholders possess this entrepreneurial knowledge. Accordingly, knowledge experts (scientists) may benefit from access to entrepreneurial knowledge through individual relationships, networks with firms and other external stakeholders. In addition, knowledge experts may gain some level of entrepreneurial knowledge themselves as a result of engaging with industry partners.

Audretsch, Aldridge and Oettl (2006) claim that entrepreneurship and entrepreneurial capital is the missing link in channelling knowledge spillovers and eventually generating economic growth. O’Gorman, Byrne and Pandya (2008) state that commercialisation of new knowledge via entrepreneurship will occur, according to the knowledge-spillover theory of entrepreneurship, when scientists: (a) are aware of personal benefits of commercialisation; (b) are able to identify the economic value of new knowledge; and (c) have access to external bodies with resources and market knowledge to invest in the new knowledge. They further note that it is nearly impossible for the scientist to be able to achieve all these requirements by him or herself. According to O'Gorman, Byrne and Pandya (ibid.) this is most efficiently achieved if the necessary market knowledge is embedded within the research projects and/or that scientists have access to external contacts. Stemming from this, relationships and interactions between persons with market and technical knowledge within networks may advance the entrepreneurial value evaluation and accelerate the performance of the knowledge filter. Stakeholder networks may, thus, foster the ability to evaluate the value of opportunities in a manifold way. Stakeholder networks offer a diverse set of opinions for the value generation, minimising the risk of opportunities leaking through the knowledge filter and spilling over to third parties not embedded within the stakeholder network. In sum, entrepreneurial capital complements the view that relationships and interactions between persons with market and technical knowledge within social networks may advance the entrepreneurial opportunity identification and evaluation and advance scientific-knowledge commercialisation. Drawing from aspects of the knowledge-spillover theory of entrepreneurship, we can see that networks of stakeholders may act as a conduit for the commercialisation of scientific knowledge.

The discovery approach highlights that opportunities are exogenous and that the discovery of them is the sine qua non for entrepreneurship to take place. Entrepreneurs identify opportunities and make entrepreneurial decisions that other people do not perceive (Shane 2003). The entrepreneurship process is influenced by heterogonous individuals with different psychological and non-psychological factors, as well as access to information, financial resources and social capital. While this approach places emphasis on the individual it mainly neglects external loci. Shane (ibid.) extends this approach in his work on the individual-opportunity nexus to highlight the importance of social networks, education and access to essential resources in the entrepreneurial process. It is frequently mentioned that scientific quality and entrepreneurial mind-set are seldom found combined in one individual (Lebret, Manson and Aebischer 2006) and that entrepreneurship does not happen in a vacuum (Shane 2003).

Reviewing these entrepreneurship theories shows that none of these theories alone are able to explain the complexity of the context in which scientific-knowledge commercialisation takes place. It is proposed that complex technologies require entrepreneurial knowledge to commercialise the specialised knowledge (Alvarez and Busenitz 2001). In order to commercialise scientific knowledge stakeholders have to be able to recognise and identify the commercial value of opportunities or create opportunities by investing in new knowledge. They also need to be willing and able to exploit those opportunities. As already noted, this is most effectively achieved if the necessary knowledge about the market is embedded within the research projects and/or if scientists have access to external knowledge (O'Gorman, Byrne and Pandya 2008). Access to technical knowledge possessed by scientists is seen as being an important factor for successful commercialisation by industry partners (Thorburn 2000, Jensen and Thursby 2001, Knockaert et al. 2009). Thus, relationships and interactions between persons with market and technical knowledge may influence entrepreneurial activity. In order to get access to people who possess commercial and technical knowledge it is important to join relevant networks or, if necessary, establish a scientific network. Social networks are regarded as crucial to the entrepreneurial process (Dubini and Aldrich 2002). They act as conduits for resource mobilisation and information flows (Stuart and Sorenson 2003), as well as for social, financial and human capital (Thornton and Flynn 2003). Managed appropriately, they can accelerate the performance of technology transfer and scientific-knowledge commercialisation (Singh 2003).

Granovetter (1992:4) argues that "economic action is constrained and shaped by the structures of social relations in which all real economic actors are embedded" and that economic activity is undertaken not just by isolated individuals, but by the entrepreneurial individuals in those social networks. Embeddedness prioritises personal linkages and networks of such linkages in generating trust and non-opportunistic behaviour (Granovetter 1985) which, in turn, is relevant for resource mobilisation. Entrepreneurs with more diverse networks are expected to get more useful information to identify opportunities, acquire resources and undertake entrepreneurial activities (Hoang and Antoncic 2003, Stuart and Sorenson 2003). Furthermore, investors are more likely to provide seed finance or venture finance if they have direct or indirect social ties with the entrepreneurs (Shane and Eckhardt 2003).

A useful definition of networks is provided by Tijssen (1998:792):

> "an evolving mutual dependency system based on resource relationships in which their systemic character is the outcome of interactions, processes, procedures and institutionalization. Activities within such a network involve the creation, combination, exchange, transformation, absorption and exploitation of resources within a wide range of formal and informal relationships".

Entrepreneurship theory recognises the importance of networks for entrepreneurial activity. Like entrepreneurship, scientific-knowledge-collaboration achievements hinge on interactions and linkages among individual stakeholders in the process. These networks imply norms of reciprocity and trustworthiness which enable the acquisition of information and mobilisation of resources. Collaborative stakeholder networks create the context for the entrepreneurial decisions that have to be made by the stakeholders. In order to commercialise scientific knowledge stakeholders have to be able to recognise and identify the commercial value of opportunities or create opportunities by investing in new knowledge. They also need to be willing and able to exploit those opportunities. Consequently, three important questions emerge from the literature: (1) why and (2) how are stakeholder networks that facilitate scientific knowledge commercialisation established; and (3) who is responsible for establishing and managing stakeholder relationships?

3.3 Relationship marketing

This chapter examine relationship marketing theory; its origin in prior literature and the applicability to scientific-knowledge commercialisation.

3.3.1 Paradigm shift in marketing

Intensive and long-lasting relationships are one of the most important corporate objectives to securing persistent business success (Bauer, Grether and Leach 1999) and are a key source of competitive advantage (Day and Wensley 1983). The tender is no longer the central point of departure to attract new customers and retain them (Diller 1995). On the contrary, issues such as individualising customer contacts and integration and retention of customers have become more and more salient (Diller and Ivens 2004). Kotler (1984 p161) emphasises the subject matter as follows: “Companies don’t make purchases, they establish relationships“. The former dominant logic of marketing was tangible resources, embedded value and transactions. Today intangible resources, the co-creation of value and relationships are the new dominant logic (Vargo and Lusch 2004).

The development from traditional marketing to relationship marketing is often referred to in the literature as a paradigm shift in marketing. This shift is essentially characterised by the following three aspects: (1) the development from functional (sectoral) marketing to holistic (trans-sectoral) marketing; (2) a shift from measures which focus on customer acquisition to measures which are focused on the preservation of existing customer relationships and; (3) the consideration of additional markets (supplier, internal, referral, employee, influencer market) besides the end customer market (Payne and Rapp 1999, Payne, Ballantyne and Christopher 2005).

Traditional marketing approaches generally focused on classical marketing instruments, with sales being the criterion for success. This, in turn, enforced the unilateral transaction. As a consequence, the acquisition of new customers was the focal point. Relationship marketing, however, postulates the necessity of an excellent relationship with existing customers. Thus, the retention of such a relationship coined the term relationship marketing. For a better contextual understanding the main differences are summarised in the following table:

Table 6: Paradigm shift in marketing

Criteria for differentiation	Transaction marketing	Relationship marketing
World view	Managing product portfolio; marketing mix parameters	Managing customer portfolio; building long-term business relationships
Assessment horizon	Short-duration	Long-duration
Key concept	4Ps, segmentation, branding etc.	Interaction, relationships and networks
Marketing focus	Product	Product, service and customer
Marketing goal	Customer acquisition	Customer acquisition, retention and recovery
Marketing strategy	Presentation of outcome	Dialogue
Marketing interaction	One-way communication	Interactive communication, mutual learning and adaptations
Internal marketing	No or limited importance to success	Substantial strategic importance to success
Quality dimension	Quality of product (technical quality dimension)	Quality of interaction (functional quality dimension)
Price elasticity	Sensitive to price	Less sensitive to price

Source: Adapted from (Grönroos 1997, Bruhn 2003)

The paradigm shift from transaction marketing to relationship marketing has been widely discussed (Grönroos 1997, c.f. Brodie et al. 1997) and while this shift in marketing theory can be observed, it is not necessarily a paradigm shift where the new theory replaces the old one but is rather a new approach to marketing. Marketing is a strategy continuum, where various types of goods can be placed along the continuum (consumer packaged goods, consumer durables, industrial goods, services) and marketers make decisions as to what strategy to follow depending on the product or service that they offer (Grönroos 1997).

3.3.2 Scope of application

Relationship marketing and the notion of establishing, maintaining and enhancing customer relationships has obtained substantial theoretical and empirical attention in the last 20 years as a result of the need for a new approach that focuses on long-term relationships with customers and other stakeholders (Håkansson 1982, Dwyer, Schurr and Oh 1987, Diller and Kusterer 1988, Morgan and Hunt 1994, Christopher et al. 1995, Brodie et al. 1997, Grönroos 1997, Gummesson 1997, Polonsky 1999, Parvatiyar and Sheth 2000, Christopher, Payne and Ballantyne 2002, Bruhn 2003). While conceptual work dominated the nineties, an increase in empirical work can be observed since the start of the new millennium (Das 2009).

A plethora of definitions can be found in the literature, all of which refer to the creation, development, maintenance, interaction, emotional content, output and long-term aspects of relationships (Harker 1999). Based on a detailed content analysis, Harker (ibid. p16), proposed that an organisation is involved in relationship marketing activity when it is engaging "in proactively creating, developing and maintaining committed, interactive and profitable exchanges with selected customers (partners) over time". This definition incorporates all of the above constructs and refers to the applicability of relationship marketing as an aspect of strategic management of organisations. Customers and partners reflect that relationship marketing can be viewed from two perspectives. Relationship marketing, in the narrow sense, deals with the end customer (micro aspect) and, in the broader sense, with relationships of organisations to any stakeholders (macro aspect) (Bruhn 2003). Möller and Halinen (2000) refer to relationship marketing as market-based or network-based relationship marketing depending on the relational complexity (number of actors involved in exchange). Accordingly, relationship marketing incorporates horizontal, vertical, lateral and internal transaction orientations (Diller 1995).

The applicability of relationship marketing depends on the sector, type of goods/services and the type of the relationship (i.e. market-consumer versus interorganisational) (Dwyer, Schurr and Oh 1987, Möller and Halinen 2000). Relationship marketing has been applied in profit and not-for-profit organisations (Peck et al. 1999, Christopher, Payne and Ballantyne 2002) and empirical research has been conducted in consumer goods (Mittal and Kamakura 2001, Olsen 2002), industrial goods (Nielson 1998, Eggert and Ulaga 2002) and service markets (Oliva, Oliver and MacMillan 1992, Patterson, Johnson and Spreng 1997). While relationship marketing has been applied in all sectors, it is most prominent in the service sector (Das 2009).

The application of relationship marketing differentiates between customers as end users (B-2-C marketing) or business customers (B-2-B marketing) (Boehm, Rennhak and Ebert 2006). This differentiation of B-2-B and Business-to-Consumer (B-2-C) markets is characterised by different types of relationships, customer needs life cycles and customer relationship life cycles. Customer needs life cycles can vary notably depending on the product or service offered and hence have a bearing on different phases of customer relationship life cycles (customer acquisition, customer retention or customer recovery) (Bruhn 2003). Accordingly, these concepts influence relationship marketing strategies in industrial goods or service markets. Consumer goods have a low level of integration and interaction due to the relatively homogenous nature of the products (Bruhn 2003, Backhaus, Baumeister and Mühlfeld 2005). Industrial goods, however, require a more intense interaction due to product heterogeneity and complexity (ibid.). Services like industrial goods require more interaction because of their heterogeneous and complex nature involving either with individual customers (e.g. banking) or organisations (e.g. consulting) (Bruhn 2003). The application of relationship marketing is, therefore, determined by relational (number of actors involved) and/or product complexity (Möller and Halinen 2000).

Relationship marketing can be viewed as an “alternative model that capture[s] better the interactive and processual nature of marketing” (Baker 2002 p145). Relationship marketing is an interactive marketing approach that is concerned with relationship building and management and is applicable to different business segments.

3.3.3 Theoretical foundation of relationship marketing

The theoretical origins of relationship marketing approach will be examined and discussed in further detail in order to understand the applicability of relationship marketing theory to stakeholder relationships in scientific-knowledge commercialisation.

Social-exchange theory perspective and research on buyer-seller relationships

Relationship marketing theory has its root in social-exchange theory and research on buyer-seller relationships. Social-exchange theory, whereby parties enter into relationships and maintain them because they expect rewards, has been used to explain B-2-B relational exchange. The non-contractual view of relational exchange was first explained by power and dependence i.e. control over others. This view has, however, been found to create conflicts and not very useful in explaining successful exchange (Lambe, Wittmann and Spekman 2001). Relational exchange theory builds upon relational interdependence. It states that, contrary to discrete transactions, relational exchange develops over time, uses formal and informal communication and will generate personal, noneconomic satisfaction (Dwyer, Schurr and Oh 1987). B-2-B relational exchange "is motivated by the mutual recognition of the parties to the exchange that the outcomes of such exceed those that could be gained from…exchange with a different partner" (Lambe, Wittmann and Spekman 2001 p12). Several authors (Wilson 1995, Turnbull, Ford and Cunningham 1996, Rao and Perry 2002) argue that mutual investments are made as a result of satisfactory relationships. These investments in relationships will create social bonds (trust, commitment, interdependence) or structural bonds (information and resource sharing, pooled knowledge, contractual arrangements and joint investments and pooled competencies) which in turn will strengthen the relationship further and are more complicated to terminate. Hence, the core domain for relational exchange success is the relationship. These relationships are strategic and organisations form relationships in order to achieve goals (Wilson 1995).

Commitment-trust perspective

Morgan and Hunt (1994 p22) refer to relationship marketing as "all marketing activities directed toward establishing, developing and maintaining successful relational exchange". Commitment-trust theory builds on social-exchange theory and states that commitment to, and trust in, exchange partners, and not power and influences over others, are the major domains for understanding relationship performance and success. Commitment and trust are regarded as enabling strong stakeholder relationships as they influence relational conduct beneficially due to non-opportunistic behaviour.

The construct of trust has been discussed by several authors (Moorman, Zaltman and Deshpandé 1992, Moorman, Deshpandé and Zaltman 1993, Morgan and Hunt 1994) and is regarded to be of great importance in facilitating exchange relationships. Trust "exists if a customer believes a [relationship partner] to be reliable and to have a high degree of integrity" (Hennig-Thurau, Gwinner and Gremler 2002 p232). In the commitment-trust theory, trust is believed to be a key mediator between antecedents and relational outcome (Morgan and Hunt 1994). All trust approaches, however, see trust as an antecedent to relational outcome (Moorman, Zaltman and Deshpandé 1992). Factors influencing trust can be individual, interpersonal, organisational, inter-organisational or project related.

Commitment, like trust, is seen to be either a key mediating factor within the commitment-trust theory (Morgan and Hunt 1994) or an antecedent of relational outcome in commitment approaches (Pritchard, Havitz and Howard 1999). Consistent with Dwyer, Schurr, and Oh's (1987) description of relational continuity between exchange partners, various attempts have been undertaken to define commitment in the context of relationships. Commitment is "an enduring desire to maintain a valued relationship" (Moorman, Zaltman and Deshpandé 1992 p316) or, in similar vein, "an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it" (Morgan and Hunt 1994 p23). These definitions imply that commitment is present if a relationship is important, valuable and long-term in nature. Commitment, however, is difficult to separate as a single construct due to its theoretical proximity to other concepts such as loyalty, relational continuity and solidarity (Rylander, Strutton and Pelton 1997). While no consensus has been reached as to whether trust or commitment are antecedents, mediating factors or separated single constructs, there is general agreement that trust and commitment have a positive and significant influence on cooperation and are central to relationship success (Morgan and Hunt 1994, Hennig-Thurau and Klee 1997, Hennig-Thurau, Gwinner and Gremler 2002).

Service marketing perspective

The paradigm shift from transaction marketing to relationship marketing was initially influenced by the service-centred view of marketing (Brodie et al. 1997). The service literature identifies the significance of service satisfaction in exchange processes and, hence, the importance of personal interactions and the delivery of these services (Parasuraman, Zeithaml and Berry 1985). There have been several attempts to define satisfaction. In respect of the theoretical foundation, however, many studies draw upon the confirmation/disconfirmation paradigm (Oliver 1980, Parasuraman, Zeithaml and Berry 1985, Patterson, Johnson and Spreng 1997, Rust et al. 1999, Homburg et al. 2002, Homburg, Becker and Hentschel 2005). In this context, satisfaction is understood as a result of a cognitive evaluation process where an expected or desired nominal output is compared to the perceived actual output. Nevertheless, there are discrepancies as to whether exact fulfilment or over-fulfilment of these expectations will result in satisfaction. If the actual output transcends the expectations, the customer is pleased and satisfied. Conversely, dissatisfaction arises where expectations are not met. In this regard, Parasuraman, Zeithaml and Berry (1985) show that an array of discrepancies exist between businesses' perceptions of good service and customer expectations. These discrepancies can create major obstacles to the exchange process.

More recent explanations take the affective view of satisfaction into account, as well as the cognitive view (Werani 2004). In this respect, satisfaction can be understood as an emotional reaction of a cognitive equation process. In B-2-B markets, satisfaction is defined as a positive affective condition which does not emerge by virtue of single transactions but rather through business relationships. Both the affective and cognitive approaches are based on the evaluation of all aspects of a business relationship and embrace economic and psychosocial perspectives of satisfaction. Economic satisfaction shows to what extent economic expectations in relation to business relationships are met; psychosocial satisfaction are positively assessed relational aspects such as reciprocal support, mutual appreciation or amicable relations.

Taken together, the evaluation of transactions and the relationship as a whole anticipate relational outcomes. It is, therefore, not only the service quality, but "the quality of the relationship [i.e. satisfaction and trust] between the salesperson and the customer that determines the probability of continued interchange between those parties in the future"

(Crosby, Evans and Cowles 1990 p68). Drawing upon commitment-trust theory and service marketing theory several authors view relationship quality as a construct of satisfaction, trust, commitment and various other constructs such as relational selling behaviour (i.e. cooperative intentions, mutual disclosure and intensive follow up contact) (Crosby, Evans and Cowles 1990, Hennig-Thurau and Klee 1997). Relationship quality and satisfaction are key constructs (Kotler 1994) and are seen to be antecedents to customer loyalty and customer retention.

Stakeholder perspective

A subjacent concept of relationship marketing is stakeholder orientation – stakeholder theory. The theory stems from the rationale that the organisation takes into account "all of those groups and individuals that can affect, or are affected by, the accomplishment of organisational purpose" (Freeman 1984 p46) or "constituents who have a legitimate claim [where] this legitimacy is established through the existence of an exchange relationship" (Hill and Jones 1992 p133). The focal underlying thought of stakeholder theory is that organisations have to concentrate on fulfilling an array of stakeholders' expectations (Rowley 1997). Mitchell, Agle and Wood (1997 p856) state that stakeholders are defined in either a narrow view "in terms of their direct relevance to the [organisation's] core economic interests" or a broader way where empirical reality contributes to the identification. They claim that stakeholders can be identified by the following relationship characteristics: (1) the stakeholder's power to influence the organisation; (2) the legitimacy of the stakeholder's relationship with the organisation; and (3) the urgency of the stakeholder's claim on the organisation.

Network perspective

Relationship marketing has also strong ties to the network literature. European marketing researchers of the International Marketing and Purchasing Group (IMP) introduced the interaction approach to marketing theory. The interaction approach accentuates the salience of previous purchases and mutual evaluation in order to establish satisfying exchange relations. It builds upon the idea that the nature of the relationship between two entities may not merely be built up during the course of a single major transaction, but rather through an interaction process within a certain environment; the occurring transactions modify the overall atmosphere or nature of the relationship (Håkansson 1982). Research by the IMP has evolved from an early dyadic perspective to a network perspective over the last 25 years. They argue that greater attention must be paid to the embedded network context and environment in which relationships occur (Anderson, Håkansson and Johanson 1994) and that no relationship can be understood without looking at the wider network and environment (Håkansson and Ford 2002). These relationships and recourses should be pooled and expanded in order to create opportunities for innovation and gains (ibid.). Knowledge-rich and dynamic industries ask for the formation of organisations that are concentrating on creating knowledge, are open to their environment and want to familiarise themselves with these environments ad infinitum. These knowledge organisations should have weak hierarchies, low departmental walls and receptivity to the environment and operating units are networked by dense lateral connections (Achrol and Kotler 1999).

Similarly, Gummesson (1999) argues that in reality stakeholders interact within these networks of relationships. The foci of relationship marketing are collaboration, co-production of values, long-term relationships, mutual benefits and interaction and communication of more than on actor. This view complements Rowley's (1997) rationale for understanding structural influences and the stakeholder environment and postulates that 'macro' relationship marketing embraces external environmental forces (Polonsky 1999). The intention of a network perspective in relationship marketing is to offer a theory that imposes a realistic view so that managers are aware of their operating environment; that they are able to identify the stakeholders and 'manage' the external environment as well as the internal.

3.3.4 Evaluation of relationship marketing

A new logic in marketing theory is emerging. Some authors argue that 'macro' relationship marketing approaches are the dominant logic. According to these authors this logic involves forming relationships of reciprocally beneficial value and goals (Wilson 1995, Christopher, Payne and Ballantyne 2002), interactions within networks of relationships (Gummesson 1999) or mutual commitment and trust (Morgan and Hunt 1994). Other scholars (Vargo and Lusch 2004) perceive relationship marketing as part of a wider logic; marketing as a social and economic process where skills and knowledge are the essential unit of exchange; where knowledge is the fundamental source of competitive advantage and all economies are viewed as service economies and a service-centred view is essentially relational. No matter how this change is perceived the sine qua non for this shift is that single transactions, gains of only one party and one-way communication are not able to explain the complexity of the context in which commercialisation takes place. It is, therefore, of utmost importance to consider the applicability of relationship marketing theory to stakeholder relationships in scientific-knowledge commercialisation.

The core domain for relational exchange success is the relationship which is formed in order to achieve goals. The reasoning behind the relational exchange theory in a B-2-B environment can be applied to scientific-knowledge commercialisation as participating stakeholders form relationships in order to achieve the idiosyncratic goal of transferring and exploiting scientific knowledge. Inherent in this mutual goal is the fact that both parties will make investments in the relationship. These investments will create social bonds (trust, commitment, interdependence) or structural bonds (information and resource sharing, pooled scientific knowledge, contractual arrangements, joint investments in equipment and machinery and pooled academic and industrial competencies) which in turn will strengthen the relationship further and produces satisfactory outcomes.

Commitment-trust theory builds on social-exchange theory and postulates that commitment and trust are the most important aspects for understanding relationship performance and success. In relation to scientific-knowledge commercialisation, a study by Becerra, Lunnan and Huemer (2008) shows that high trustworthiness assists the transfer of tacit knowledge. Thus, trust influencing factors in scientific-knowledge commercialisation could be related to researcher integrity, willingness to reduce research uncertainty, confidentiality, expertise, tactfulness, sincerity, congeniality and timeliness. Other non-interpersonal aspects affecting trust could be the research organisation's power and the extent to which the research (process or product) is customised. Commitment is present if a relationship is of importance and valuable. Assuming that relationships with other partners in the commercialisation process are of importance, trust and commitment can be regarded as influential to the relationship outcomes and cooperation of different stakeholders within scientific-knowledge commercialisation.

The service marketing perspective suggests that satisfaction and the perception of the business relationship are of great importance in B-2-B markets. Economic and psychological satisfaction are based on the evaluation of all aspects of a business relationship. Similar concerns apply to the delivery and realisation of scientific-knowledge commercialisation. Different stakeholders may have different expectations on the outcome, service transactions, process etc. The evaluation of satisfaction with the commercialisation process might, therefore, provide some valuable insights and help identify discrepancies. In the context of scientific-knowledge commercialisation one would expect that relationship quality, and not just perceived service quality, will have an influence on stakeholder loyalty and retention. It is, therefore, important to consider the evaluation of all aspects of a business relationship when looking at scientific-knowledge commercialisation. Economic satisfaction shows to what extent economic expectations in business relationships are met and psychosocial satisfaction are positively assessed relational aspects such as reciprocal support, mutual appreciation or amicable relations.

While research on stakeholder theory shows that the strategic management of relationships with stakeholders has a direct influence on financial performance (Berman et al. 1999), stakeholder theory's use, effectiveness and its theoretical underpinnings, as well as its simplicity in implementation, require further elaboration (Agle et al. 2008). Complementing this, Polonsky, Carlson and Frey (2003 p351) conclude that "there are no universally accepted definitions of stakeholder theory or even what constitutes a stakeholder". Furthermore, most of these approaches focus on individual stakeholder influences and dyadic ties between the organisation and the individual stakeholder. In reality though, stakeholder relationships occur through more complex interactions with multiple stakeholders (organisation-stakeholder and stakeholder-stakeholder interactions) and do not happen in a 'vacuum of dyadic ties' (Rowley 1997). The same applies for the commercialisation of scientific knowledge which is a complex and heterogeneous process, requiring complex interplay between research suppliers, the businesses who want to exploit the research and the investors. In this regard, it is salient to analyse the stakeholders in order to get an overview of all participating stakeholders. It is deemed appropriate, however, to take Rowley's rationale into account. He argues that "network models begin where stakeholder research stops – the dyadic relationship – and examine systems of dyadic interactions, capturing the influence of multiple and interdependent relationships on organizations' behaviours" (Rowley 1997 p894).While network theory and analysis on its own might have a bearing on the examination of stakeholder relationships in the scientific-knowledge-commercialisation process, as it assists with examining all participating stakeholders and capturing the embeddedness of a relationship within a network of relations, methodological issues emerge. These issues relate to boundaries of the network and the type, reciprocity or direction of relations to be assessed (Rowley 1997).

Adding a network dimension to relationship marketing theory extends the analysis to the embedded network context and environment in which relationships occur (Anderson, Håkansson and Johanson 1994). In a scientific-knowledge commercialisation context the embeddedness will be analysed, however, with fewer methodological discrepancies. The intention of a network perspective in relationship marketing is to offer a theory that imposes a realistic view so that managers are aware of their operating environment; that they are able to identify the stakeholders and 'manage' the external environment as well as the internal. In order to understand which and how stakeholders in the scientific-knowledge-commercialisation process should be addressed, it is necessary to consider stakeholder groups – structural influences – that are not directly linked to each other, but will still influence behaviours and network exchanges. The extent literature (Freeman 1984, Savage et al. 1991, Altman and Petkus 1994, Polonsky 1995, Polonsky 1999, Bunn, Savage and Holloway 2002, Payne, Ballantyne and Christopher 2005) provides the following guidelines for identifying and managing stakeholder relationships:

(1) Identify the key stakeholder and context;
(2) Determine the stake and importance of each stakeholder/group:
    - Describe stakeholder interests and resources; and
    - Analyse and classify the stakeholders according to stakeholder relationship characteristics;
(3) Examine the dynamic relationships among stakeholders;
(4) Determine how effectively the expectations and needs of each of the stakeholders are being met, i.e. is there a gap between performance and stakeholders' expectation;
(5) Review objectives and priorities to consider stakeholder interests and reduce the gaps that exist; and
(6) Evaluate generic stakeholder management strategies.

According to Cook (1977 p77) "no single theoretical perspective will enable us to explain everything about organizational interaction. Every theory typically has a set of (explicit or implicit) scope restrictions, and thus is limited." Network theory enables the analysis of the embedded context and relationships within this context, but does not explain the different phases that lead to relationship success, mutual benefit and reciprocal commitment and trust. On the contrary, commitment-trust theory and social-exchange theory view personal, noneconomic satisfaction, commitment and trust as important aspects for successful relational exchange. Relationship marketing on the other hand is "systems-oriented, yet it includes managerial aspects" (Grönroos 1997 p332). In view of this, the 'macro' approach of relationship marketing, where the network of different stakeholders is taken into account, offers several significant theoretical perspectives to explain how stakeholder relationships and stakeholder retention influence and/or facilitate scientific-knowledge commercialisation.

As illustrated above, there are ample examples of approaches to define relationship marketing. For scientific-knowledge commercialisation the following definitions are deemed to be most relevant. Grönroos (1997 p327) defines relationship marketing as:

> to establish, maintain, and enhance relationships with customers [i.e. industry partners] and other partners [i.e. other stakeholders e.g. investors], at a profit, so that the objectives of the parties involved are met. This is achieved by a mutual exchange and fulfilment of promises.

Shani and Chalasani (1992) define relationship marketing similarly as an incorporated endeavour to identify, sustain, enhance and strengthen a network with the aim of mutual benefits. This is achieved through long-term interactive, individualised and value-added relations. Following the network perspective, Gummesson (1996 p32) identifies relationship marketing as “marketing seen as relationships, networks and interaction”. Networks are sets of relationships and interaction within these networks refers to cooperative and collaborative activities (Gummesson 1996, Parvatiyar and Sheth 2000). Drawing on the prior contributions this thesis will employ the following definition:

> Relationship marketing is a proactive endeavour to initiate, manage, intensify and adapt relationships with customers (i.e. industry partners) and stakeholders to identify, sustain, enhance and strengthen a network for the mutual benefit of all participating stakeholders. This is accomplished by an ongoing process of engaging in cooperative and collaborative activities.

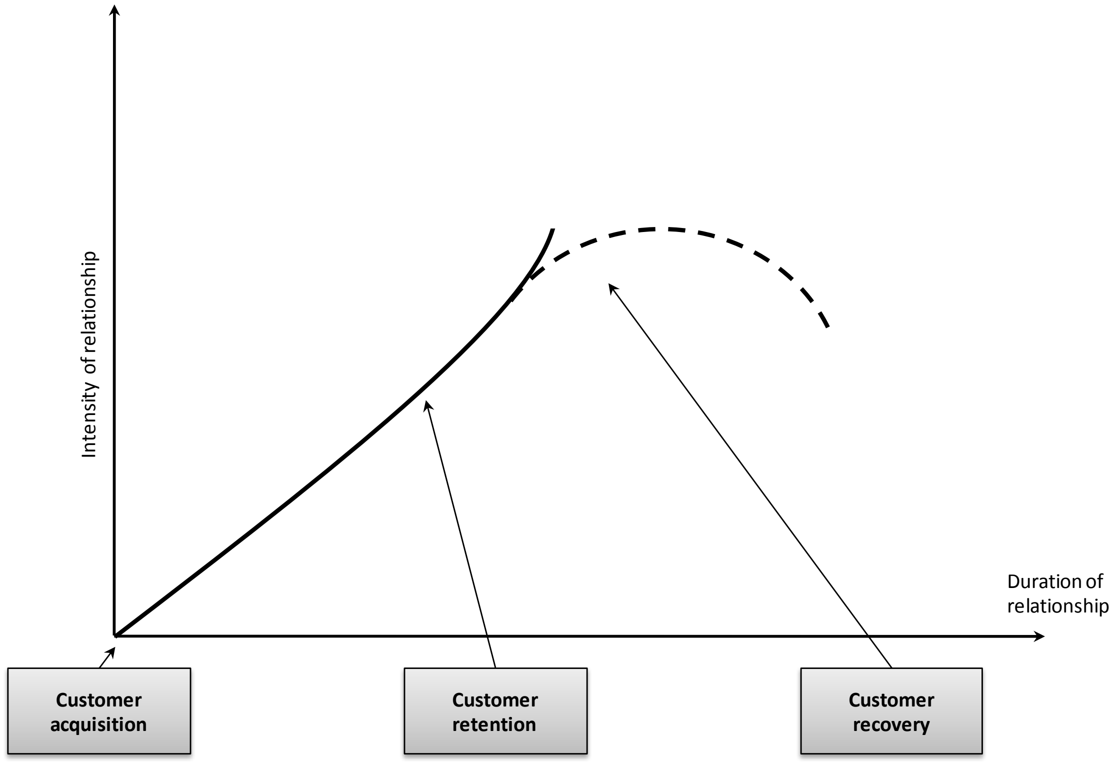
This definition underlines that relationship marketing does not just refer to dyadic relationships but polyadic relationships. The B-2-C context is extended to consider the relationships with other stakeholders and the formation of networks with these stakeholders. Complementing the definition, Liebeskind et al. (1996) suggest that firms should have relationships with academic scientists, and therefore access to their social network. This access will then help to benefit considerably. In addition, short time-to-market cycles, high R&D costs and risks from the industry perspectives postulate the necessity of partnerships to commercialise knowledge (Mohr 2001). The definition above identifies dimensions of relationship marketing (i.e. stakeholder, network, value and long-time orientations) which exhibit a great deal of salience in the process. It is evident that relationships are fundamental to the development of new technology and that the relationship marketing approach can therefore be applied to S-2-B relationships for scientific-knowledge commercialisation.

3.3.5 Integration of relationship marketing constructs into the scientific-knowledge-commercialisation framework

This section seeks to show how relationship marketing theory can be used to explain how long-term, mutual stakeholder relationships and networks are developed to facilitate scientific-knowledge-commercialisation environment.

Considering the objectives of relationship marketing, relationship success can be identified as the overarching aim (Diller 1995). A prerequisite to realising the superior goal of relationship success, however, is customer retention (Werani 2004). It is regarded as a pre-goal to achieving the overall objectives of relationship marketing. Relationship success can be understood by looking at the intensity of the relationship and the duration of the relationship as exemplified in the customer relationship life cycle.

Figure 8: Customer relationship cycle



Source: (Dwyer, Schurr and Oh 1987, Stauss 2000, Bruhn 2003)

The intensity of a relationship can be measured in respect of psychological, behavioural or economic indicators. Psychological indicators refer to trust, commitment and relationship quality; behavioural indicators to purchasing, information, integration and communication behaviour (recommendations) and economic signs of relationship intensity are increasing sales, profits the customer contributes and customer lifetime value (Bruhn 2003). Accordingly, core targets are not just the acquisition of customers, but the retention and maintenance of the relationship. An empirical study by Reichheld and Sasser (1990) outlines that the profit made per customer increases with the length of the relationship due to the fact that loyal customers tend to recommend and contribute to organisations reputation through positive word-of-mouth. Long-term customer orientation reduces costs as retaining and maintaining customers costs less than acquiring new ones. Furthermore, customers who are satisfied with products and/or services are more likely to repeat business with the organisation in question. It has to be noted, however, that profits in B-2-B markets differ as a result of different customer needs cycles (Bruhn 2003).[3]

The basis for customer retention is the business relationship between a consumer and a supplier. Thus, customer retention comprises of two perspectives: a demand-related and supply-related view. With reference to the university, as the supplier of scientific knowledge, retention can be perceived as a bundle of activities to intensify the relationships with the stakeholders. These activities are often associated with the relationship management (Diller 1996). On the other hand, when viewing stakeholder retention[4] it can be noted that loyalty is pivotal to retention. Thus, a stakeholder is retained when he is loyal towards the university. Therefore it is not solely previous behaviours (ex-post consideration) which are an inherent aspect in loyalty, but also future behaviours (ex-ante consideration) (Homburg, Becker and Hentschel 2005). As the business relationship is the point of reference for stakeholder retention, and as the consumer and supplier (i.e. stakeholders and university) have to be involved to realise

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[3] The customer needs cycle illustrated the needs a customer have during different phases. It helps to evaluate present and future potentials of customers. However, influencing factors such as the environment cannot be predicted (Bruhn 2003).

[4] As stakeholders can be considered as potential customers who either demand the use the technology transfer service of the university or have a stake in any other form in the scientific-knowledge commercialisation process, the term stakeholder retention will be used synonymously to customer retention.

retention, the following definition, which is based on definitions of Diller (1996) and Homburg and Bruhn (2005), can be perceived:

> Stakeholder retention exists if repeated information, goods or financial transactions occurred (ex-post consideration) or are planned (ex-ante consideration) between business partners within an appropriate period of time. Inter alia, stakeholder retention includes all activities a university can undertake to influence the stakeholder's intentional and actual behaviour or to improve its goods and services in order to maintain and expand relationships in the future.

3.4 Conclusion

The commercialisation of scientific knowledge has become a primary objective for universities worldwide. Collaborative research projects are viewed as a key to successfully achieving this objective and spurring innovation. Entrepreneurship theory recognises the importance of relationships within networks for entrepreneurial activity. Like entrepreneurship, scientific-knowledge collaboration achievements hinge on interactions and linkages among individual stakeholders in the process. These networks imply norms of reciprocity and trustworthiness which enable the acquisition of information and mobilisation of resources. Stakeholder-relationship networks create the context for entrepreneurial decisions made by the stakeholders. In order to commercialise scientific knowledge stakeholders have to be able to recognise and identify the commercial value of opportunities or create opportunities by investing in new knowledge. They also need to be willing and able to exploit those opportunities. Consequently, it is important to assess who is responsible for establishing stakeholder relationships and how and by whom these relationships are managed in order to create a stakeholder network that facilitates scientific-knowledge commercialisation.

This study draws on relationship marketing and entrepreneurship theory to examine the initiation and management of relationships between universities and their stakeholders. These relationships develop within collaborative networks and are mutually beneficial to all participating stakeholders. Stakeholder retention is considered the most important objective to relationship success. Relationship success and stakeholder retention contribute to the success of scientific-knowledge commercialisation due to repeated information, physical or financial transactions and ultimately the formation of collaborative networks.

4 Methodology

4.1 Introduction

University entrepreneurship is an emerging research field and entrepreneurship theory is, while garnering considerable interest, still considered a young phenomenon (Neergaard and Ulhoi 2007). Entrepreneurship research has mostly been descriptive and empirical research is mainly conducted using quantitative approaches (Bygrave 1989, Chandler and Lyon 2001) and a positivist stance (Neergaard and Ulhoi 2007). New movements in entrepreneurship show a slight shift away from positivist epistemologies and quantitative methodologies to constructionist epistemologies and qualitative methodologies (Fayolle 2003). Although researchers continue to call for more qualitative methodologies (Bygrave 1989, Gartner and Birley 2002, Hindle 2004, Neergaard and Ulhoi 2007) quantitative approaches are still prevalent in most journals (Bygrave 2007). This chapter discusses the selection of the research methodology for this study. Section 2 provides an overview of scientific paradigms and their philosophical assumptions in general. The subsequent two sections discuss the justification of the research paradigm and methodology. Section 5 elaborates the research process. In section 6 the convergent interviewing process for the pilot case study to assist the design of the interview protocol is described. Section 7 outlines the research context and section 8 elaborates reasons for selecting specific cases. In section 9 the interview protocol is presented and section 10 outlines the case study procedures. The eleventh section describes the analysis and limitations of the study and section 12 concludes.

4.2 Research paradigms and their philosophical assumptions

A paradigm “stands for the entire constellation of beliefs, values, techniques, and so on shared by the members of a given community” (Kuhn 1970 p175). Kuhn’s view on paradigms denotes that research paradigms are overarching frameworks. They serve as basic belief systems based on ontological, epistemological and methodological assumptions (Guba and Lincoln 1994). Ontology is concerned with the form and nature of reality. Ontological questions deal with the issue of existence, i.e. whether reality exists objectively and external or whether reality is a result of subjective perceptions. Epistemology is concerned with the relationship between reality and the researcher (Guba and Lincoln 1994). It tries to answer questions in relation to the nature of knowledge (Burrell and Morgan 1979)**,** for example whether knowledge is gained through experience or acquisition. Methodology is the use of different techniques and methods to conduct research (Guba and Lincoln 1994). The prevailing paradigms utilised in social science and in particular business research are outlined in the following Table 7 below.

Table 7: Research paradigms and their philosophical assumptions

Philosophical Assumptions	**Research Paradigms**			
	Positivism	Realism	Critical Theory	Constructivism
Ontology	Reality real and apprehensible	Reality is real but only imperfectly and probabilistically apprehensible	Reality shaped by social, ethnic, economic, political and other forces over time	Reality is constructed by people based on feelings and experiences
Epistemology	Objectivist: Researcher is remote from reality; Findings are true	Modified objectivist: Mutual interaction between researcher and interviewee; Findings are probably true	Subjectivist: Researcher is involved with those being researched; Value mediated findings	Subjectivist: Researcher is a passionate participant; Created findings
Methodology	Experiments and surveys; verification of hypothesis, mainly quantitative methods	Case studies/convergent interviewing; triangulation, interpretation of research issues by qualitative and/or by some quantitative methods (e.g. structural equation modelling)	Action research, dialogic/dialectical; researcher is transformative, changing the participant's social world	In-depth interviews, hermeneutical/ dialectical; researcher is passionate participate
Deduction/ Induction	Deduction	Induction	Induction	Induction

Source: Adapted from (Guba and Lincoln 1994, Perry 1998, Healy and Perry 2000, Hine and Carson 2007)

Positivism is concerned with a reality that is understandable and possible to measure. Researchers are objective to the existence of the world and isolate themselves from their research. Positivistic quantitative research is concerned with causal effects “driven by immutable natural laws and mechanisms” (Guba and Lincoln, 1994 p4). The other three paradigms are more concerned with human beings’ own perceptions and experiences in order to apprehend reality and the research field (Healy and Perry 2000). “Human behavior, unlike that of physical objects, cannot be understood without reference to the meanings and purposes attached by human actors to their activities” (Guba and Lincoln, 1994 p 106). Critical theory and constructivism, as opposed to realism, are associated with subjectivist postures (Guba and Lincoln 1994, Healy and Perry 2000). Researchers add their own values and actively participate in the research. Realism in an ontological sense refers to reality as separate from, and independent of, the language we use to describe it. Logical positivism, post positivism, logical empiricism, transcendental realism, scientific realism or critical realism (Guba and Lincoln 1994, Healy and Perry 2000, Patton 2002, Hunt 2005, Bøllingtoft 2007, Wigren 2007) emanate from the realist ontological position, but they differ in their epistemological approaches. For example, critical realists argue for the use of causal language when determining explanations (Easton 2010). Realism is an evolving framework and Hunt (1990 p 8) notes that this is an enormous problem for realism and that “we can lump together all the versions of realism and refer to them as ‘scientific realism’. Hunt (1990) argues that scientific realism stems from the fundamental views of classical realism, fallibilistic realism, critical realism and inductive realism. Scientific realism, as opposed to the ontological stance of classical realism, accepts that reality exists but does not agree that the perceived external world is known with certainty. It is more a critical consideration of reality. Hunt further acknowledges the critical aspect of realism by accepting the fallibility of perceptions. This is in line with Guba and Lincoln (1994), who note that the term critical refers to the ontological stance of realism. Easton (2002 p104), on the other hand, while acknowledging that Hunt’s scientific realism approach incorporates certain characteristics of Sayer’s critical realism argues, that “critical realism goes beyond and makes other assumptions about the nature of reality and how to determine it”. Similar to scientific realism, critical realism is more critical about reality than positivism and holds that reality is real, but only imperfectly and probabilistically apprehensible (Hunt 1990, Guba and Lincoln 1994, Healy and Perry 2000, Hunt 2005). Critical realism in social science and social systems, on the other hand, accepts that reality is not socially constructed but construed (Easton 2010). It distinguishes not only between the real world, but also the actual (created by the real world) and empirical (things we can capture and record). Critical realism is concerned about causal explanations. Causality in critical realism does not concern cause and effect but causal powers or liabilities of objects and relations (Sayer 1992). In critical realism research "perceptions are being studied because they provide a window on to a reality beyond those perceptions" (Healy and Perry 2000 p120). In other words, the perception of one human being is not, of itself, reality. Multiple perceptions of several people, however, allegorise reality. According to Sayer (2000 p17) "critical realism is only partly naturalist, for although social science can use the same methods as natural sciences regarding causal explanation, it must also diverge from them in using 'verstehen' or interpretive understanding." Critical realists in social science research approach their research with a 'largely' objectivist view of the world while allowing the fallibility and scepticism of a subjective world view. This enables detection of how hidden mechanisms work and explanation of research phenomena. This is achieved by contrasting the research to pre-existing knowledge/theory, predisposing it to a critical community such as editors and referees and acknowledging that replicated findings are probably true (Guba and Lincoln 1994) but could be "fallible and open to adjustment (Danermark et al. 2002 p. 15).

4.3 Choosing an appropriate research framework – justification of realism

"[T]heory is primarily a form of insight, i.e. a way of looking at the world, and not a form of knowledge of how the world is" (Bohm 1981). Accordingly, theory insights can be generated from different paradigmatic perspectives. Theory-testing is considered to be positivistic and theory-building to be a phenomenological process such as critical theory, constructivism and realism (Perry 1998). Theory is developed through either hypothetico-deductive models or inductive theory-building approaches such as case studies, grounded theory or ethnography (Colquitt and Zapata-Phelan 2007). Researchers with specific ontological and epistemological beliefs, however, are predisposed to the use of certain methodologies by virtue of following an objectivist or subjectivist approach. Furthermore, the decision to choose an appropriate paradigm is determined by prior research in the field of inquiry.

Research on university entrepreneurship shows, that although university entrepreneurship is a recent field of research, scholars have already conducted a relatively high share of quantitative studies, bypassing the need for new theory development (Rothaermel, Agung and Jiang 2007). Only a few scholars apply sociology, network theory or strategic management theory to the university entrepreneurship phenomenon, limiting the progression of the research field in question. Leading researchers in the area support this position (Markman, Siegel and Wright 2008) and ask for more theory building research. The analysis in the previous chapter shows that multilevel interaction has not been studied in the required depth. While the contribution to the understanding of linkages is growing, little emphasis is placed on the establishment, development and management of relationships in order to effectively build networks of scientific-knowledge commercialisation. Researchers should examine the context in order to understand why, how and by whom entrepreneurship happens (Welter 2011). An ecosystem approach predisposes the researcher to examine the context as well. This study is taking a novel interdisciplinary approach, by working on the application of both entrepreneurship and relationship marketing theory, to the commercialisation process in order to build theory.

Entrepreneurship theory is a multi-paradigmatic research field that can be investigated by employing diverse methodologies (Neergaard and Ulhøi 2007). Research on entrepreneurship is influenced by various disciplines such as sociology, psychology, economics and management, and accordingly, multiple empirical methods have been applied (Bygrave 2007). As indicated above, positivism has dominated entrepreneurship research. Bygrave (1989 p. 21) argues that “the heart of the entrepreneurship process will be found in the ‘descriptive background’” as entrepreneurship models are more fragile and factors are always changing, as opposed to physics where models are robust and stable. Entrepreneurship research should consider the different contexts in which entrepreneurship takes place (Welter 2011). Contexts set the limits in terms of theory generalisability (Whetten 1989). Stakeholder relationships are, thus, best examined within the phenomenon’s real life context i.e. the ecosystem of scientific-knowledge commercialisation. When dynamics and contextual factors are taken into account, other more constructivist paradigms need to be considered to study entrepreneurship (Bruyat and Julien 2000). Realism, as the middle ground and growing intellectual movement in the social sciences such as economics, management and marketing (Miller and Tsang

2010), has been used in entrepreneurship research and its contributory disciplines (Blundel 2007 p58). Sayer (2000) argues that critical realism accepts the interpretive and hermeneutic facets that are inherent in social science research. He believed that it is important to analyse the system in order to understand the actors' actions of one another. Researching the context is "consistent with the realist concept of causation and requires us…to decide what it was about a certain context which allowed a certain action to be successful" (ibid p26). It is believed that critical realism is the appropriate paradigm to examine the entrepreneurial context and processes (such as entrepreneurial activity and interaction within networks) and that critical realism is proficient to address the need for multi-level analysis (Blundel 2007).

Looking at marketing theory whilst choosing an appropriate framework for this study reveals that critical realism is also a significant paradigm in marketing research (Easton 2002, 2010), especially in relationship marketing (Healy and Perry 2000) and B-2-B relationships in industrial marketing (Easton 2002, 2010). "Critical realists argue that in the real world there are entities such as organisation, which have powers to act and are liable to be acted upon by others" (Easton 2010 p128). Necessary relations (which will have an effect) or contingent relations (which exist independently, but may have an effect) between objects/entities (buyer and seller) are important to critical realist explanations (Easton 2002). Critical realists are concerned with mechanisms (deep processes and structures) that cause effects (Sayer 1992). Thus, it is important to understand the mechanisms that cause effects. For example, industry partners, university PIs, TTO managers and government agents are entities which have necessary relationships in terms of commercialising knowledge and may or may not have contingent relationships (for example competitors or other universities). Working on the application of both entrepreneurship and relationship marketing theory and incorporating the above views of scholars on realism the adoption of a realist posture to this study is proposed. The study of stakeholder relationships within the university entrepreneurship environment is concerned with human behaviour and has to be understood in relation to the meanings and rationales of its actors and stakeholders. Employing a realist approach will, thus, enable the identification of underlying mechanisms and structures that are able to explain why, how and by whom stakeholder relationships are established and managed in order to create stakeholder networks for scientific-knowledge commercialisation. Critical realism is believed to be the more suitable approach as it enables the identification of these hidden mechanisms that positivism cannot detect that easily (Easton 2002). The biggest problem of positivism is that "constant conjunction of elements or variables is not a causal explanation or indeed explanation in any kind. It is simply an atheoretical statement about the world" (Easton 2010 p118). Constructionism, on the other hand, rejects the possibility of knowing and discerning causality, and, thus, only concentrates on identifying the constructions that actors make (Easton 2010). In sum, critical realism enables to research the context, multiple levels of stakeholder interaction and complex human interactions by identifying underlying social structures, causal powers and mechanisms.

4.4 Justification of the research methodology

As outlined in the literature review there is a need for qualitative research on scientific-knowledge commercialisation. Such an approach is suitable when existing research is incomplete or conflicting (Eisenhardt 1989) and a 'how' or 'why' question is required to clarify the issue (Miles and Huberman 1994, Yin 2009). Critical realism is characterised by both qualitative and quantitative methods (Easton 2010). Qualitative data, however, is understood to be the better methodology for providing insights into human activities (Guba and Lincoln, 1994) the context and dynamics (Eisenhardt 1989). Additionally, a multilevel analysis that is inspired by a critical realism methodology is best researched by using a qualitative approach (Blundel, 2007). A qualitative critical realist approach helps to identify complex set of factors and relationships (Easton 2010). To address the aforementioned need for theory-building, case research is believed to be the most suitable approach as topics in case research are usually contemporary and pre-paradigmatic (Perry 2001, Eisenhardt and Graebner 2007). In order to differentiate between case studies, which are more descriptive, Stokes and Perry (2007 p. 138) amalgamate the literature and postulate that case research is:

- an investigation of contemporary, dynamic phenomena and its emerging (rather than paradigmatic) body of knowledge (Eisenhardt1989, Chetty 1996, Gable 1994, Romano 1989, Yin 1994);
- within the phenomenon's real-life context where the boundaries between the phenomenon and context under investigation are unclear (Bonoma 1985, Chetty 1996, Stake 1995, Yin 1994);

- when explanation of causal links are too complex for survey or experimental methods (Eisenhardt 1989, McGure 1997) so that single, clear outcomes are not possible (McGuire, 1997);
- using interviews, observation and other multiple sources of data (Bonoma 1985, Perry 1998, Robson 1993).

Similarly, a critical realist case research approach is "suited to relatively clearly bounded, but complex, phenomena such as organisation, interorganisational relationships or nets of connected organisations" (Easton 2010 p123). Case research is, thus, the most suitable approach as research on scientific-knowledge commercialisation from universities is a newly emerging research area. It is the appropriate method as the analysis of stakeholder relationships is best examined within the phenomenon's real life context i.e. the ecosystem of scientific-knowledge commercialisation. In addition, qualitative data will provide deeper insight into stakeholder relationships as they involve complex social processes that quantitative data cannot disclose (Eisenhardt and Graebner 2007). Case research will provide an opportunity for intensive analysis of specific details often unnoted by other methods. Critical realism is the more appropriate epistemological guide for case research. It is inductive, objective and commensurable (Perry 1998) allowing for continuous reflection to identify mechanisms that can be considered as explanations (Easton 2010) for having caused collaborative networks for scientific-knowledge commercialisation.

As with any method questions about the rigour of the results have to be addressed. Healy and Perry (2000) have identified six quality criteria to conduct case research within the realism paradigm. Ontological appropriateness refers to the suitability of the research design and was outlined and explained above.

Epistemological quality criteria are addressed by using multiple perceptions of participants and peer researchers. In this study multiple interviews with different stakeholders were collected and broad probe questions were asked in the interviews in order to get multiple perceptions. In addition, the researcher was aware of own values and, thus, independent individuals were consulted to interpret findings.

In order to allow for transferability and generalisation, external validity within this study is achieved by (a) identifying research issues before data collection; and (b) formulating an interview protocol to provide data for confirming or disconfirming theory. These research issues are identified through a thorough literature review coupled with convergent interviewing to get preliminary theoretical constructs on which the analysis is based. This enables analytical generalisation as it refers to generalisation from empirical observations to theory rather than a population (Yin 1984, Gibbert, Ruigrok and Wicki 2008).

Construct validity denotes the quality of the investigation (i.e. the correct observation of reality) (Gibbert, Ruigrok and Wicki 2008). In order to attain construct validity and confirmability in case research, scholars suggest the use of prior theory, a case study database, triangulation and a clear line of evidence (Yin 1984, Perry 2001, Riege 2003, Gibbert, Ruigrok and Wicki 2008, Yin 2009). Triangulation can be addressed by different approaches such as methods triangulation, triangulation of sources, analyst/analysis triangulation and theory/perspective triangulation (Patton 2002). In this study, triangulation is achieved by triangulation of sources (compare observation with interviews and interviews with written material), theory triangulation (relationship marketing perspectives and entrepreneurship theory perspectives) and analysis triangulation (analysis via N-Vivo, as well as ordinary analysis).

Methodological trustworthiness or reliability refers to the ability to replicate a study (Yin 1984, 2009). In order to allow replication, a case study database and an interview protocol was developed and used, incorporating descriptions of procedures such as case selection and interview procedures.

Finally, contingent or internal validity is achieved in the data analysis phase. Theoretical and literal replication for case selection, in-depth questions and description of the research context provide for credibility of the study. The following table outlines the discussed quality criteria for this study.

Table 8: Quality criteria for case study research within the realism paradigm

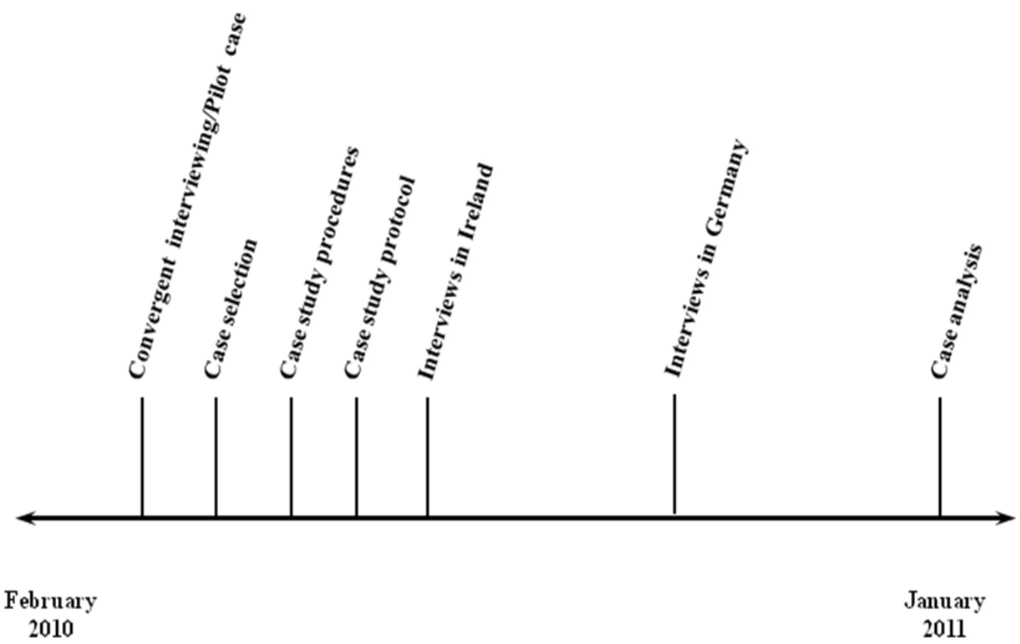
Level		Criteria	Research Phase	Case Study techniques	Philosophical Assumptions
Ontology	**1.**	**Ontological appropriateness**	Research design	Selection of research problem (why or how)	Reality is real but only imperfectly and probabilistically apprehensible
	2.	**Contingent validity (internal validity)**	Data analysis	Cross-cases, theoretical and literal replication, in-depth questions, description of the context	
Epistemology	**3.**	**Multiple perceptions of participants and peer researchers**	Data collection	Multiple interviews, supporting evidence, broad probe questions, triangulation, aware of own values	Modified objectivist
Methodology	**4.**	**Methodological trustworthiness (reliability)**	Data collection	Case study database, use in the report of relevant quotations and matrices that summarise data, and of descriptions of procedures like case selection and interview procedures	Triangulation, interpretation of research issues by qualitative methods
	5.	**Analytic generalisation (external validity-** through the specification of theoretical relationships)	Research design	Identify research issues before data collection/a priori constructs, to formulate an interview protocol that will provide data for confirming or disconfirming theory	
	6.	**Construct validity**	Data collection	Use of prior theory, comparison with conflicting literature, case study database and triangulation, multiple sources of evidence (replication logic across cases)	

Source: Adapted from Healy and Perry (2000), Eisenhardt (1989), Yin (1984)

4.5 The research process

The research process comprises the following two elements: (1) a thorough literature review combined with convergent interviewing in a pilot case study (at the National Centre for Sensor Research (NCSR) in Ireland) in order to identify broad research issues and (2) the main study, which involved 82 interviews with all participating stakeholders. The main study was completed after the research issues to guide the interview protocol were established. The research process consists of five stages; (1) case selection, (2) case study procedures, (3) case study protocol, (4) interviews, (5) case study analysis. Figure 11 illustrates the timeline of the overall research process.

Figure 9: Research process



Although this process outlines a linear approach, some of the stages have been undertaken simultaneously.

4.6 Convergent Interviewing process and pilot case study to assist the design of the interview protocol

Prior theory is identified from the literature review and from convergent interviewing as the first step in the theory-building process of case study research. Prior theory gaps are not expressed as precise, testable, closed hypotheses, but as general, broad, open research issues (Yin, 2009). Convergent interviewing is a technique for pilot cases (Williams and Lewis 2005) which allows the researcher to narrow down the research focus (Rao and Perry 2003) and identify the key issues within a specific setting (Jepsen and Rodwell 2008). The convergent interviewing process is summarised as follows (Carson et al. 2001, Rao and Perry 2003, Williams and Lewis 2005):

1. The research topic is identified;
2. Open research issues are identified by literature review;
3. These research issues operate as guidance for interviews;
4. Interviewees are identified;
5. Interviews take place;
6. Key issues are identified;
7. Interviews are concluded when convergent themes are identified; and
8. Interview results are used to design the interview protocol.

Ten convergent interviews at the National Centre for Sensor Research (NCSR) were conducted and analysed in order to get the theoretical constructs as outlined in Table 9. This included interviews with principal investigators, industry partners, a TTO manager and a government agent.

Table 9: Research issues identified in the pilot case study and literature review

Extraction of meaning units and descriptive concepts from the interviews	Constructs
University approaches industry; problem statement from industry partner; solved particular problem before; good experience; good reputation; great reputation; focus research around certain areas; champions; islands of competence	**Use of university**
Science relevant to business drivers; set expectations; meeting deadlines; outcome good experience	**Satisfaction**
Create and maintain trust; trust has to be established; trust has to come first; combination of commitment, trust and satisfaction; commitment because of risky projects	**Loyalty**
Good experience want to replicate; repeat business because of experience; bad experience no recommendation	**Retention**
Team effort; depend all on people; TTO should be involved earlier; being there before the start RM management position missing; need to recognise, manage and maintain people build up portfolio; ability to identify the right people	**Relationship management**
Success on success; snowball effect; multidisciplinary competences; access to resources	**Entrepreneurial activity**
TTO issues; clear vision and mission in university; national IP policy; cultural factors; infrastructure; funding; government support	**Factors**
University infrastructure; communication of vision; PI career issues; TTO inefficient economic times; limited seed funds;	**Barriers**
PI interest in basic science; industry as centre of application; university as basic science distributor; university as driver of the future; Government only interested in applied science at the moment	**Applied vs. Basic research**

Consistent with the methodological approach the preliminary results provide rich and interesting constructs including use of university, satisfaction, loyalty, retention, relationship management, entrepreneurial activity, barriers and factors as well as applied versus basic research. Based on these constructs an interview protocol, which is described in the next section, was designed.

4.7 Case selection and research context

The methodological approach is consistent with realism where, in order to investigate and identify relationships between structures, cases should be selected considering the requirements of analytical and not empirical generalisation (Blundel 2007). Following Yin (1984, 2009) and Eisenhardt (1989) replication logic, and not sampling logic, is used for multiple-case studies. Literal replication (predicts similar results for predictable reasons) and theoretical replication (produces contrary results for predictable reasons) are the basis for the case selection. Comparative analysis reveals root causes of the performance differential and, hence, possibilities for future research, whilst the existence of similar research results enables theory building (Eisenhardt 1989). Two comparisons are central to analysis and are discussed in this section.

Despite the growing attention at the policy level, as outlined in the literature review, the evidence on the role of universities in knowledge transfer is unclear. A comparative study within Europe is, therefore, extremely relevant to current policy debates and will contribute to the commercialisation of scientific knowledge generated in universities.

The first comparison in this study is between transfer practices in Germany and Ireland. Germany and Ireland have been chosen as both have similar policy initiatives with regard to creating centres of excellence but with different economic and financial infrastructures. Germany is ranked amongst the leading economies of the world with a strong tradition of university-industry collaboration. In particular, Bavaria has a long tradition of industry-university partnerships with a base of global companies such as BMW and Siemens. It has one of the highest levels of R&D expenditure in Europe, with R&D expenditure of 2.63% of GDP in 2008 (Eurostat 2012). This compares to Ireland's R&D expenditure of 1.43% of GDP in 2008, which although catching up, is still well below the expected EU target (Forfas 2009). The industry context in Ireland is primarily multinational subsidiaries, which are generally less embedded in the local economy.

The challenge is to encourage multinationals to undertake more research in Ireland. The Strategy for Science, Technology and Innovation (SSTI) seeks to meet this challenge by investing heavily in the research capacity of the university sector. The objectives are: (a) to build a sustainable system of world class research teams across all disciplines and (b) double the output of Ph.D. students by 2013 (Department of Enterprise Trade and Employment 2006). Controversially, a recent study by Jordan and O'Leary (2007) indicated that higher education institutes contribute less to the innovation output than expected. Therefore, we would expect that Ireland would have a lot to learn from Germany in terms of knowledge transfer. Nonetheless, a recent report by the Commission of Experts for Research and Innovation (2009) revealed that knowledge and technology transfer in Germany is not perfect either. Germany, although having a long established and successful past in contract research, lacks the know-how of strategic partnerships for business-university collaborations.

Secondly, the performance of *externally* funded designated centres of excellence and faculty-based research centres are compared. As indicted above Germany and Ireland have been chosen as both have similar policy initiatives with regard to creating centres of excellence. Excellence centres in both countries are funded by dedicated government initiatives and are allocated on average €5 million per year. They were introduced to create excellence in research and to form interdisciplinary research hubs for collaboration and networking. The funding incorporates funding for research as well as administration and equipment. These initiatives served to place universities at the centre of the science system. The Irish excellence centres (Centres for Science Engineering and Technology or CSET) focus on life science, energy and information technologies. Industry involvement is a requirement for funding for CSETs. German centres of excellence cover several sectors with latent research potential. While industry involvement is considered desirable and plays an important role, the main aim of the German excellence centres is to improve cutting-edge research in Germany and to improve its international competitiveness. Faculty-based research centres, on the other hand, are research centres or research of faculties which are located within a faculty and are not funded through a specific policy initiative. They acquire their funding by applying for government or EU grants and are, thus ordinarily less well equipped in terms of administration, support structures or equipment than centres of excellence.

Consequently, we would expect that centres of excellence would outperform faculty – based centres.

By addressing these comparisons nine excellence research centres and eight faculty-based centres located in Ireland and Germany were identified.

Table 10: Case characteristics

	Ireland	**Germany**
Excellence Centre	**4 CSETs**: Centres for Science, Engineering and Technology (CSET) are interdisciplinary Irish state funded (approx. 5 Mio per CSET per annum) research centres whose aim is to provide excellence in research and to exploit opportunities in science, engineering and technology. Currently there are 10 CSETs; in addition they acquire their funding by applying for government or EU grants	**5 Centres of Excellence**: Clusters of excellence are state funded (3-8 Mio per centre per annum) centres which are one of three funding lines of the German excellence initiative and whose aim is to establish internationally visible, competitive research facilities to enhance scientific networking and cooperation ; in addition they acquire their funding by applying for government or EU grants
Faculty based centre	**4 Faculty-based research centres:** are research centres or research faculties which are located within a faculty and are not funded through a specific policy initiative; they acquire their funding by applying for government or EU grants	**4 Faculty-based research centres:** are research centres or research faculties which are located within a faculty and are not funded through a specific policy initiative; they acquire their funding by applying for government or EU grants

The cases (i.e. collaborative projects) were selected in universities that had provided both, excellence centres and faculty-based research in the life science, engineering and information technologies sector.

Table 11: Case study selection

	Ireland		Germany	
	Trinity College	**Dublin City University**	**Ludwig Maximilian University**	**Technical University Munich**
Excellence Centre	CRANN – Centre for research on adaptive nanostructures and nano devices	BDI – Biomedical diagnostics institute	MAP – Munich advanced photonics NIM – Nano initiative Munich	COTESYS – Cognition for technical systems
	CTVR – The telecommunications research centre	CNGL – Centre for next generation localisation	CIPSM – Centre for integrated protein science	Universe Cluster – Origin and structure of the universe
Faculty-based centre	TCIN – Trinity college institute of neuroscience	RINCE – research institute focused on engineering technologies	CeNS – Centre for nano science	Faculty for aerodynamics
	Trinity centre for bioengineering	ICNT – International centre for neuro-therapeutics	BioImaging centre	Faculty for flight system dynamics

These sectors were chosen for several reasons. Firstly, they reflect the focus of the Irish CSETS and, secondly, they mirror the sectors of firm-university cooperation (Forfas 2011). Thirdly, and more importantly, it is believed that collaborations are more important to firms and academics than spinning out or licensing (Perkmann and Walsh 2009).

All research centres collaborate with multinationals and SMEs and some have their own spin-out companies. Thus, the cases present a broad spectrum of collaborative activity. Comparative analysis will reveal root causes of the performance differential, and hence further research possibilities, whilst the existence of similar research results enables theory building (Eisenhardt 1989). In other words, by selecting the specific cases and considering multiple heterogeneous sources this research design is facilitating analytical generalisation to build theory. Researching the context will also set boundaries for generalisation (Whetten 1989).

4.8 The interview protocol

A semi-structured interview protocol was used for the main study.[5] Firstly stakeholders were asked to outline their backgrounds and briefly summarise their projects. While this got the respondents to start talking, the interview protocol was used as a guide to structure the interviews. Questions were not asked in any particular order to facilitate a conversation with the interviewees. In this way interviewees were able to lead the conversation to issues that they viewed as important rather than being led towards talking about specific issues. As the interviews were interviewee-led, trends were less likely to be identified but where trends are identified they are likely to be more significant. Where a respondent mentioned a particular research issue, probe questions were asked to explore in more detail how and why these issues were of importance. The interview protocol was developed based on the identified research issues through the convergent interviewing process in the pilot case study and insights of the literature review. In order to reveal why universities are used for collaborative research projects the participants were then asked to reflect on the following topics: (a) how projects are initiated; (b) project objectives; and (c) differences in the initiation process across projects. Questions for the identified satisfaction, loyalty and retention constructs were broadly based on customer satisfaction and customer retention indices in the marketing literature. Interviewees were, thus, invited to reflect on whether they have or will undertake another project with current partners and were asked to explain their answers. They were invited to make suggestions in relation to what the individual players can do to encourage additional projects. The respondents were questioned on: (a) how they evaluate the success or failure of a project; (b) what sort of information they share with the partners; and (c) whether they shared all information. In order to address the relationship management issue more general questions were asked in relation to: (a) who establishes and manages the relationships; and (b) how a collaborative network of relationships is being facilitated/developed. In addition, questions were asked to identify whether relationships are important, have an impact or are beneficial (Larson 1992). Finally, they were asked to (a) reflect on the barriers and enablers to collaborative relationships and commercialisation in general and (b) the benefits of network involvement. In order to ensure validity Perkmann and Walsh's (2009) methodology

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[5] Please refer to the appendix A for a sample interview protocol

was followed and respondents were asked for facts to reduce cognitive bias and to limit impression management. The identification of specific projects enabled this process. Confidentiality was assured to encourage participants to provide truthful answers.

4.9 Case study procedure

As the study is designed to include all stakeholders collaborating on a specific project, stakeholder interviews constitute the primary unit of analysis for our research. A letter of introduction from the President of DCU enabled the first contact with the excellence centre managers[6]. The centre managers were asked to identify a collaborative project within the centre. By choosing a particular project they were in the position to provide the names and contact details of all participating stakeholders. This was not only beneficial for identifying the participating stakeholders but the possibility of talking about a specific project also helped the stakeholders to identify specific issues more easily as they could refer to a particular example. The managers or commercialisation managers of the excellence centres provided details of faculty-based research centres and/or scientists that matched their research interest or were in the engineering or IT sector. Once a contact to a faculty-based centre was established a collaborative project and stakeholders were also identified. When all stakeholders were identified, emails were sent out seeking participation. These emails were supported by the centre or commercialisation managers. It is worth mentioning that the industry partners and government agents were faster in responding and organising the meetings than the PIs. This might reflect the PI’s tight schedules, as proposed in the findings.

Interviews were carried out until the point of data saturation was reached. In total 82 semi-structured interviews were conducted. From these interviews 75 were face-to-face interviews and 7 were telephone interviews. The interviews were conducted with 25 PIs, 13 research centre/commercialisation managers, 13 TTO managers, 22 industry partners and 9 government agents who participated in collaborative projects. Most of the research centre/commercialisation managers had a science and not a business background. All government agents were responsible for multiple centres. Where they covered two projects, they were interviewed once but were asked to discuss both

[6] Please find a sample letter in the Appendix B

projects. The same applied for the 4 TTOs of the 4 universities. In order to protect the confidentiality of the interviewees, it is not possible to elaborate further on the characteristics of the case-study participants. Interviews lasted between 45 and 60 minutes. The German interviews were all translated and all 82 stakeholder interviews were transcribed and formed the basis for the analysis.

4.10 Case study analysis procedure

Qualitative data analysis commences during the data collection phase (Rocks, Carson and Gilmore 2007). Comments and ideas that arose during each interview were summarised separately. All interviews were read by the interviewer in order to allow for interpretative flexibility and universal understanding. General expressions and similar descriptions for the same meaning were identified. All data and summarised notes were reduced into categories (Glaser and Strauss 1967, Miles and Huberman 1994, Voss, Tsikriktsis and Frohlich 2002). The technique of coding was then used to analyse the data. Coding facilitates the connection of data with the theoretical constructs and is the first step in categorising the data (Rocks, Carson and Gilmore 2007). “The underlying theoretical standpoint is essential in a theory generative study and necessary to use in cross-case analysis” (Halinen and Tornroos 2005 p.1295). The analysis of the main case studies was, thus, based on the theoretical constructs identified through the literature review and convergent interviewing. Guided by the theoretical constructs, the interview transcripts were then coded accordingly and meaning units extracted. The primary codes included text extractions referring to the use of the universities, satisfaction, loyalty, retention, relationship management, entrepreneurial activity, factors and barriers and quotations referring to applied versus basic research. When all transcripts had been coded, each code was read again. Some of the codes had similar meanings or referred to more than one code. In re-reading the transcripts, sub-categories emerged, similar categories were combined or others split up until everything had been categorised.

Table 12: Codes and categories

Constructs – 1st coding	Category – 2nd coding	Category – 3rd coding	Category – 4th coding
Use of university	I contacted U	Experience & knowledge	
		Reputation	
		Existing contacts	
	U contacted I	Existing contacts	
		Interest	
	TTO contacted I		
Satisfaction/ dissatisfaction	Evaluation process (expectations met/not met)	Professionalism	
		Timing	
		Market and industry awareness	
		Realistic evaluation & feasibility	
		Communication	
		Research output & quality	
		Relationship quality	
		Willingness of the PI	
	Affective condition		
Loyalty	Trust		
	Commitment		
	Favourable attitude		
Retention	Repeat business		
	Recommendation		
Relationship management	Role of PI		
	Role of TTO		
Entrepreneurial activity	Network capabilities	Idea-generation and opportunity identification (Access to info & social capital)	
		Access to financial resources	
		Success builds on success	
Factors	Build network		
	Importance of relationships		
Barriers	Interaction issues	Concerns and Interests	Interest & entrepreneurial spirit
			Time horizons
			Motivation/strategic change
			View on applied vs. basic science
		Norms and Values	Ivory tower view
			Value of 3rd mission/philosopy
			Value of Comm. – lack of incentives
			Job norms –balance diff. activities
		Resources	Skilled labour & financial aid
			Time
	Technology barrier	Embryonic in life science – strategic in nature-differences in sectors	
	Economic barrier	Shortage of funding RO – D happy	
		ROI agents & GOV strategy	
	Societal barrier	Dissatisfaction with GOV in ROI	
		Different cultures	
		TTO	
		Legal framework	
	Ecological barrier		
Applied vs. Basic research	PI's view on the type and need of science		
	Industry's view on the type and need of science		

The codes “are retrieval and organising devices that allow the analyst to spot quickly, pull out, then cluster all the segments relating to a particular question, hypothesis, concept or theme” (Miles and Huberman 1994 p56). In addition, N-vivo was used to check and ensure that all relevant aspects had been identified. After the data was reduced to categories, the data was displayed to enable conclusion and verification drawing (Voss, Tsikriktsis and Frohlich 2002). It is believed that the a priori selection of cases, based on an analytical replication, guides the analysis (Eisenhardt 1989, Yin 2009). Within-case as well as cross-case analysis enables the researcher to view evidence from different perspectives. In order to present the empirical evidence and build theory it is recommended to compare the data with existing literature and analyse it in the form of a dialogue between data and theory (Eisenhardt 1989, Halinen and Tornroos 2005, Eisenhardt and Graebner 2007, Yin 2009). It is also advised to illustrate the supporting data (verification) by using summary tables to confirm the rigour and depth of the empirical foundation of the theory (Eisenhardt 1989, Eisenhardt and Graebner 2007).

Eisenhardt and Graebner (2007) recommend the use of highly knowledgeable interviewees who view the researched phenomena from multiple perspectives as this helps to avoid bias. The multi-stakeholder approach enables the analysis of the true value of all stakeholders’ roles as it incorporates a holistic view, as opposed to prior research which tends to comprise single units or dyadic units of analysis. While it is acknowledged that qualitative analysis does not account for statistically significant results, a multi-stakeholder analysis will, if the stakeholders agree on certain topics irrespective of size, type or location of the centre, inform a general understanding. The design facilitates analytical generalisation as it refers to generalisation from empirical observations to theory, rather than a population (Yin 1984, Gibbert, Ruigrok and Wicki 2008). This is in line with theory development and generalisability from a critical realist perspective. “Expansion and generalisation come from identifying the deep processes at work under contingent conditions via particular mechanisms” and relationships with existing theory (Easton 2010 p126-127).

4.11 Limitations

The strengths of case research yield weaknesses as well. “The case study method is not a panacea” as pointed out by Parkhe (1993 p. 255). Good theory is characterised by parsimony, whereas case research can to lead to overly-complex theories (Eisenhardt 1989). This issue, however, can be addressed by using existing theory and precise research questions as guidance (Parkhe 1993). It is also noted that theory development from case research can be quite narrow and idiosyncratic (Eisenhardt 1989). While case research came under criticism for not producing grand theory, it has to be noted that the case research method does not aim for final theory development (Stokes and Perry 2007). The developed theory should be subject to researchers testing it by employing other methods i.e. statistical generalisation (Eisenhardt 1989, Parkhe 1993).

Given the complexity of the system it is possible to “make causal misattributions” or that different mechanisms are able to cause the same effect (Easton 2010 p124). It is suggested, however, that by contrasting the research to pre-existing knowledge/theory, predisposing it to a critical community such as editors and/or referees (Guba and Lincoln 1994) or discussing our findings with other researchers and interviewees (Easton 2010) these limitations are overcome to the extent possible. Nevertheless, it is acknowledged that replicated findings are probably true, but could be “fallible and open to adjustment” (Danermark et al. 2002 p. 15).

4.12 Conclusion

The choice of critical realism as an ontological and epistemological tenet and adopting case research as the methodological approach reflects the outlined need for more theory development and the nature of the research problem. The methodology enables theory building but also reflection and comparison to prior theory. Considerable time and effort was given to the identification of theoretical research issues, selection of cases and careful documentation of procedures of the case research method. The alleviation of case research limitations and the development of trustworthy knowledge are, thus, achieved through an attentive research design that is therefore truly worthy of others' trust.

Analysing the data in terms of codes and categories allowed to cluster the findings in relation to the phenomena's real-life context and the particular research questions: (a) how collaborative stakeholder networks develop to facilitate scientific-knowledge commercialisation; (b) why collaborative stakeholder networks are established for scientific-knowledge commercialisation; and (c) by whom are collaborative stakeholder networks for scientific-knowledge commercialisation established and managed?

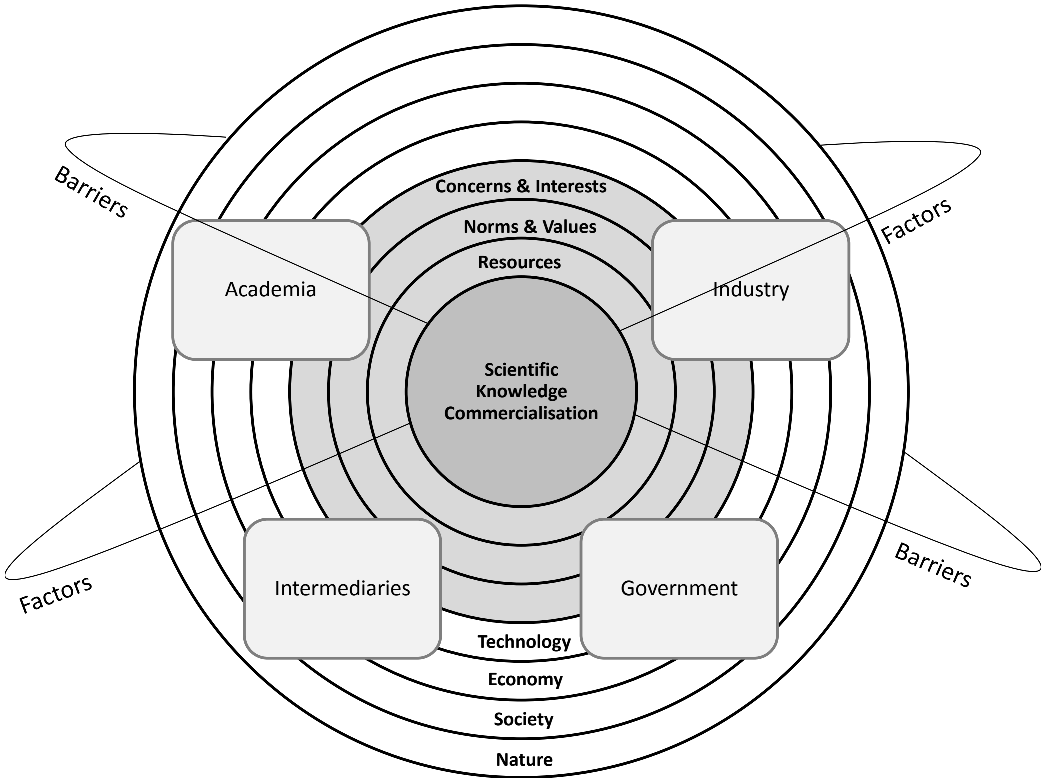
The findings section is, thus, presented in two chapters. The first chapter, Chapter 5, highlights the context in which the formation and management of collaborative scientific-knowledge-commercialisation networks is taking place. Chapter 6 answers the three research questions: (1) How collaborative stakeholder networks that facilitate scientific-knowledge commercialisation are formed, (2) why collaborative stakeholder networks are established for scientific-knowledge commercialisation, and (3) who establishes and manages scientific-knowledge-commercialisation networks. The findings are then discussed in Chapter 7. Chapter 8 concludes on managerial and policy implications, strength and weaknesses of the study and the contributions to the knowledge base.

5 The ecosystem of scientific-knowledge commercialisation - contextual drivers and impediments

5.1 Introduction

As proposed in the methodology chapter, stakeholder relationships are best examined within the phenomenon's real life context. In order to contextualise theory, it is essential to apply a multi-context perspective (Welter 2011) i.e. the ecosystem of scientific-knowledge commercialisation. Adopting an ecosystem approach to investigate the stakeholder relationship context, this study draws on the new St. Gallen Management Model to develop an ecosystem model of scientific-knowledge commercialisation. The St. Gallen Management Model states that management is not just the management of a firm, but a mode of operation: i.e. a system of tasks which are embedded in an environmental context (Rüegg-Stürm 2003). Under this lens, the commercialisation of scientific knowledge is a process and thus a mode of operation; an entrepreneurial endeavour that requires the management of a complex system of tasks which exists across different spheres (society, nature, technology and economy) and involves different stakeholders. The rationale behind the St. Gallen Management Model can be thus applied to the ecosystem of scientific-knowledge commercialisation. In addition, the issues of interaction (resources, norms and values, concerns and interests), which are relevant in the management of an operation, can be employed as stakeholder relations are of major significance to the commercialisation process and the formation and development of stakeholder networks. The scientific-knowledge-commercialisation ecosystem is presented diagrammatically in Figure 12 and its application is examined in the rest of this section.

Figure 10: The ecosystem of scientific-knowledge commercialisation



Source: own conception based on the St. Gallen Management Model (Rüegg-Stürm 2003)

The following discussion is based on the contextual environment and interprets the findings in relation to existing theory.

5.2 Interaction issues

Scientific-research commercialisation is a complex and heterogeneous process, requiring complex interactions between research suppliers, businesses who want to exploit the research, governments and investors. The transfer of scientific knowledge requires the involvement of several stakeholders and new partnerships between political actors, businesses and higher education institutes. As evidenced in the St. Gallen Management Model, stakeholders provide either resources and/or determining factors depending on the value added (Rüegg-Stürm 2003). The stakeholders interact in a manifold manner. Interaction issues, according to the model, are matters that arise between stakeholders during the commercialisation process and could pertain to ideas, tradable goods or rights. While concerns, interests, norms and values are personal or cultural aspects, resources relate to non-sentimental objects (Rüegg-Stürm 2003). Concerns reflect universal aims of the stakeholders; interests can be understood as self-seeking or self-interested behaviours. The observation of different values is essential so that stakeholders involved in the commercialisation process can evaluate concerns, interests and norms, where, according to social-exchange theory, norms are generally accepted behaviours or guidelines for interaction (Lambe, Wittmann and Spekman 2001). They provide governing mechanisms for relationships in order to guide actions of stakeholders and to minimise potential danger of opportunistic behaviour. Furthermore, norms help to create long-term relationships. Resources, as an interaction issue for stakeholders, can be tangible or intangible. Tangible resources are goods such as buildings and IT, etc. Intangible resources are know-how, licences, patents and trademarks. When looking at the development of stakeholder networks for scientific-knowledge commercialisation, it is important to look at diverse interaction issues that influence the formation of stakeholder relationships. Personal and cultural matters, as well as important resources, that can be hindrances or drivers are discussed.

5.2.1 Concerns and Interests

The findings indicate that there are several cultural challenges regarding individual interests and general targets which cause potential conflicts. These conflicts arise in various guises and manifest themselves in a variety of different ways. The willingness of the PI to commercialise and transfer technology was directly mentioned as a barrier to doing collaborative research projects by 19 interviewees, with almost all interviewees referring to this issue at least indirectly. The requirement for there to be an interest in engaging in and performing commercially relevant research was shared among all stakeholders with no differentiations being observed between Ireland and Germany or between different types of centres. Many of the academics cited this as a personal reason for not engaging in the commercialisation process. One Irish technology transfer manager stated that “if they don’t want to engage then there is nothing you can do”. This statement accords with the view that academics have. A German PI summarised the issue as follows:

> “The bottom line is that it all depends on your own impetus…my favourite proverb that captures it is *‘you can lead a horse to water but you cannot make it drink’*. If you don’t have an eye for a possible application or a market need the technology transfer office won’t be able to do it either. They only help you; the drive has to come from the scientist.”

In addition, the notion that only people with entrepreneurial capabilities will show interest in the commercial relevance of their science was evident. The identified lack of willingness of PIs to engage in commercialisation endeavours and the lack of entrepreneurial behaviour is in line with prior studies, which show the impact of personal motivations (O'Shea et al. 2004, Vohora, Wright and Lockett 2004, Zhao 2004, O'Shea, Chugh and Allen 2008) .

It is commonly acknowledged that a PI's motivation mainly derives from their desire to increase and enhance their publication output. The common parlance of academics was that publication of papers is the academic's real target. As Ndonzuau and co-authors (2002) point out, a 'publish or perish' driven university is disinterested in academic research commercialisation by nature and the relationship to money is entirely different in the 'publish or perish' driven environment. This view is corroborated by the interviews with nine separate interviewees explicitly stating that academics are motivated more by publication than commercial interests. In contrast to the motivations of academics, industry researchers are interested in short-term return on investment in terms of new insights for products or services, as postulated by the industry partners.

The short-term profit-oriented mission of industry conflicts with the long-term research-oriented goals of academia (Cyert and Goodman 1997, Polt et al. 2001, Jones 2006, Lockett, Kerr and Robinson 2008). While Ndonzuau, Pirnay and Surlemont (2002) are right to some extent in their assumption that a 'publish or perish' driven university is disinterested in commercial research endeavours, the results of this study show that it is mainly dependent upon on the PIs' personal interests. Of course, the "publish or perish" culture can directly impact on a PI's' personal interests (e.g. through incentive structures).

The causes of the conflict between industry and academic interests need to be thoroughly understood before they can be addressed. One of the German academics referred to there being an issue with the incentive structures, with one of the Irish commercialisation managers said that getting academics to think about commercialisation is difficult as the academics will not "make lots of money" by taking on the work involved in the commercialisation process. Instead that commercialisation manager observed the academics are under something more akin to a “social obligation” to commercialise at present.

It would, however, be an oversimplification to think of motivations as being driven purely by financial rewards. Researchers want to publish their scientific knowledge as it is connected to prestige, financial rewards and academic promotion (Goldfarb and Henrekson 2003). While reward structures can be put in place to promote commercialisation through financial rewards and promotions, the desire of academics to attain prestige in the academic community is a motivation that is more personal to each academic and cannot be addressed through financial reward systems. It is important to bear in mind, therefore, that while reward structures might influence PIs towards commercialisation, there are personal motivations, such as an inherent personal desire to publish in prestigious journals, that reward structures cannot address.

When considering factors that motivate academics on a personal level, it is interesting to note that the concept of academic freedom was regularly cited as being important. One German academic expanded on this point and explained that by giving “people more freedom to do things” and backing this up with incentives, entrepreneurial spirit was more likely to become evident. Similarly, an Irish academic believed that those that exhibit an entrepreneurial spirit should be given “freedom to be able to operate in some ways”. One of the Irish government agents observed that academic freedom is something that the Government should allow academics to have but went on to observe that some academics fail, when exercising that freedom, to make the link between the funding that they received and their obligation to generate commercially valuable research. The government agent went on to point out that funding should not necessarily be provided to academics where they do not show an ability to move away from an isolated interest in generating publications. Notwithstanding the comments of this government agent, the attraction of freedom to academics should not be understated. Rather than dismissing the desire of academics to work in an autonomous way, this could be a strong incentive in rewarding entrepreneurial behaviour.

Table 13: Sample findings – Concerns and Interests (a)

Interest & entrepreneurial spirit	• Get rid of the civil-servant-thinking; start being more entrepreneurial…give them more freedom to do things...give them incentives **(Academic G10)** • The best thing the State can do is to leave the academics alone, less administration. You just can't force people to think entrepreneurial. Either you are like that and you accept gain and losses or not. And that is the case in every society. The only thing you can do is help…and it doesn't work if it is done by a civil servant, civil servant pace is totally different **(Industry G3)** • It's almost entirely because [person x] head to the group likes to do stuff the industry is interested in **(COMM I2)** • Commercialisation… you need to want to do it. And you can't force colleagues and academics particularly, to do that. Some just don't understand it, others do. I think that those who do should be doing, given a little bit more flexibility to do it in certain ways. And maybe given a little bit more and freedom to be able to operate in some ways **(Academic I13)**. • The most important thing is for the person who is in charge of that piece of knowledge to be committed to the commercialisation **(Academic I7)** • Either you are such a person who wants to do it and who is willing to invest time and energy into it or you're not and a project will only get through if you are such a person. If you aren't such a person there is nearly no hope for the project at all, because people are just too different…so if there is some sort of resistance from one party or the other…I mean I can go and speak to an industrial people and if there is a resistance there, it won't fly, and likewise people from the industry can come to speak to me and if there is resistance there, the project will not take off **(Academic I12)** • The bottom line is that it all depends on your own impetus…my favourite proverb that captures it is 'you can lead a horse to water but you cannot make it drink'. If you don't have an eye for a possible application or a market need the technology transfer office won't be able to do it either. They only help you the drive has to come from the scientist **(Academic G1)** • I would say it is always a matter of people and not funding. I have seen institutes where the manager is doing spin offs, technology transfer etc. where it just works and then there are some where it doesn't work independently of the funding. People who don't want to do that will try to get funding from the DFG [basic science funding agency], while people who are interested it will try to get money from others such as BMBF, AIF and other research funders [give also funding for applied science projects] **(GOV G2)** • Ideally you are working with people who really want to see the stuff commercialised and then you've got both sides covered. If you're dealing with good technology and the people aren't treating it in the same way they would with the basic research project, there's little point **(GOV I3)** • There has to be some form of entrepreneurial spirit …you need to want to do something commercially relevant **(COMM G1)** • It will only work if somebody at a university has entrepreneurial capabilities… a researcher who has no entrepreneurial capabilities will not do something even if the technology transfer office is holding his hands **(Academic G5)** • The main inhibitor would be you know other priorities directly ahead of you so if you need to write proposals or papers or develop work in the project then you're unlikely to get that time to commercialise right…a much bigger priority now is publication. That is the challenge…is commercialisation of interest to some extent for individuals? I think it's a people problem first and most of all right? I think that if the person who is doing it doesn't want to do it or wants to go and do something else it is very hard to make it happen **(Academic I7)** • Part of it is who's going to do this commercialisation? I mean I'm a professor of physics, I'm not trained or qualified and truth be told, I am not interested in starting a company; others are, I'm not. So who's going to do it? Perhaps the post docs, perhaps the post grads, they don't know anything about it... publication of the paper is the academic's real target…if you force them to fill out an invention disclosure form for something that they know will never go anywhere you're building up a lot of resentment. **(Academic I9)**

	• The interest of professors to patent is nearly nil. It's a mentality question…I wouldn't research something if I'm not interested. **(Academic G10)** • To be fair the government in some ways is asking the PIs to do something and some of the PIs just don't like …if they don't wanna get involved in commercialisation…we say 'well that's fine, just don't come and apply for any of our funding'… You gotta distinguish between the TTO's and between the universities they're interests aren't always aligned. Effectively it gets back to PIs are in a very unusual situation. In fact there's very few other jobs around with academic freedom and what a lot of them are saying is that the government should make money available and basically and let them publish and then that's it…but that doesn't necessary mean they should get it? **(GOV I3)** • The availability of entrepreneurs and the willingness for example of Post Doctoral researchers or the PIs to undertake the entrepreneurial activities. They would have to have a wish to do that; I mean you can't force researchers to entrepreneurial activity **(GOV I1)** • You've different roles between industry and academia. Academia, they have publications, their load of the basic science research. I think the industry have the pull of the more short-term. They need the products they need to get those out so it's rare that you would have a relationship that doesn't have kind of some issues or road bumps **(GOV I1)** • Sometimes you get so frustrated; not because you've got an industry partner coming in with something and you've got the PI just saying that they're too busy. Sometimes the research is very focused on an individual and if they don't want to engage then there's nothing you can do **(TTO I8)** • A lot of the time the academic doesn't want to leave or doesn't even want to start a company. They don't want to be involved **(TTO I7)** • Some of them have been successful in turning from being semi-gods to [doing commercial or applied research] **(TTO I2)** • The most difficult problem is the divergences in concerns. So there's no question it can be very difficult to get some of the graduate students or even some of the PIs as excited as the company would like them to be about their problem. So it is about trying to make sure that you get this balance between science that motivates the research teams as well as science that delivers for the company. And that's a very difficult thing to achieve. I think you've got two very different cultures. What dictates the success for an academic is different **(COMM I5)** • Move the academics away from thinking about publications and academic stuff to thinking "I can start the company." I can't get them to think about it in a realistic way and they are not going to make lots of money but that it's a social obligation **(COMM I2)** • Academic researchers want to publish, want to be respected in their field. And progress to a career and it isn't always in their interest to actually work on a single piece of technology for a sustainable period of time in order to embellish its commercial potential. They are better, they prefer to do an experiment, publish a paper and move on, which leads to technology limbo **(COMM I1)** • Industry tries to get out as much as possible for them **(COMM G5)** • Technology transfer has here a novercal existence… loads are not even interested in transferring results into some products or services but rather to publish as many publications and get citations as possible **(COMM G4)** • The university is still a group of academics who's primary concern is academic things. Their primary concern isn't industrial things, they don't understand industrial things, they need to get out of that mind-set. I'm not saying that they turn it into a, maybe they should turn it into, a Calltech or something like that where people do think about industrial things. But, yeah, I'm a scientist I love the science but it has to be funded and … they are primarily academics. People at the top don't have enough industrial experience…Academics have a tendency to take the government money and back off into their ivory towers and you can't get the door open…I can see now after two/three years of very active working with them. Some have stepped out and realized that there are both things to do. But they're a few basically don't venture out of the tower very often, come out lay, down a bit of sarcasm and then bugger off back to the tower again **(Industry I4)**

The study identifies significantly conflicting views on the length of time that should be afforded to a research project. The conflicts of interests in this area appear to be at least tripartite. As noted in various places in this study, but particularly in Table 16 [applied v basic research] below, academics are generally motivated by a desire to conduct basic research. Basic research can take considerable periods of time, with two interviewees citing 50 years as a potential timeline. These timelines can apply to applied research, depending on the sector that the research is being conducted in. From the interviews with academics it seems reasonably clear that their preference would be for research projects to have time horizons of 10 years or more. As one academic puts it, the investment that is required from the Irish Government appears to be “an inter-generational, a multi-generational investment”.

In contrast, the interviews with industry partners show that a primary concern of companies is the time that will take to get the research to a stage where it can be marketed. From the perspective of the industry partner, the shorter the project takes to generate a result, the better. As one German industry partner put it, “In universities it’s about years and remote future; here it is about days and near future”.

The position is further complicated by the expectations underlying government policy. Two Irish academics referred to the pressure that the Irish Government, represented by the government agents, is exerting now that it has provided sustained funding for 10 years. Similarly, a centre manager noted that Ireland is relatively immature in terms of its focus on funding research and that more mature countries have been funding research for up to 50 years. It is not clear whether these expectations were present when the funding policies were drawn up or whether they are a manifestation of pressures on funding caused by the recession. One Irish academic speculates that “the agencies as a whole have retracted back because of the funding situation”. Regardless of the cause, concerns were expressed at the pressure from the Irish Government to focus on applied research to the direct detriment of basic research.

Table 14: Sample findings – Concerns and interests (b)

Time horizon	• We fund projects for the companies that should be driving the research agenda and they want more control of over what is gonna be done and they usually will wanna see near-term return on the investment in terms of new insights for their products or new products or due processes or whatever **(GOV I4)** • Companies have their own problems, their own targets, each want to look good. **(Industry I1)** • Academia is viewed kind of… as playground, right, with less project management focus. So when I go to work with academia I need to be very milestone deliverable focused, right? And academia really doesn't really want that. So there is a clash of interest there, right. Academia it's all about science, research development, no time records right? Whereas in business it does it's very important. So you're there's always that clash in time and deliverables … that's a major barrier **(Industry I3)** • I was thinking we could do loads of collaborations…but I had to learn that the time constant is completely different. In universities it's about years and remote future; here it is about days and near future **(Industry G3)** • Ireland's still very immature when it comes to research. We are only funding research in a serious way for a decade; less than a decade. And realistically you're playing catch up with countries that have been doing this for 30, 40, 50 years….Now [after funding got reduced] I would say there is a lack of clarity around that. I would think there's been a forced de-emphasis under the quality of the research from SFI. They have failed to articulate why it's important that Ireland continues to do really high quality basic research. I don't think SFI as an organization doesn't believe that anymore. But I believe they don't know how to tell that story politically to get the support to do it. And I think there is overlap now between what SFI and EI are trying to deliver. **(COMM I5)** • They [SFI] are shifting towards more applied science…It could create problems in the future because you have less people working on… fundamental research which is very risky so you need put a lot of money in and the return is not for five years or ten years it's potentially 20 years…if you don't have the fundamental research being funded then you're going to somehow stop during the pipeline with all these potential that could become applied research. So for example if we do something with Enterprises Ireland…and we're looking for money to potentially set up a company… But I'm starting to worry that if we apply for this once and we don't have success with the company they might not fund you again. Whereas my opinion is that you should be, they should like fund lots of these they need to fund hundreds of them to get a few successful outputs. And they shouldn't say because we funded one and it wasn't a success we're not gonna fund anymore. The view that like a lot of business people talk about….. you know failure shouldn't be viewed as a bad thing, it should just be viewed as you learn you've got the experience so next time you're more likely to be successful. Whereas here if you could get money from EI and didn't end up with a successful spin out company. They look at you like well we're not gonna put you in again, we are not gonna give you anything anymore **(Academic I4)** • First of all the government agencies have to completely rethink their notion as to how innovation works. I mean there're claims being made that we've invested for the past ten years in…such as Blue Skies fundamental research and now it's time to stop doing that and to reap the harvest. So basically we sow plants for 10 years and maybe the vineyards are good, which takes about 20 years before you've got any grapes at all right? But anyway so we planted this wisely, we believe, and now we're going to just take all the resource and put it into harvesting. But if you do that then there's no harvest the next year. And so they just don't understand this and they also don't understand that the same people that do the fundamental work, they're the same people that do the applied work. It's the same side it's just one coin with two sides. And they don't understand that. And because it's a value proposition… for researchers that to get engaged in solving problems means you have to understand the problems and that relationship, that value proposition is hugely important to researchers. I mean if they are actually just involved in a proposition where they solve

	problems that other people define for them, that doesn’t interest them. They want to be able to understand how to really change and define problems and new opportunities.…I think the agencies as a whole have retracted back because of the funding situation and they have no idea what the cold face looks like. SFI has gone into policy mode, worried about justifying policy rather than worrying what’s actually happening in the labs, the people working for SFI have no freaking clue about the sciences going on in the labs. It’s not peer reviewed, it’s the biggest joke ever….But actually what you see is a shit lot of companies and this companies they are all there because the university facilitates the companies being there. It's not the IP that they produce it's because they are universities, because they are facilitators in innovation and if you don’t' get that you don’t get what universities are about. And actually they don't get it **(Academic I8)** • An intelligent government would understand that actually the investment that you make now is a multi-generational one. We know that's true for investment in the education system, we don’t expect a return from an 18 year old or a 22 year old, what we expect is a return from that investment over their whole working life which could be 50 or 60 years. And that's where the return should come, and we should be thinking about investment and research in exactly the same kinds of cycles. That it's an inter-generational, a multi-generational investment. And the return will be there **(Academic I11)**

In addition, conflicts in interests arise as industry partners' foci change more rapidly than in an academic setting. Company takeovers, changes in the board of management as well as strategic management decisions influence the motivations of companies. That this occurs and that it is a problem was accepted by industry partners. An Irish industry partner indicated that:

> "Motivations and industry change very quickly…our whole world in [Company X] changed yesterday because [Company Y] bought our main competitor. The landscape is completely different this morning. People are revising their entire strategies that we thought of yesterday… flushed down the toilet. So it's a different world this morning …There are so many constituencies involved and it's very hard to get a common direction".

The differences in motives between industry and the universities are not something that can be addressed directly. These motives are deeply embedded and expecting that they can be changed would not appear to be a reasonable proposition. That industry partners are commonly perceived to engage in sweeping changes of strategy that undermine research is something that must be borne in mind when contracts are being drawn up at the initial funding stage.

Table 15: Sample findings – Concerns and interests (c)

Motivation/ **strategic change**	• Companies change direction, they change focus and you know particularly with a five year research project. You have to understand that that's gonna happen as well, so you know what maybe a great idea four years ago may not be the best idea today **(TTO I1)** • [Company] went through major changes; they went through major direction changes, staff changes. It was a company in flux to a certain extent. And I don't think even if all of the deadlines and all of the stuff had been met, I'm not sure that that would have made any difference **(Industry I2)** • Motivations and industry change very quickly like our whole world in [Company X] changed yesterday because [Company Y] bought out main competitor. The landscape is completely different this morning. People are revising their entire strategies that we thought of yesterday… flushed down the toilet. So it's a different world this morning …There are so many constituencies involved and it's very hard to get a common direction **(Industry I4)** • The other thing that needs to be managed is expectations. If you draw a parallel between say corporate research environment and academic research environment, corporate research environment people understand that they are there to do certain research for the benefit of the organization. Academic tend to think they are there to do research for their own benefit, and they don't all see the benefit of economic development they don't understand economic development. And you know for the most part they see the research funding that they are being given all along the lines of stuff they can use to build their own careers, and that's not always helpful **(GOV I5)** • So some companies, it depends a lot on their, on what they're focusing on at the moment. But then the last years they became less interactive because they, they'd changed the focus the company. And the whole company basically was saying we're focusing on this for two years **(Academic I4)** • The difference between industry and academia is that their targets can shift … in industry all of a sudden there can be a decision from the top that this division is gone or that that new product will not be rolled out and that can have a huge influence on what research is being done and hence… it has an influence on what we are expected to do **(Academic I9)** • Industry research has, since the mid-nineties, little basic research. In our fast paced life only product development is important. That nearly doesn't exist anymore **(Academic G10)** • A barrier is, for example, company takeovers. They can stall long-term projects **(TTO G2)** • The best combination for us is the, we are in control of the direction of the research. But we need to get out and talk to industry and companies and see what they think. Get their advice, get their direction. If there are things that we think are appropriate that we deviate so that we can better fulfil the industrial need then we do that. But we still operate in a much more stable environment that the mood of a company, if it's changed or their priorities have changed, wipes you out and then you are off doing something different **(Academic I1) response to strategic change**

The results suggest that there is a divergence in concerns. There is a difficulty in getting the PIs interested in an industrial research problem. An Irish commercialisation manager explained that it is about getting “the balance between science that motivates the research teams as well as science that delivers for the company” right. The findings indicate that stakeholders value the type of research differently.

The study finds that there is a conflict of interests in terms of the type of research that motivates academics and that which industry wants to pursue. A German multinational industry partner explained that:

> “the academic often struggles when you ask them to do a certain thing…they always say ‘I am not a developer or the predevelopment unit for you, I want to research, I am an academic’”.

Some academics, on the other hand, see industrial research as engineering work where understanding the problem is not important. One Irish academic referred to it as a:

> “brute-force approach where they just make a gazillion measurements and hopefully one of them will work. That is completely the opposite of what we do. So, immediately there is scope for conflict.”

Almost all academics expressed their interest in doing basic or fundamental research and pointed out that this is a prerequisite to doing applied research. An Irish excellence centre manager, while stating that the majority of the research within the centre would be fundamental research, said that you have to have a portfolio approach. He explained that “if you are not doing basic research within a university you have nothing to bring to the table in your discussions with the company.” Industry partners also recognised the need for basic research and even referred to the collaborative research projects as basic research projects. One German industry partner stated that “it is fundamental research, as opposed to product or technology development, that we do in-house.” The industry partners, however, highlighted that a key problem lies in the identification of when collaborative research is feasible. One German industry partner referred to it by saying:

> “the negative touch is that there are risks too and that was missing [when we were talking to the promoter] they were always close to the break through and the world revolution was just yesterday. “

Industry partners claimed that PIs are often overenthusiastic and naïve about the feasibility of a project which can lead to disappointment. This point is looked at in more detail in Section 6.2.2 below.

Table 16: Sample findings – Concerns and interests (d)

View on applied vs. basic science	• I think you have to have a portfolio approach. If you're not doing basic research within a university you have nothing to bring to the table in your discussions with the company **(COMM I5)** • It is fundamental research as opposed to product or technology development that we do in house **(Industry G6)** • We would consider more fundamental than applied **(Industry I6)** • The academic often struggles when you ask them to do a certain thing…they always say 'I am not a developer or the predevelopment unit for you, I want to research, I am an academic'….this is understandable…but if he needs money then they are suddenly interested…if they don't need money then they won't do it, they then do want they like to do…I think that industry and academia could meet better if they acknowledge the interdependency **(IndustryG4)** • Predominantly they are basic research centres **(GOV I5)** • You have to do original creative research and only when you make some new discoveries do you then enter into a situation where something really worthwhile can be produced **(Academic I5)** • What the problem is in industry they don't always work that way. In many cases they may have engineers that solve problems and then understanding is not often driving factor, it's what we would call a brute force approach where they just make a gazillion measurements and hopefully one of them will work. That is completely the opposite of what we do. So, immediately there is scope of conflict and that has to be managed very carefully …If the academic researchers do what they're good at which is really understanding the fundamental science of whatever the problem is and then that understanding could be applied to solving the problem that industry are interested **(Academic I9)** • I don't believe in the basic-applied divide…Basic science isn't irrelevant science; it's science has a particular context. Like when we work with particular materials or systems, we do it not because we just think, "what I'm going to work on today", just pull it out of the air. We don't pull it out of the air. We pull it out because this particular material, we think is has got distinct properties and we want to understand how do you exploit these properties and how do you tune the materials to get better properties, okay? But once you've done that you say what will you do you do with it? And so we say, well that's interesting for maybe this partner over here and then we try to form a relationship between the industry partner and this new material and so all of our PIs that engage in fundamental science and work with industry in addition **(Academic I8)** • I have to say my aim is fundamental science but with a view on the applied side of things **(Academic G1)** • Fundamental and industry related science has to complement one another **(Academic G9)** • It is not of interest to the university to improve a product or do engineering type of work, how I should say it…contract research **(Academic G10)** • It is applied basic science **(TTO G3)** • The answer of professors is again and again we are an extended work bench…we want to do research **(TTO G4)**

5.2.2 Norms and values (institutional-culture)

The study aimed to draw out the norms and values that impact on the stakeholder network. These norms and values exist both at a macro level (i.e. the stakeholders in the network) and micro level (the individuals representing those stakeholders). In order to understand the context to stakeholder networks, it is necessary to have some appreciation of these norms and values. It is also important to understand what each stakeholder perceives to be norms and values that exist in other stakeholders.

In a German context, the prevailing perception of industry partners is that universities in Germany continue to operate as ivory towers. German academics, especially in natural science, are perceived as arrogant and detached from the real world. The view is that they do not take the research required by industry partners seriously. German academics in the engineering and IT sector are viewed as the exception, as illustrated in an engineering context by the following summary from a German academic:

> "within the biotechnologies people say that the faculties are like ivory towers. This is not the case anymore in engineering…not for years…they sorted that out long time ago. We differ from the natural sciences in a way that we are willing to compromise on our results…we want things to work and not to understand the problem in all little details".

This explanation indicates that the interests of engineers and academics in the information and communication technology (ICT) sector are more aligned with their industry partners than in other sectors. Taking the engineering sector as an example, this view is not surprising given that German Ph.D. students traditionally work in sectors such as the automotive industry and are therefore integrated into industry from an early stage. Mangematin (2000) also finds that this is particularly true for the engineering sector. He observes that if collaborations with industry are not encouraged during the Ph.D. phase, contacts between academia and industry will be reduced. Mangematin and Robin (2003) suggest that Ph.D. involvement should be encouraged in the life sciences.

It is interesting to see that this 'ivory tower' perception does not appear prevalent in Ireland and that just one Irish interviewee mentioned this point. While this is discussed in more detail in Chapter 7 and 8 below, one explanation for this difference might be that there are different funding structures in both countries. Almost all funding agencies in Ireland require some industrial engagement. In Germany, PIs can just apply for basic research funding and are, thus, not dependent on industry partners at all. Another explanation might be, as one Irish centre manager stated, that:

> "the hunger that we have that's different from the hunger of people in the US. I think this is very important. Individual scientists, what they say is 'I've got to do my research anyway; somebody else will take care of that [commercialisation]' and in the US it works; why? Because it's a big country. And statistically the job will get done. But in a small country like Ireland I am dependent. The guy next door, each of us is individually dependent on the success of national funding in Ireland. That's a very heavy obligation and so that's really quite different and because we are responsible we understand that we can't, even though we might say we'd like to do just basic fundamental science. We know, if just everybody does that, it's not going to work. We know we have to look at the full commercialisation pipeline and that's what we do and our PI's understand that. That's what I call the value proposition…we will provide you access to the best funding in the world, the best facilities in the world, hopefully the best students we can find in the world, but you have to do the best science. But, in addition you have to also do some of this commercialisation stuff. And that I think is the way forward".

The ivory tower behaviour of German academics was also observed when setting up the interviews. While one might expect that it is easier to get in contact with and agree participation on research with academics, it was the industry partners, including multinationals, that made themselves more readily available than PIs. Conversely, there was little difference between the attitudes of the various stakeholders when setting up the Irish interviews and the Science Foundation Ireland (SFI) proved most difficult.

Table 17: Sample findings – Norms and Values (a)

Ivory Tower view in Germany	• The problem at universities is that the professors and working groups are like princedoms or the professor is the boss and everybody else is a slave. You have to try to get these big egos to work together **(COMM G1)** • The universities are structured to do mainly basic science…I am from England and there it is split 50-50. They do basic and applied science…and there is heaps of money, especially in chemistry…but here in Germany, I still get the impression that universities persistently adhere to the basic principles. We say professors live in ivory towers. I think you should know exactly that when you ask for money from industry that you have to adhere to certain rules and do certain things respectively. Some professors see it as if they have to prostitute themselves….but if I do something applied then I have to understand that there are certain rules of the game and market influences that dictate it…if you cannot accept it then I shouldn't do it…. What they can really get rid of is this arrogance….the 'we know everything better' arrogance. **(Industry G9)** • Some professors get together in their academic ivory towers **(Industry G10)** • I got the impression that it is a self-aggrandisement instead of wanting to hear the problems in a real world **(Industry G7)**

As mentioned in the literature review above, the third mission (i.e. the entrepreneurial role) has become more important to universities. The implementation of this third mission involves the changing of certain norms and cultures within universities. The difficulties with creating a 'commercialisation culture' within universities were frequently mentioned by interviewees.

The lack of an anchored philosophy within the institutions is a major obstacle. There was common agreement that technology transfer and the commercialisation of scientific knowledge should be valued by the institution. Clear commitment from the university is regarded as being essential. At the moment, technology transfer is perceived as an incidental matter rather than part of an environment where people are given the freedom to innovate. There is tension between the traditional university missions of teaching and research and the new third mission. Some argue that the universities' objectives should not be profit driven and that the commercialisation of IP could damage the university's standing in society (Bok 2004, Nelson 2004). Commercial activities are sometimes even seen as a threat to traditional academic freedom and basic research, a strain on independence and differing interests (Etzkowitz 1998, Etzkowitz, Webster and Healey 1998, Polt et al. 2001, Nelson 2004). While some individuals in academia might still hold this view, time has moved on and scientific-knowledge commercialisation is, at this stage, practically always required by governments. Technology transfer and commercialisation should, thus, be put forward as an aim of the university that has equal importance to teaching and research. The findings suggest that certain aspects and characteristics of the university influence the reasoning of scientific-knowledge commercialisation and will influence peoples' behaviours. As Clark (1998) points out, universities have to take an entrepreneurial pathway in order to be prepared for the future. Clark's view was evident in the interviews, with one Irish centre manager summarising the position as follows:

> " It's about the team that's working on that project all understanding the importance of how we value that relationship and getting the communication right…it's about creating a culture within the centre…industries are never going to come knocking at your door, you've got to get out. I mean [university] claims that innovation is now the third pillar of its activity along with research and education. But it's currently not set up in a structured way to enable that. So I think there is a massive amount the universities could do better".

Thus, while universities are conscious of the need to embed the third pillar in their culture, the interviews suggest that this is not being done. Against the context of the failure to embed this culture, it is easier to understand the comments made by the interviewees regarding conflicts of interests between stakeholders. This is discussed further in Chapter 7 and 8.

Table 18: Sample findings – Norms and Values (b)

Value of third mission – anchored philosophy in the institution	• A problem is that industry here and elsewhere have no long-term strategic research units anymore. It's too expensive. But you have to give an adequate bunch of people enough creative space; technology transfer is to create a culture where people have enough freedom to be creative, to innovate and then realise and transfer it **(Academic G6)** • I mean, industry looks to get the best deal wherever they are, okay? I think this is something Ireland doesn't quite understand. If I'm in industry and I want to engage in a certain activity with a university. In principle, if I am an important company, I can work with any university in the world and they are looking for the best deal and so the only way you can compete is if you have an infrastructure that's world class and we've built this facility to be world class and you have PI's that publish in place so that people recognize that they are world class and then they are attracted, okay, but then you have to compete with Harvard and MIT and the Max Plank and you have to demonstrate why it's good value **(Academic I8)** • Get rid of the civil servant thinking and start being more entrepreneurial…give the people more freedom to do things...and give them some incentives **(Academic G10)** • You have to start looking at change as part of the culture in the universities to be honest. I think that's one part of it. The mind-set. **(TTO I7)** • The most important aspect is to create an environment for technology transfer at the university **(TTO G3)** • What you find is that there is definitely an inconsistency across the universities so they'll say they support tech transfer but you find out they don't put any form of budget into it. So if the president of a university is committed to it you can be sure a lot of these academics change… the bigger the height and the bigger the threat or the carrot or the stick the more people will change **(TTO I2)** • The provost could appear to make technology transfer more important. If you look at international universities, technology transfer is always a central tenet for the chair and not an appendix of the administration **(TTO G2)** • The overall opinion is that technology transfer has no standing. To put it mildly, there are some people who just say "why do technology transfer?" **(TTO G3)** • I think that you have to start looking at change as part of the culture in the universities to be honest. I think that's one part of it. And the notion that academics to a large extent think "well, I'm professor such and such, it's my God given right to be given all this research money to do what I want" ... The mind-set. So in terms of recognition, so recognize innovations as researching duty, I think is a key part of it. **(TTO I 8)** • Clear commitment [to technology transfer] from the university is indispensable, it is extremely important **(TTO G5)** • [In universities] money and industry are something dirty **(Industry G2)** • Commercial awareness of the institution [should be present] **(Industry G12)** • The best thing the state can do is to leave the academics alone, less administration. You just can't force people to think entrepreneurial. Either you are like that and you accept gain and losses or not. And that is the case in every society. The only thing you can do is help…and it doesn't work if it is done by a civil servant, civil servant pace is totally different **(Industry G3)** • Open mindedness, acceptance has to be increased…the most important thing is that the people in the university, the scientists, researchers, professors become more open minded. That commercialisation is accepted (**COMM G4)** • It's about the team that's working on that project all understanding the importance of how we value that relationship and getting the communication right…it's about creating a culture within the centre…industries are never going to come knocking at your door, you've got to get out. I mean [university] claims that innovation is now the third pillar of its activity along with research and education. But it's currently not set up in a

	structured way to enable that. So I think there is a massive amount the universities could do better **(COMM I5)** • One major aspect that is really important to us and that we expect and which is part of the whole excellence initiative is to create sustainability. We expect that the universities will continue financing the professors that we finance through the initiative at the moment. That the university is committed **(GOV G3)** • Important is the creation of a transfer friendly climate and structures as well as the creation of incentives **(GOV G4)** • Like there is a lot more to be done like there is you know with regards you know education and training and you know. I think a lot of the time when people look at us as funding agencies you know they’re actually afraid to approach us you know and the thing is in most of the funding agencies people are actually very personable…So I think like from the researcher’s perspective if they can if they feel that they can approach us even more readily then you know things would actually improve quite a bit as well **(GOV I2)**

In addition, the study suggests that inadequate incentives are a major barrier created by institutions. In order to enable technology transfer to become a central value in a university's culture this failure to incentivise commercialisation has to be addressed. Almost all academics in both countries highlighted that being involved in collaborative innovation projects and working on technology transfer activities is additional work that is not incentivised as it should be. This view was shared by many industry partners, technology transfer officers and government agents. As a result, despite the mission statements from universities stating that the entrepreneurial role is a central pillar, this is not reflected in the incentive structures of those same universities. A statement that summarises the academics' view is that "Technology transfer is an element of our work that is actually not worth your while." One German TTO manager summarised the issue as follows:

> "[They] have the full load, research, teaching, administration, self administration and so on. I think the biggest barrier is that the researchers are already drowning with too many tasks and unclear priorities…Technology transfer is not research and that means it is an additional task. So it shouldn't come as a surprise that the average researcher does not adopt this task. They might not even know what it means… so why should they saddle themselves with an additional task."

The failure of universities to properly incentivise commercialisation appears to be giving rise to a certain amount of resentment. While they may not be satisfied with the failure of academics to engage in commercialisation activities, many stakeholders fully understand the academics reasons for this failure.

Scholars (Australian Research Council 2000, Goldfarb and Henrekson 2003, Siegel et al. 2004, Lockett, Kerr and Robinson 2008) criticise the dearth of incentive structures as they regard them as hindrances to the commercialisation of scientific knowledge. The results of the study, however, suggest that monetary incentives are not the most prominent ones, but that non-financial rewards are regarded to be of utmost importance in changing the PI's attitudes towards technology transfer and commercial activities. As pointed out by an Irish PI, "universities' promotion structures do not value commercialisation activities". Government agents, as well as TTO managers, explained that PI's sacrifice or hinder their research careers as only teaching and publications are considered for promotions and universities, therefore, have to change their policies. An Irish industry partner even referred to it as a 'PI's hobby'.

Table 19: Sample findings – Norms and Values (c)

Value of commercialisation – lack of incentives	• And at the moment innovation is not rewarded in any way so if you are an academic and you spend time doing innovation, we’ll only publish all your papers **(TTO I8)** • One of the problems here in this university, and probably other universities as well, is that promotion requirements don’t technically include commercial outputs…If it’s holding back your career, why get involved in commercialisation unless you are interested **(TTO I7)** • The irony of it is, if you were a researcher, in most cases I’m negotiating the commercial terms on your behalf; I get nothing out of a good commercial agreement or a bad one, so if I give it away, no effect on me. If I make millions of Euros it all goes to the researcher or the school or the university… Researchers get no credit for commercialisation so what the hell are you gonna do commercialisation for. So the metrics drive the behaviour. **(TTO I2)** • Give professors an incentive if they are doing technology transfer… the more technology transfer affine a professor is, the more of an award he should get **(TTO G3)** • The basic intention of a university, a research institution, is to do research and they should do research. Technology transfer is not research and that means it is an additional task. So it shouldn’t come as a surprise that the average researcher does not adopt this task. They might not even know what it means…and it’s difficult enough to consist in their research areas…so why should they saddle themselves with an additional task **(TTO G1)** • There has to be a process of rewarding recognition for those academics who spent the time and make the effort to engage in technology transfer because not all of it will be successful…you have to give people credit for the effort and recognize the commitment; there has to be a process, especially with younger researchers, of ensuring that the promotional opportunities within academia are not negatively affected by the lack of papers that might occur during the technology transfer project….I think the university has to change its policies… start to recognize the commercialisation of technologies… there has to be recognition that it is an important thing to do… nationally **(TTO I4)** • It’s [commercialisation] not recognized yet as the same part of applications at all **(TTO I6)** • They don’t get promoted on the basis of a company being happy with the research that they do. They get promoted on the basis of the quality of their teaching, the quality of their research output and their international reputation for what they do. And they're quite different metrics from what a company’s looking for. So it’s about trying to create a balance where everybody wins from a programme and that’s not easy to do. **(COMM I5)** • Universities’ promotion structures do not value commercialisation activities; so, for example, to me a patent is much harder to get than a journal article and very few people entirely would appreciate that. Even just creating something by research, you could say a journal article or a patent and I would say they are equally valuable outputs, never mind about all other the stuff about administration and teaching even within judging research career, the universities don’t generally do it well enough, so many things, like licenses, to me they are very hard things to achieve but they are not hugely valued. The last point then is that financially, universities, this university for example, has a policy on what funding comes back to research institute, let’s say from a patent or a disposal of the company, a spinoff company and what funding comes back to a department or research group and to the inventor themselves. It used to be better in this university; and now it's going against the inventor and the institute that created it. In my opinion, the more money that you can show flowing back to the people who created the IP and exploited it the better it should be in the long run. That's an issue for university policies but it is a reason…These are all reasons why an academic or research team should not get involved with commercialisation **(Academic I6)**

	• The internal barriers as an academic you are not really… Certainly the company is not in your contract, your contract is teaching, your contract is administration, your contract is research. So am I meant to set up a company? I don’t think so. I think my job is to do research which could potentially result in a company being set up but at there is a certain age where I would need to transfer that technology under research we developed out to a commercial partner or out to a person in my lab who wants to commercialise it. And that’s where generally the problem lies. The research is taken to a certain point but then who actually takes it the step further in, like, developing prototypes, marketing, that type of stuff that we don’t have any experience with and we don’t have any formula to get people to do it … If there was the potential or the funding available for people to, you know, take their ideas and set up companies. But you won't find many permanent academic staff who are going to go through the ideal of leaving a permanent academic job to set up a company that may or may not work **(Academic I4)** • The motivation for a researcher to patent something is close to zero. We do that so that PhD scholars can put it into their CVs….even if we are able to commercialise a patent, our employee invention act is construed that it is not worth the effort. Furthermore, the structures in the federal republic are totally different than in the USA. I have a patent with an American university and they have patent offices there where real patent lawyers are. And it is so attractive for them that they rather work there than becoming self-employed. It is different here. I am not sure what they get. But I guess that a patent lawyer wouldn’t get up in the morning for that **(Academic G10)** • [Technology transfer] is an element of our work that is actually not worth your while…maybe if look at it from a long-term perspective and you do it on a regular basis you might get a return **(Academic G7)** • In addition, realise that universities are populated by smart, creative people who, if the appropriate incentives are built into the system, will do brilliantly **(Academic I11)** • Another barrier there is that senior academics are not paid and they are not valued in any form by the funding parties, by the government, by the SFI for what they do; so basically its hobbies, all the senior PIs…the researchers themselves are paid, the post docs are paid but the PIs who actually hold the whole thing together, are not paid in any way to do this **(Industry I4)** • It is not valued in universities so far, it really isn’t … So people are willing to kind of sacrifice the publication of their work to actually work in the commercial potential of their work. And it does tend to be a hindrance more than anything else. It’s strange in a sense too, because we… you know we rate people on their academic brilliance and not on their commercial awareness **(GOV I2)**

In line with the universities three missions, academics see their work norm as breaking down three basic areas, those being research, teaching and commercialisation. The balance between these three different activities is constrained by administration. Academics view their administrative workload as the biggest operational inhibitor. They also expressed concerns about the bureaucratic and inflexible nature of universities.

While operational inertia of universities is a widely discussed barrier that hinders the efficient and rapid commercialisation process (Polt et al. 2001, Walter 2003, Siegel et al. 2004, Walter 2005, Berman 2008), the findings suggest that high levels of administration actually inhibit the technology transfer process from occurring. A German academic stated "I have stopped engaging with patents because the bureaucracy is so dreadful...I want to do that because it is fun and not masochism". Similarly, an Irish PI referred to administration by saying:

> "Barriers, I think time is an important aspect; when we see the paper work of things…I give you an example, I mean I actually applied for a grant once and I got the grant… I think it was about six weeks. It took me about eight months … just to try to get it accepted here. And this was even before we've done a single experiment."

The results appear to indicate that while universities expect academics to embrace the commercialisation activities arising from the third mission, academics feel that the universities have not addressed the additional workload that this new mission entails. The academics' view is that the administrative burdens connected with the third mission mean their current workload is unsustainable. As a result of this unsustainable workload, academics struggle to balance their activities. A consequence of this struggle is that some academics will prioritise the tasks that they are expected to carry out. This prioritisation of tasks will be influenced by the system of incentives that universities employ. As noted above, the perception is that universities have failed to incentivise commercialisation activities, thereby leading to these activities being given a lower priority than other activities. In that context, the reticence of academics to balance their activities in such a way as to accommodate commercialisation activities is not surprising and was a strong trend among interviewees. It is worth noting that this trend was noticeable in both Germany and Ireland and that the views expressed were quite entrenched.

Table 20: Sample findings – Norms and Values (d)

Job norms – balance different activities	• Barriers, I think time is an important aspect; when we see the paper work of things…I give you an example, I mean I actually applied for a grant once and I got the grant and the grant was accepted within, I think it was about six weeks. It took me about eight … just to try to get it accepted here. And this was even before we've done a single experiment **(Academic I12)** • Administration is a big problem; it is taking up far too much time **(Academic G 8)** • Administration is overrated in Germany, maybe in Europe as a whole **(Academic G10)** • There are some problems with industry partners with regards to the use of our funding. We cannot operate that freely as the industry partners can as our capital is paid by the taxpayer. We always have the problem that we have to meticulously justify and explain the usage of the funds which can lead to long-term lack of clarity.**(Academic G9)** • I have stopped engaging with patents because the bureaucracy is so dreadful...I'd say 'I want to do that because it is fun and not masochism' Professors spend their time with too many things that they are a) not able to do and b) don't like. We are overloaded with administrative work and then the teaching load got bigger and bigger over the years too. **(Academic G6)** • Bureaucracy sounds so negative. It is a question of processes and process efficiency. And universities in Germany are traditionally not leading in the organisational domain. This is the case for everything and it is not better or worse for technology transfer and that is the problem **(TTO G1)** • The question is do they use the financial aid for bureaucratically effort or really for the research? **(Industry G10)** • There may be tension there going forward and how the PIs balance all this different activities **(Industry I6)** • One thought is how can you stay as a Professor and form a company…If you are a Professor you have three working loads…looking for funding, teaching and to push your research and on top you have all these voluntary work such as papers, being a referee and so on. This itself is 200 % and establishing a company is 200% too. So you have to make a decision which 200 % you take because 400% is impossible **(Industry G3)** • The biggest problem they're facing is they're losing a lot of older academic staff. That means younger academic staff have to take on a lot more teaching responsibilities. This is really affecting the research capabilities; you can't do ten jobs, usually there's only so many hours in a week you can do this. Once you have a big teaching commitment it really destroys the level and quality of research that you do. There is a problem between applied research, basic research and teaching. There is no way unless you are working night and day, that you can juggle all three balls **(GOV I2)** • You have the full load, research, teaching, administration, self-administration and so on. The biggest barrier is that the researchers are already drowning with too many tasks and unclear priorities and not so optimal structures **(TTO G1)** • The pressure is on us though. Essentially we have to do excellent research, we have to do teaching. I have to do a load of education and outreach stuff as well. We have to engage with industries, we have to do research with industries; we have to do technology transfer. **(Academic I10)** • We could spend a lot more time talking to each other which is really where ideas come out but no one has tried to do that because we've all got far too much teaching, far too much teaching to do **(Academic I9)** • You have to do a certain amount of teaching, and the amount of teaching that you do is effectively the total teaching divided by the number of academics. So it's more or less the same for everyone. Teaching is fine; I don't think anyone minds teaching. What is more problematic is administration. There are many administrative tasks that academics have to do. And some of them are extremely time-consuming. So the research really is probably about a third of your time for all your research. So you need to get money and you need to get post docs to work as middle management. It's hard to balance and most people if I'm frank, probably don't get the balance right. **(Academic I9)**

In sum, the study shows a number of interesting findings on the concerns and interests for the various stakeholders. Industry partners' views on the specific problems within universities and faculties differ depending on sector or country. Despite this, there is common consensus that universities' practices are not generally conducive to commercialisation. It is important for universities to impart a commercial attitude to other stakeholders and to foster a commercial culture within the university. Universities, however, still do not appear to fully comprehend what is needed to create a comprehensive commercialisation environment. The lack of incentives (in both a financial and non-financial sense), the time spent on administration and the bureaucratic and inflexible nature of the universities, influence the value that PI's attribute to commercialisation activities and therefore the success of commercialisation efforts. It is interesting to see that, although all participating stakeholders mentioned the need to change how research commercialisation is recognised, no progress has been made since the incentives discussion started. This in itself indicates the inflexible nature of universities. Academics are of the view that the new activities have not been reflected in a rebalancing of the activities that they are expected to carry out. This failure to rebalance activities, coupled with the deficiencies in incentive structures, has resulted in job norms being structured so as to disincentive the commercialisation of scientific knowledge.

5.2.3 Resources

Resources that are necessary for commercialisation are time, skilled labour and funding. The availability of financial resources for different stages of the commercialisation process is considered to be a significant factor (Degroof and Roberts 2003, 2004). The financial resources required include R&D financing, innovation grants, seed financing, early-stage venture capital and growth-stage venture capital. The findings reveal that a lack of seed finance and venture capital are barriers in Ireland. The availability of seed finance in Germany, however, was generally perceived as adequate. While funding issues are referenced in Table 21 below, funding issues and the impact of economic changes thereon is better discussed in the context of the economy sphere. This is done in Chapter 7 and 8 below.

While the need for qualified research staff was highlighted as a factor for commercialisation, it was not generally perceived as a difficulty. Time, on the other hand, seemed to be the biggest factor. Timing difficulties have two facets. The first of these facets is the conflict between the time horizons envisaged by industry partners and academics, as discussed above. Notwithstanding these different expectations, a lack of time caused by the way academics balance their activities impacts upon the speed of execution of activities on a micro level. Academics perceive time as a big barrier. The aforementioned balance between activities hinders adequate allocation of the PIs' time for collaborative research and innovation.

Industry partners, on the other hand, have completely different time lines. For industry partners, it is important to have short time-to-market cycles as their strategic goals change rapidly. This need for short cycles informs industry partners' expectations of the time horizons that as those short cycles dictate whether or not a project is commercially feasible.

One Irish TTO manager highlighted time issues for TTOs as well. He said that "we spend a lot of time protecting the IP and we don't spend enough time trying to commercialise and so half the battle is that IP protection is time consuming."

The findings of the study show that the speed with which scientific knowledge is commercialised is inhibited by the time constraints of PIs and TTOs. Industry partners criticise the slow execution of collaborative projects. Industry partners claim that it has something to do with different time horizons within academia. While the long-term research-oriented goals of academia can be responsible for this issue, it might be that adequate time allocation is not possible due to PIs having insufficient time to handle all their activities. A lack of human resources to support a growing workload and an imbalanced system of incentives therefore appear to be creating a barrier to academics meeting the expectations of their industry partners. The result of this is to prejudice the chances of trust developing between the stakeholders and projects being considered as having concluded satisfactorily. The importance of trust existing between stakeholders and the perception of a successful conclusion to the project are both discussed in Chapter 7 below.

Table 21: Sample findings – Resources

Skilled labour and financial aid	• The resources available to bring it to commercialisation. Very often it's the time, the resources and the experience, the skill that slows things down. I mean Ireland, for example, would not have a huge venture capital industry**(GOV I1)** • The experience and the band width resource of the technology transfer office will be an important factor there as well **(GOV I1)** • Qualification of the employees [is important] **(GOV G4)** • Typically it's resources and I think it's people and money and time... those are constraining **(Industry I 2)** • Barriers to commercialisation. I suppose resources. So if we want to commercialise an idea, we need a lot of money to do it so you can apply to Enterprise Ireland. But the amount of money they would give you to commercialised research is very, very limited **(Academic I4)** • There is no funding infrastructure for maintenance... it's a big problem **(Academic I9)** • It's just a resource issue and us finding the right people issue **(Academic I10)** • And we need to have more seed capital for projects **(Academic I13)** • But financing the exploitation of the results is extremely costly. It is unspeakably difficult in Europe. It is a lot easier in America but there you have to sell your soul. **(Academic G5)** • Seed funding is good in Germany...but after the seed funding stage it is difficult to find an investor or business angel **(Industry G12)** • Money again… We do some human clinical trials in association with our teaching hospitals but only if the company involved pays specific insurance to do that project **(TTO I5)**
Time	• Time is actually the problem, money is obviously a key problem but time is really the key thing **(Academic I11)** • Give researchers more time to attend to put together research collaborations, because this is very time consuming **(Academic G9)** • Time is a big factor **(Academic I7)** • I wouldn't necessarily inform all of my collaborators of what we are doing and what we are up to…that is not necessarily through lack of want, it is through lack of time **(Academic I12)** • We could spend a lot more time talking to each other which is really where ideas come out but no one has tried to do that because we've all got far too much teaching, far too much teaching, to do **(Academic I9)** • Collaboration is desperately difficult to do and I think people underestimate time, the time it takes **(Academic I10)** • The limitation in our job is that we spend a lot of time protecting the IP and we don't spend enough time trying to commercialise and so half the battle is that it is time consuming **(TTO I7)** • Industry is fundamentally totally different from the universities in their time lines **(TTO I6)** • Generally companies have shorter time frames than researchers **(COMM I2)** • I was thinking we could do loads of collaborations…but I had to learn that the time constant is completely different. In universities it's about years and remote future, here it is about days and near future **(Industry G3)** • Time is an important factor; Time-to-Market. This way of thinking does not exist at the university at all. Time is an aspect in education, getting students through the system, but not in research. Time doesn't play a role in research. **(Industry G8)** • The primary issue that we face is in terms of the speed, getting stuff done…we operate and they operate on two different time scales, in terms of project

	delivery. For us projects need to get results substantive results, what I mean is significant research is coming out in terms of having publications, demonstrations, prototypes and experiments. In many cases we want to stop projects in a year, maximum two years. If you look at what the university does, they're operating on three to four year time scale with the PhD students…that's the mismatch there. That sometimes can cause issues in terms of being able to ramp up and execute on a program before our own strategy has actually changed or evolved **(Industry I7)**

5.2.4 Conclusion on interaction issues

From the interviews conducted it would appear that while resources are a concern in an Irish context, the primary barriers to scientific knowledge being commercialised comes from how those resources are utilised to influence behaviour within universities. The incentive structures in universities have not been adapted to take account of the third mission. Equally, academics do not consider that there has been sufficient thought put into how the third mission will impact upon their work load. As a result of what academics view as an unsustainable workload, a balancing of activities is necessitated. The failure to incentivise commercialisation activities prejudices the potential success of the commercialisation process. In addition, incentive structures in universities continue to create a "publish or perish" culture, with the German system also suffering from the perception that an "ivory tower" culture persists in many academic sectors. The existence of this culture leads to commercialisation activities being seen as being of secondary activities, with some viewing commercialisation as being something that PIs do if it happens to interest them. This culture manifests itself through numerous conflicts of interest between the universities and the various stakeholders. Indeed, such is the level of conflicting interests that the PIs' interests seem to conflict with those of the university. This leads to the PIs being viewed as an additional stakeholder. This point, and the difficulties emanating therefrom, are discussed further below.

The foregoing is not to suggest or undermine the concerns about resources in an Irish context. As some of the interviewees pointed out, the investment in building a sustainable knowledge economy is long-term in nature. It is quite easy to see that the primary concern could quickly shift to a lack of funding. The concerns about funding appear justified and are discussed further below. Notwithstanding that these concerns might be justified, however, this investment will be futile if it is directed into institutions where commercialisation is seen as a hobby for those who are interested in it or where the culture is heavily weighted against commercialisation and in favour of publication and/or teaching. The overriding theme of the interviews was that the issues of properly directed incentive structures and an appreciation of what is necessitated to create a culture of commercialisation are of critical importance.

5.3 Contextual spheres

The different environmental spheres are the context that influences the commercialisation of scientific knowledge and the formation of stakeholder networks. These spheres cannot be distinguished rigorously but function as analytical tools to assist in the identification of upcoming developments. There are several barriers which hinder the creation of collaborative research projects and the commercialisation of university research. The barriers are, thus, discussed in relation to: (a) economic; (b) technological; (c) societal; and (d) ecological spheres.

5.3.1 Economy sphere

The economy sphere relies on the fact that the commercialisation process is embedded within a national economy. Ipso facto, the exploitation of scientific knowledge is influenced by the economy of a nation and/or the global economy. The following aspects are of importance when considering the exploitation of scientific knowledge: efficiency of labour and financial markets, availability of capital and interdependencies of global economies (Rüegg-Stürm 2003). The lack of capital is a major barrier to the commercialisation of scientific knowledge (Spilling 2004, Wright et. al 2004, Wright et. al 2006). It is therefore of utmost importance to look at the wider environment to gain a deeper insight.

Universities must be able to adapt and embed themselves in different environmental contexts. These environmental contexts will differ region by region, with each region having different needs. Economic issues such as a recession or job losses are critical to the commercialisation system. This is the case at regional, national and international levels. These issues can result in shortages of funding for helping agencies or services (Zhao 2004) or the university itself (Johnson 2006) and affect the support structure needed for successful knowledge exploitation.

The findings of the study reveal that there are bigger concerns about funding in Ireland than in Germany. The German interviewees generally stated that they are content with the funding situation and the most common position taken was that the economic crisis had not significantly impacted on funding. Only a few German interviewees mentioned that the recent economic crisis had an effect on industry partners’ interest in doing innovative research collaborations due to financial constraints on the part of the industry partners. Conversely, almost all Irish interviewees mentioned a reduction of funding as an issue. There are widespread fears among all Irish participants that a shortage in funding will lead to a cessation of commercially relevant research and technologies. An Irish Government agent explained “if funding is reduced even more…the commercialisation pipeline could dry up pretty quickly”. While most of the interviewees stated that their funding was reduced due to the economic crisis, this quote indicates that the funding issue might pre-date the financial crisis. Nevertheless, the fears are vested. An Irish multinational industry partner emphasised the reliance on the government agencies’ funding by stating:

> “Speaking from a large multinationals point of view …to make it clear, we wouldn’t be doing this work here with the [CSET] without SFI funding…just wouldn’t be happening…I could say things have changed over the recession and whether that might be harder for the Irish government to justify funding and their interests may change … we compete in a global market so we have companies in 78 nations…the research could be done in Singapore, in China, India. So we have to compete and for the moment SFI can offer good terms.”

Beyond the importance of government funding, this statement refers to a wider policy issue; namely, the high degree of dependency on foreign direct investment. In contrast to multinationals, Irish indigenous companies were often described as being highly risk averse, with poor absorptive capacity, no R&D culture and incapable of doing research projects with academia. Long-term policy implications are discussed in Chapter 8.

Irish academics, TTO managers and commercialisation managers fear a deficiency of research excellence as a whole due to a lack of support for basic research in favour of applied science, as discussed in Section 5.2.1 above. They further question the Government’s and the funding agencies’ strategies and the abovementioned conflicting views in terms of time horizons. In their efforts to support scientific excellence, SFI seems to have shifted more focus to applied science rather than continuing to fund basic research. One CSET manager summarised it as follows:

> “Ireland’s still very immature when it comes to research. We are only funding research in a serious way for less than a decade. And realistically you’re playing catch up with countries that have been doing this for 30, 40, 50 years…Now [after funding got reduced] there is a lack of clarity around that. There’s been a forced de-emphasis under the quality of the research from SFI. They have failed to articulate why it’s important that Ireland continues to do really high quality basic research. I don’t think SFI as an organization doesn’t believe that anymore. But I believe they don’t know how to tell that story politically to get the support to do it. I think there is overlap now between what SFI and EI are trying to deliver.”

The expectation from the government agents appears to be that basic research will generate returns within 10 years that are comparable to countries that have invested for 50 years. The other stakeholders, however, are asking for a clear and consistent funding strategy to underpin Irish competitiveness as a knowledge economy. It was mentioned by a number of interviewees that a certain level of continuity was necessary to build the knowledge necessary to be able to disseminate something worthwhile and harvest the rewards. There seems to be a concern among academics, TTO managers and commercialisation/centre managers that policymakers: (a) don't understand the timelines involved in developing a sustainable knowledge economy; (b) do not clearly articulate the timelines or promote the necessity of basic research; and (c) allocate insufficient funding as a result of (a) and (b).

In Ireland there are currently economic constraints that impact research and research collaborations. The concern of the other stakeholders, however, appears to go beyond a lack of funding due to the recession. Their fear is that the deficiency in funding is due to policymakers having a short-term view of research and they further fear that this will lead to a long-term dearth in funding. This may be connected with what one academic referred to as Ireland being "very immature" in terms of research. Two interviewees pointed out that research projects, especially in the life sciences, can have time horizons of up to 50 years. Three interviewees mention that results are now being insisted upon due to ten years of funding. The findings highlight the need to continue funding fundamental research in order to generate ensure commercially viable research is available which will then allow Ireland to compete with other nations.

From the comments of the interviewees, it seems reasonably clear that Ireland is struggling to compete with German levels of funding. These concerns about current funding levels need to be viewed in light of the extraordinary difference between what Irish academics view as necessary time horizons and the timescales for commercial success that Irish Government view as acceptable. The strains that a current shortage of funding have created and the doubts that have surfaced due to those shortages raise potentially major policy implications, which are discussed in Chapter 8 below.

Table 22: Sample findings – Economic Issues

Shortage of funding in Ireland & Germany content with funding situation	• We will definitely have a drop in potential commercial research towards the end of this year because the research funding dropped last year…thankfully the amount of research for this year is okay, so it will be a temporary hitch **(TTO I5)** • The problem is associated with a lack of funding to do things on the scale with which you want to do it. So I think we are compromised by the limited budgets available and by virtue of the fact that there has been a huge reduction for experts in terms of funding for a tight research. Many of the projects that might make it into potential beginner companies are not being funded… that is a great pity ….What is the biggest issue the biggest issue for technology transfer is probably finding other funding to take really good ideas that have been developed by researchers to the next stage. That means a lack of seed capital, if that is an early stage company and a lack of applied research concept funding to validate the ideas to the point that the company will be interested in licensing them **(TTO I4)** • I would be more worried about the shortage of funding. You could use all the post docs and PhDs, having trained them and then there is no sufficient money to keep them in employment…so then they move abroad … it's a loss to us because you really want to be in a position to keep your best people here if possible….The other difficulty I foresee right now is that at the moment there is virtually no funding for clinical trials. Obviously we've got funding from SFI for the basic science but they don't cover clinical trials. **(Academic I5)** • Well, at the moment, well there are loads of big problems; one is post graduate funding. So with the recession SFI's budget was cut and because of commitments going forward that meant that in the year after the cut there the number of post grads has dropped…a huge drop so that's a big problem. **(Academic I9)** • What I do have a problem with is the issue of co-funding… when the government created these institutes or gave the capacity to create them there was no long-term funding put in place to manage the core activities of those institutes. The maintenance contracts for those are something like 5% of the capital cost annually and we have to find that money from somewhere. Finding that money is a strain and will always be a strain. And we've been doing it but we've been doing it off the back of overheads from research grants. And we've been looking at the university to provide us with some form of core funding which it has told me it will do, but it hasn't done so yet and I look forward to the day when it will happen, which I don't think will be terribly far off **(Academic I11)** • Since the recession started things got even worse. We have more and more people interested in being a part of [CSET] and we cannot accommodate them all. And also the funding situation has changed so, the next round of funding we can only apply for 15 million plus overheads, which brings it to 20 million in total. So we were to get 10 times the amount of industry interaction we could still only apply for that. Whereas if we could scale up according to the industry interaction we have, we could apply for way more. **(Academic I10)** • The funding situation in Europe is quite good in the meantime. **(Academic G5)** • In Ireland you know we are very reliant on the government input. And if we get into a situation now where the government continued to reduce funding then that will have a major impact on our competitiveness **(GOV I 2)** • If funding is reduced even more….So that's the problem the commercialisation pipeline could dry up pretty quickly **(GOV I3)** • I would say it is always a matter of people and not funding. I have seen institutes where the manager is doing spin offs, technology transfer etc. where it just works and then there are some where it doesn't work independently of the funding. People who don't want to do that will try to get funding from the DFG [basic science funding agency], while people who are interested it will try to get money from others such as BMBF, AIF and other research funders [give also funding for applied science projects] **(GOV G2)**

	• Typically it’s resources and I think it’s… money... things that are constraining **(Industry I 2)** • Speaking from a large multi nationals point of view …to make it clear, we wouldn’t be doing this work here with the [CSET] without SFI funding…just wouldn’t be happening…I could say things have changed over the recession and whether that might be harder for the Irish government to justify funding and their interests may change … we compete in a global market so we have companies in 78 nations…the research could be done in Singapore, in China, India. So we have to compete and for the moment SFI can offer good terms…**(Industry I6)** • Maybe there would have been more funding if there wasn’t a crisis **(Industry I3)** • Seed funding is good in Germany **(Industry G12)** • External challenges: funding yeah particularly in Ireland … because of that situation where academics have to move on. They’ll, they don’t get funding for doing repeat experiments at the same time. So you need to have funding to come from a commercially focused entity and typically would have been the national the national funding agencies. But in the recent down time that money hasn’t been forthcoming and therefore you have no other vehicle available to you to advance… to research beyond an academic paper into a real commercial opportunity. **(COMM I 1)** • You need a certain level of continuity to go build the knowledge up to the point that we’re that there was anything worth disseminating. So the difficulty is that that might be hampered by you know, the way some of the funding is organised. Continuity but with no ten year plan or something like this. So funding was given for three to four years and then the actual funding stream was postponed and cut off. Here they basically promised one cohort of funding whereas in Germany they had five or six cohort before. And it’s just very short sighted and ludicrous, I don’t know what they were thinking doing it that way **(COMM I3)** • The economy is in a situation where companies as a start try to gain ground again after the economic problems of the last years. They do not invest at the moment in innovative areas but try to get back to the level of 2008 **(COMM G4)**
Irish funding agencies and government strategy	• Ireland’s still very immature when it comes to research. We are only funding research in a serious way for a decade less than a decade. And realistically you’re playing catch up with countries that have been doing this for 30, 40, 50 years….Now [after funding got reduced] I would say there is a lack of clarity around that. I would think there’s been a forced de-emphasis under the quality of the research from SFI. They have failed to articulate why it’s important that Ireland continues to do really high quality basic research. I don’t think SFI as an organization doesn’t believe that anymore. But I believe they don’t know how to tell that story politically to get the support to do it. And I think there is overlap now between what SFI and EI are trying to deliver. **(COMM I5)** • The biggest problem at the minute is the government you know our boss our bosses they’re problems their putting the researchers under more pressure to become very much more commercially aware about the research which is a good thing. And you know it's a good thing in one way and possibly a bad thing in another. It starts to really hurt the basic research...you need strong basic research before you have anything of commercial worth. So if you don't have that sort of strong infrastructure of research then you’re never gonna get to a point where you have something that's gonna be any and of any commercial value **(GOV I2)** • I would say there is a general perception that the competence within the agency isn’t as a good as the competence within tech transfer offices. So you have a little bit of ambivalence from SFI in the sense that they sort of say it, but they don’t really and then you get some senior executives in SFI giving all inconsistent messages **(TTO I2)** • They [SFI] are shifting towards more applied science…It could create problems in the future because you have less people working on… fundamental research which is very risky so you need put a lot of money in and the return is not for five years or ten years it’s potentially 20

years…if you don't have the fundamental research being funded then you're going to somehow stop during the pipeline with all these potential that could become applied research. So for example if we do something with Enterprises Ireland…and we're looking for money to potentially set up a company… But I'm starting to worry that if we apply for this once and we don't have success with the company they might not fund you again. Whereas my opinion is that you should be, they should like fund lots of these they need to fund hundreds of them to get a few successful outputs. And they shouldn't say because we funded one and it wasn't a success we're not gonna fund anymore. The view that like a lot of business people talk about….. you know failure shouldn't be viewed as a bad thing, it should just be viewed as you learn you've got the experience so next time you're more likely to be successful. Whereas here if you could get money from EI and didn't end up with a successful spin out company. They look at you like well we're not gonna put you in again, we are not gonna give you anything anymore **(Academic I4)**

- One is a lack of understanding about how the route commercialisation works and two, perhaps some panic; money has been spent and we don't have an Irish Google, an Irish Yahoo, an Irish whatever. But I mean the problem is that you can't just take a very large shovel and fire money at researchers and hope the economy is going to grow by 10%, because that's not how it works. …So the money goes into research, there is no support or very little support after the research level and yet people are wondering why these companies aren't coming out. It doesn't make a lot of sense to me….but either way they have to realize that you fund basic research and then you fund research that focuses on using anything of interest in there to help industry. But you can't have one, you can't have the industry problem without the basic because there's nothing to build on but they don't realize that. Part well, maybe they do but they're not allowed to realize that because the government doesn't realize it and this just, I don't think, this is not really relevant for you but this is something I think is a root cause of all of this. Ireland is one of the least scientifically literate countries in Europe... So this is part of the problem and in addition just because of the sort of traditions in Irish politics I think people in the Dail are less likely to have a degree than people in the population in general. So if the population is scientifically illiterate I think people in government are even more so. So it's not hard to see how that is going to lead to problems when large quantities of money need to be spent on something that no one knows anything about and it's very easy to stick your hand up and say, what, those scientists are really doing? **(Academic I9)**
- First of all the government agencies have to completely rethink their notion as to how innovation works. I mean there's claims being made that we've invested for the past ten years in…such as Blue Skies fundamental research and now it's time to stop doing that and to reap the harvest. So basically we sow plants for 10 years and maybe the vineyards are good, which takes about 20 years before you've got any grapes at all right? But anyway so we planted this wisely, we believe, and now we're going to just take all the resource and put it into harvesting. But if you do that then there's no harvest the next year. And so they just don't understand this and they also don't understand that the same people that do the fundamental work, they're the same people that do the applied work. It's the same side it's just one coin with two sides. And they don't understand that. And because it's a value proposition… for researchers that to get engaged in solving problems means you have to understand the problems and that relationship, that value proposition is hugely important to researchers. I mean if they are actually just involved in a proposition where they solve problems that other people define for them, that doesn't interest them. They want to be able to understand how to really change and define problems and new opportunities.…I think the agencies as a whole have retracted back because of the funding situation and they have no idea what the cold face looks like. SFI has gone into policy mode, worried about justifying policy rather than worrying what's actually happening in the labs, the people working for SFI have no freaking clue about the sciences going on in the labs. It's not peer reviewed, it's the biggest joke ever….But actually what you see is a shit lot of companies and this companies they are all there because the university facilitates the companies being there. It's not the IP that they produce it's because they are universities, because they are facilitators in innovation and if you don't' get that you don't get what universities are about. And actually they don't get it **(Academic I8)**

	• An intelligent government would understand that actually the investment that you make now is a multi-generational one. We know that's true for investment in the education system, we don't expect a return from an 18 year old or a 22 year old, what we expect is a return from that investment over their whole working life which could be 50 or 60 years. And that's where the return should come, and we should be thinking about investment and research in exactly the same kinds of cycles. That it's an inter-generational a multi-generational investment. And the return will be there **(Academic I11)** • If you're solely interested in the economy and you want science or the economy supporting science only in those areas that support the economy it's not going to work for you. How many world changing inventions have been planned? And I think the answer is really very few. If you look at for example magnetic resonance imaging, that came from stuff that was studied in the early stages of development of quantum mechanics and that certainly was and that certainly was not funded from an industrial stand point. There are very many examples like that and if you have a narrow funding mechanism the reality is what you will do is you will miss out on the breakthroughs that were made in what would be considered from the outside as fundamental research but in reality many aspects that can't be used for economic gains effectively **(Academic I 9)**

5.3.2 Technology sphere

The technology domain necessitates the supervision of technological progress (Rüegg-Stürm 2003). Scientific knowledge at universities and research organisations, as well as R&D surveillance (i.e. observation between competing firms in industry or competing research institutions within academia), form an important part of the technology environment and therefore technology development and progression. Furthermore, the technology sphere bears upon the development of a contextual framework for technology diffusion. Clusters such as the Silicon Valley, Bay Area and Boston in the US, Cambridge in the UK or Martinsried/München in Germany are examples of areas with high technological dynamics.

Looking at the technological domain the findings imply that there are barriers flowing from the embryonic nature of university research, especially in the life sciences. Prior literature discusses commercialisation strategies based upon the stage of the technology development i.e. early-stage invention, proof of concept, reduction to practice, and prototyping (Markman et al. 2005). According to Thursby, Jensen and Thursby (2001) licensing for sponsored research is, for the most part, done when the technology is at an early stage with a low degree of resolution. Licensing for cash, on the other hand, is executed when the technology is already a prototype with a high degree of technical resolution. These two strategies usually involve large firms as transfer partners, whereas licensing for equity is performed with new ventures at a proof of concept or reduction to practice stage.

This study finds that scientific knowledge needs to be categorised when considering the attitudes towards assisting in the development of the technology sphere. In this respect, one would need to distinguish between industry partners that are willing to invest in applied science and those that will invest in basic science. The likelihood of obtaining industry-partner investment in basic science will vary on a sector-by-sector basis.

Investments in basic research are long-term in nature and are therefore most likely viewed as strategic investments, as opposed to product development investments, by industry partners. Sectors such as life sciences are more amenable to this type of investment as developments occur at a slower pace. As a result, it would appear that industry partners are willing to make strategic investments in order to progress developments within the technology sphere with a view to gaining from future developments that flow therefrom. It should be noted that, in this context, the investments are not necessarily financial investments but may be the investment of time in the creation of a long-term relationships with research organisations. Some of the industry partners interviewed did, however, advance both funds and equipment to aid this long-term research. These funds and equipment develop research and relationships within the technology sphere and it is therefore hoped that this will increase the chances of competitive advantage in the future. In general there is agreement that collaborative research projects in life science initially tend to be of a strategic nature and that only upon successful proof is a commercial deal possible. Companies like to be in a position to act quickly if successful results manifest. The main aim, thus, is to acquire complementary knowledge which, if required, will be jointly patented.

On the applied science side, industry partners will generally require high standards of proof before they think about commercialisation or patenting and in some cases will demand this as a prerequisite to collaborating at all. One Irish industry partner stated as follows:

> "Industry partners want more of the concept proved before they take a license … So, in that regard, there is a barrier to commercialisation because it's just not enough to have a good idea and show in general that it works…. We are not going to pay; we are not going to acquire; we are not even going to push to license or patent; we want to see really if it works. I think that's a good understanding to have; that the research needs to be on to a different level before you get that kind of engagement."

This view was affirmed by numerous interviewees and there was no substantial distinction between the Irish and German perspectives on this point.

The differences between different sectors can be seen through a comparison of the life sciences sector and the ICT sector. One German academic highlighted this distinction as follows:

> "in ICT its different…you calculate with half a year, one year max and then it has to produce a profit … if it doesn't work you put more people on the project and you have a software … That definitely does not work in the life science".

An Irish academic in one of the CSETs summarised the position by stating “you’ve got to show much more proof that your technology really does what it says on the tin. Get it much more down the track before anyone would be interested in it.” A TTO manager noted that “what you have is a few things that need a lot of nurturing and a lot of development … it is interesting but nobody’s knocking my door down.”

Table 23: Sample findings – Technical issues

Technological issues	• Large companies, particularly in the diagnostics sector, are not prepared to invest in an early-stage technology. They prefer somebody else to take the risk and then it will be the survival of the fittest and the ones that come through the commercialisation path way, then the larger companies will look at them and see when the technology has been de-risked even though the cost are more at that point but at least the return on investment is easier to define **(COMM I 1)** • In industry it would be done the other way round. In industry the marketing department would tell the research department there is an opportunity here; we need to try and figure out how to do A, B or C. Go off and do the research and then we'll move it in towards the product. So, it's kind of the wrong way around, but it's the only way that makes any sense because for academic world to be kept in purely by a market would be the wrong thing to do. You would miss out on an awful lot of opportunities **(COMM I2)** • Industry partners want more of the concept proved before they take a license … So, in that regard, there is a barrier to commercialisation because it's just not enough to have a good idea and show in general that it works…. We are not going to pay; we are not going to acquire; we are not even going to push to license or patent; we want to see really if it works. I think that's a good understanding to have; that the research needs to be on to a different level before you get that kind of engagement **(Industry I2)** • My job is to do research which could potentially result in a company being set up but there is a certain stage where I would need to transfer that technology under research we developed out a commercial partner or out to a person in my lab who wants to commercialise it. And that's where generally the problem lies. The research is taken to certain point but then who actually takes it the step further in … developing prototypes, marketing, that type of stuff that we don't have any experience with and we don't have any formula to get people to do it **(Academic I4)** • We are just after holding a site visit … and we brought in a number of people who would have a very strong background in commercialisation and IP another two people from a research perspective … and basically it didn't have enough data behind it, for it to actually become something that would become very commercially viable ... So what you tend to get with the commercialisation of different platforms is you come up with the general concept, the general idea. You build whatever device or platform. Then you would do a number of … studies to … justify your hypothesis or prove your hypothesis. And then you would advance that on into, especially within life science area, you'd advance that on until into more stringent sort of clinical studies. So I think with devices, they have got to a certain level …structured clinical study where they show that the device that they have is something that could be used routinely and give far better results than whatever is out in the market **(GOV I 2)** • There's nothing that I see even in the ICT space [as] absolutely block-buster, breakthrough technology that people would be knocking my door down. What you have is a number of interesting things that need a lot of nurturing and a lot of development …it's interesting but nobody's knocking my door down **(TTO I2)** • One big barrier is that our research is very early stage. It's probably very good because we have world class scientists. But their results is something that requires a lot of further investment to get a part of the pie on the market ….or it's very, very good but in the case of [technology x] we've been told by the industry 'but this is not something we are selling now. This is something we want to do for the next generation but we are not ready to work on the next generation because there is a lot of other stuff'. So that is the barrier; our stock is too early staged. Not in ICT…But in life sciences and some of the physical sciences. We don't have an in-house resource to do prototype development at all for the physical sciences because the life sciences require animal trial and trials for the regulatory process etcetera. So that is a definite barrier **(TTO I5)** • We didn't have a technology to give them. We didn't have something ready to go that we could say 'okay, we can develop that to fit your particular

	application'. What we were doing, we were starting from scratch. And I think as the project evolved, you could start to see this mismatch…I mean if somebody has something that's genuinely commercialisable, good commercialisation technology, you see so many examples across the world, where so and so does some work in the laboratory for whatever and a company comes and swallows it all up for millions because they think it's so important. And there are areas of research that are like that, particularly some parts of the bio sciences. But in other areas you've gotta show much more proof that your technology really does what it says on the tin. Get it much further down the track before anyone would be interested in it. So it's a real battle **(Academic I1)** • In physics, there is so much technology in it, so many things…you can't just sell that as a product to industry. In chemistry it is different. If you develop a chemical approach you can sell it without big investments to industry. Insofar they have closer collaborations **(Academic G6)** • We drew the conclusion that we are so far away as to get really closely evolved with industry **(Academic G12)** • On aspect is that we have extremely long lead times. To develop a new product we need a lead time from at least 10 years….and this only works with planned collaborations…in ICT its different … you calculate with half a year, one year max and then it has to produce a profit … if it doesn't work you put more people on the project and you have a software … That definitely does not work in the life science **(Academic G8)**

5.3.3 Society sphere

The society sphere pertains to humans as individuals in society. Humans are informed by their environment and therefore influenced by a complex array of factors or barriers e.g. educational background, human capital, age, willingness to take risks, role of the State, public infrastructure and educational infrastructure etc. (Rüegg-Stürm 2003).

The study reveals that German stakeholders are generally content with the involvement of government agents and the execution of the funding procedures. In Ireland the results paint a different picture. There seem to be high levels of dissatisfaction and disenchantment within the Irish academic community when the role of government agents is discussed. The SFI came in for particular criticism, as did the Higher Education Authority (HEA), whereas Enterprise Ireland (EI) evoked both positive and negative feedback. The perception among academics appears to be that the government agents are not well equipped to understand the science that they are trying to commercialise. Beyond this, the SFI did not seem to have convinced the academics interviewed that they added any value to commercialisation efforts. In fact, there was a common perception that the bureaucracy involved in the process meant that the commercialisation process was being hampered. This view was less evident when EI were discussed, with one academic noting that EI's lower rate of staff turnover meant that "they know what they are doing". The view appears to be that SFI are coming under pressure due to the level of funding that has been advanced to them. One centre manager put this down to SFI not being able to explain their story politically, though the issue of government agents demanding results now was frequently mentioned.

The Irish Government and the HEA came in for criticism due to their perceived lack of understanding of the scientific research that they are trying to commercialise. Table 24 should be read in conjunction with Table 22 above. The views of the Government, and the government agents as a corollary, could not be more starkly contrasted with those of the academics. The value that the academics see in their research is in the long-term benefits that the research will generate. The Government, in contrast, is looking for commercial benefits in the short to medium-term.

The academics view on the Government's policy may be connected to the doubts academics have about the manner in which the HEA disburses funding. One academic and centre manger challenged the agencies and encouraged competition among universities by saying "every university has a slice of the pie and it doesn't matter how crap they are. They need to compete. Crappy institutions need to go away."

The issues raised by academics on this area are so fundamental that one must query whether the policy decisions that were, and continue to be, taken to generate a knowledge-based economy were based on an informed understanding following consultation with Irish and international academics. This issue is explored further in the discussion chapter below. It is, however, worth noting at this point that these complaints should be looked at in light of the economic issues discussed above, insofar as some comments may be a result of restricted funding levels. Notwithstanding this, the differences in the views of Irish academics and the government agents appear to be causing conflict. Given the type of concerns raised, these conflicts are likely to linger.

Table 24: Sample findings – Societal issues (a)

Dissatisfaction with Government & government agencies in Ireland	• You have to make a request if you want to change the allocation funds, there is a very rigorous definition of this…You can't move between one category to another in the sub-category so between travel and consumables and equipment, you have to make a request if you want to move…So it tends to be very rigid, very time consuming…I think it's the too much bureaucracy of the paper work particularly from some of the funding agencies and some of the funding agencies being overtly negative… so you have the funding agency coming in and stamping the table demanding more commercialisation progress in projects which tends to maybe get people to pull back a little. **(Academic I13)** • There is all sorts of paperwork now that you have to fill out …like all the stuff we use we have to import them from abroad. And each time we do this we have to apply to the department of Agriculture for import license…. before you can place the order …it's just so much paper work and bureaucracy …it seems to be getting worse and the government seems to want to scrutinize the universities in greater detail. I would have said there is more than enough of bureaucracy in the universities already. **(Academic I5)** • I don't know that it's necessary or that it benefits anybody. Because the amount of time and energy that goes into just satisfying SFI's need to know is significant **(Academic I1)** • External barriers I guess okay SFI as a funder I don't think their review process is perfect so it's quite monolithic in the sense that the review panel can close things down. They get a snap shot of the program once a year they don't necessarily take up all the good things and they have a lot of priority to recommend against this and that and it does lead to a flip flopping. You know one year they want you to do this, the next year they want you to do something else. … Being the funder they can call the tune as they wish. The commercialisation specialists …they've [Enterprise Ireland] have had people stationed here …they were to help the research teams commercialise and in truth they were almost completely useless and somewhat destructive in that they controlled the flow of information from the university to the Enterprise Ireland organization. In terms of how commercialisation specialists perhaps could help you…are things like marketing, contacts with possible client companies, possible customers….help with market information that potentially helps in the business plan; very much industry facing things. What they turned out to be was sort of heavy handed project managers and they added very little value. In fact I think they detracted value ….this so called commercialisation specialists were just, to be blunt about it, they were just minding their back and I think that to me my negative dealings with them were far greater. So to be blunt about it there is a very strong criticism, a barrier to commercialisation to be frank ….In general the agencies wholly underestimate the amount of time and money required to commercialise something and they have no appreciation themselves about how hard it is **(Academic I6)** • I think SFI are the masters of changing the goal posts and this is the big problem. And I think you get contradictory information from them on a regular basis. But I think they are getting contradictory input as well. So I won't blame them completely… but really this not knowing, I mean there are people who are told they've got too much involvement with industry and next minute you're told you've got too little involvement with industry; it's this kind of oscillating that's very difficult to deal with **(Academic I10)** • We went to visit a few politicians…. But they've been so far out of the loop that they won't even know what research is. So we tried we thought okay let's go visit some of the politicians. It's depressing **(Academic I10)** • Take a problem like [particular] diseases …you may have changes in your 50s that don't become manifested until you're in your mid 70s. And you end up with this disease over a 20 or 25 year period of evolution. Now how do we solve that problem? I don't know but it's a really hard problem. But at the same time it's the problem that's going to affect policy makers everywhere because of the rapid grain of western societies. How are we going to solve it? It's going to take an awful lot of money and it's going to take an awful lot of time, and most of the ideas that people will have will be wrong. And this has already happened, drug companies have spent billions on compounds that haven't worked…and this is the thing the

timelines for solving problems like this are really long, and quick returns are not possible…The real problem is the politicians themselves just don't get what it's like. A little bit of experience would make all the difference. And you see this; the higher education here is another great example of it….none of those people have PhDs. None of them have lectured in the university; none of them have graduated as PhD students or taught on a master's program or put together an enormous research course. You get just crap from them…what planet are you people from? **(Academic I11)**

- The people working for SFI have no freaking clue about the sciences going on in the labs. It's not peer reviewed, it's the biggest joke ever. HEA's a pretence peer review. It's a paper exercise to make it look like its peer reviewed but it's not. If you talk to the reviewer, they are not allowed to implement the recommendations they want to implement on any of the HEA funded programs. That's the truth; that's the reality. **(Academic I8)**
- Irish politics people in the Dail are less likely to have a degree than people in the population in general. So if the population is scientifically illiterate I think people in government are even more so. So it's not hard to see how that is going to lead to problems when large quantities of money need to be spent on something that no one knows anything about **(Academic I9)**
- The agencies? I would get rid of pretty much all of the program managers, fire them all. I might start from scratch, I go back and try to find out what is it we're trying to do. I would at an agency level, I would require that the agency's coordinated across agencies so they'd understand the roles and I would require that HEA for instance did not cap, at an institutional level, funding. That they allow universities to compete and do not allow, as it is at the moment you're entitled to your slice of the pie. If you look at HEA funding over the years I don't care what number of PRTLI it is. Every university has a slice of the pie and it doesn't matter how crap they are. They need to compete. Crappie institutions need to go away **(Academic I8)**
- There are problems certainly and the main problem is that they have no memory in the system. So they usually have a high turnover of staff. And sometimes the people that they hire aren't the best people for the job. So often they'll give you advice that's just wrong or bad and that's because they have a turn over with people they can't remember that oh we tried this ten years ago it didn't work, now it's not going to work now and they don't remember that. SFI was clearly building academic excellence. They seemed to have been told now to get more involved in the industrial side and they really don't know anything about it. EI they know which industries are likely to want to do collaborative research or have the capacity to absorb research. And also know the guys in the universities who are capable of generating good IP so yeah, EI have a longer memory for sure and they know what they are doing **(COMM I2)**
- I really question how HEA disburses money not just for this project but across the board **(COMM I3)**
- I don't think SFI as an organization doesn't believe that anymore. But I believe they don't know how to tell that story politically to get the support to do it. And I think there is overlap now between what SFI and EI are trying to deliver. **(COMM I5)**
- The likes of EI, they need to effectively back off and let us go on and do it. The problem is you need to have a firm understanding of what does the government or the state wants from all these things in the first place **…** the problem was that they relied on the academic to be an entrepreneur which is nonsense, absolute, it's just crazy. To be honest, in the past every university has had a couple of examples, people that can do it; you are really good researcher and you can do the commercialisation bit, we had people that could do it, but the problem was that we are expecting too much and when you look across academics, it's probably 80% of them can't do it, 10% should never do it, should never even be allowed to try it, and 10% should help just to get them to open up …but the way the whole system was set up it was almost like a series of barriers. Okay so you want to spin off your company or you want to commercialise your research but that's the barrier **(TTO I 8)**
- It may need to get more imaginative about how to manage these universities from the point of view, generating commercial impact on what they're doing. My feeling is that SFI have a very good idea of how to get good science out the door, I am yet to be convinced that they are very good in terms of getting commercial results out of that science **(Industry I7)**

The creation of a ‘standort’ (communities, cities, states or nations) as an entrepreneurial society is considered to be a new public policy approach for generating economic growth (Audretsch 2006a). This study shows that different cultural aspects have to be taken into account. Policy makers cannot just try to adopt the American commercialisation template and their model of creating successful spin-offs without considering the differences that exist between the USA and Europe. It is also important to recognise that there are significant differences within Europe itself.

Both Irish and German stakeholders compared themselves with the USA and highlighted that there are enormous differences in ideological aspects. These aspects include the risk appetite of both individuals and companies, attitudes towards failure and social prestige. The most prominent cultural difference cited was the Europeans’ attitude towards failure. In stark contrast to the American approach, interviewees pointed towards failure being particularly stigmatised in Europe. This stigma adversely impacts upon attitudes towards commercialisation. One German academic noted that having his own company was viewed as something ‘dirty’ in university circles and that the typical academic’s focus was primarily on publishing papers.

Another important point that was made by numerous interviewees is that people are more risk averse in Europe than they are in America. This directly impacts upon the willingness of people to take on the responsibility of spin-off companies, particularly as certain personal risks arise (e.g. tenure associated with an academic position can be lost). One German government agent put it as follows:

> “Maybe the spin-off and enterprise formation question isn’t necessarily a German question. I think the situation here is just different…we have different people here than in America…and the question is ‘does it work here?’ People who study here are just not like that…only a few exist who really want that. Most want a different way of innovation transfer… I think that our research and transfer is often measured by foreign criteria…My cause of concern is that in principal we try to fill templates that fit others, but not so much us… and that’s why we have to find a German version of transfer”.

In Ireland the situation is similar. An Irish industry partner of a big American company said that “the Irish system structurally is set up for the delivery of scientific impact. It is not structurally set up for the delivery of commercial impact at this point in time.”

A CSET manager outlined the differences between the Irish system and American system as follows:

> "When it comes to commercialisation … there is a real lack of culture in Ireland around successful commercialisation … [In the US] there is a much more mature ecosystem …there is an acceptance of failure… around start-up companies. And there is much greater willingness within the university environment to let academics go back to industry and come back into academia, there is greater freedom of movement. There is a much clearer sense around the terms of creating a spin out in relation to the amount of that company that will be owned by the university, the licensing terms that will be put in place for the university. There is a much greater awareness around the sort of high-end-volume low-content model. And what I mean by that is in Ireland the universities try to hold on to the companies as much as they can and that basically reduces the amount of companies that go out. While in a place like Stanford they are all taking 1% of the company but they get a massive amount of companies going out and a lot fail, some succeed. But your 1% of something that succeeds is worth more than, well, a lot of the small companies that never go anywhere. So the Irish universities don't really know yet how to enable successful commercialisation of technology…There is a lot we need to learn and there's a lot we need to put in place culturally to enable it."

The interviewees cite numerous factors that contribute to the USA having a more mature ecosystem. Knowledgeable venture capitalists, extensive experience in IPOs and more developed senior management experience all contribute to more successful commercialisation. Interviewees generally felt, however, that it was important to point out that simply applying the American model will be unlikely to work in Europe. Put another way, the strengths that are evident in the American system are not the same strengths that are evident in Germany or Ireland. The German interviewees felt that there are significant differences between Germany and Anglo-Saxon countries more generally. For example, one TTO manager stated "In Great Britain and the USA it is quite common to take licences. It is no problem to invest a couple of thousand dollars to concentrate on a specific topic. In Germany this works entirely different". There seems to be a fear among the academics interviewed that these cultural differences will simply be ignored.

Table 25: Sample findings – Societal issues (b)

Different cultures	• There is a severe difference in procedures in comparison to the Anglo-Saxon regions. In Great Britain and the USA it is quite common to take licences. It is no problem to invest a couple of thousand dollars to concentrate on a specific topic. In Germany this works entirely different **(TTO G5)** • Maybe the spin-off and enterprise formation question isn't necessarily a German question. I think the situation here is just different…we have different people here than in America…and the question is 'does it work here?' People who study here are just not like that…only a few exist who really want that. Most want a different way of innovation transfer… I think that our research and transfer is often measured by foreign criteria…My cause of concern is that in principal we try to fill templates that fit others, but not so much us… and that's why we have to find a German version of transfer (**GOV G2)** • When it comes to commercialisation …there is a real lack of culture in Ireland around successful commercialisation ... [In the US] there is a much more mature ecosystem …there is an acceptance of failure… around start-up companies. And there is much greater willingness within the university environment to let academics go back to industry and come back into academia, there is greater freedom of movement. There is a much clearer sense around the terms of creating a spin out in relation to the amount of that company that will be owned by the university, the licensing terms that will be put in place for the university. There is a much greater awareness around the sort of high-end-volume low-content model. And what I mean by that is in Ireland the universities try to hold on to the companies as much as they can and that basically reduces the amount of companies that go out. While in a place like Stanford they are all taking 1% of the company but they get a massive amount of companies going out and a lot fail, some succeed. But your 1% of something that succeeds is worth more than, well, a lot of the small companies that never go anywhere. So the Irish universities don't really know yet how to enable successful commercialisation of technology…There is a lot we need to learn and there's a lot we need to put in place culturally to enable it. **(COMM I5)**. • I think it's part of this whole thing that Ireland needs to get better at. You need to try, you need to be able to fail and then you need to try again **(Academic I10)** • Culture matters…American companies…and the British companies are much more open as well **(Academic I11)** • Time is an issue … I find difficult to adjust to as I come back to Ireland, although I'm Irish coming back to Ireland. I just find that things take so much longer **(Academic I5)** • But what are the real barriers to commercialisation? There are so many. But key among them, certainly within Ireland, is critical mass…their absorptive capacity for technology is really poor. They are very safe players; Irish companies are not risk takers. There is absolutely a cultural aspect to it … Ireland's problem is that we have a lot of large multi-nationals. Foreign direct investment is brilliant. But you can't knock on Abbot's door. You can't knock on you know Roche's door or someone like that. They are not interested... you just you don't even register on their radar. So large multinational FDIs are often of no benefit in terms of exploitation of indigenous technology. And our own SMEs really are not capable of or do not have a culture of development **(Academic I1)** • The attitude of the Americans in comparison to the Germans…how you sell yourself, how you pragmatically approach a problem…they act professionally which is not always the case with Europeans…it is less professional…the Americans communicate better…on average the personal vanity is put in the rear. The Europeans, however, are on average more selfish…possibly, because of the green-eyed monster. The Americans interact and network more and if they want to push a research project through they do it together...in total everybody gets more...They are better in

	networking and synergising **(Academic G4)** • In the USA the university structures are easier. In Germany, in the faculty of physics, it was nearly obscene to do something like that… when I did applied science they said ‘applied physics is no physics’. In a sense they are more relaxed in the English speaking regions. In Germany there is always this suspicion that when you are collaborating with industry you are using the university …taking their money etc. And that is different in the USA and England. There is a tradition of readiness to talk between industry and university. This is not very distinct in Germany. You need to create a culture for technology transfer. **(Academic G6)** • People are too anxious; in the USA they are less anxious. I guess this is a big problem in Europe, not just Germany **(Academic G8)** • The problem is the following: It is not that it works in America and not here. It is not that they created positions there and not here. It is an ideological consideration. In America it is common practice that professors are engaged in entrepreneurial endeavours. It’s a natural thing. In Europe an especially in Germany is a dreadful separation between pure and I mean noble, recognition science and dirty applied science. And as long as this in their heads you can create technology transfer offices and stuff as much as you want. When I was saying ‘I have a company’ people here look at me as if I’d say ‘I make my wife work the streets’. Whereas in the USA, when I told them, my shoulder was hurting as everybody was patting me on the back. Here they just ask ‘How many Nature papers do you have?’ The ivory tower and the slop. This is the main problem in Germany. The other is entrepreneurial thinking **(Academic G5)** • Here there is such a culture of suspiciousness; in Germany they threaten you with the audit court right away. I would guess that I know what I need for my research and that I compare for different prices etc… and then I have to meticulously justify why I’m not taking the other one. It takes hours. It doesn’t matter if its patents or collaborations or travel **(Academic G10)** • The Irish system structurally is set up for the delivery of scientific impact. It is not structurally set up for the delivery of commercial impact at this point in time. **(Industry I7)**

The mature American ecosystem that is noted above is characterised by regional infrastructures that enable spin-off activity (O'Shea, Chugh and Allen 2008, O'Shea 2007) and commercialisation of scientific knowledge in general. These regional infrastructures "can influence the propensity for scientists to engage in commercialisation activities by providing access to spatially bounded knowledge spillovers and by shaping the institutional setting and behavioural norms and attitudes towards commercialization" (Audretsch, Aldridge and Oettl 2006 p29). The creation of ambidexterity within research institutions, in the sense that the research institutions facilitate both academic and commercialisation activities, by providing dual structures such as TTOs (Ambos et al. 2008) is a way of building these regional infrastructures. Research shows the importance of TTOs and that (1) the availability of well trained staff with commercial experience, (2) the need of an agreed and clearly understood way of managing and owning IP and (3) trust in the ability and value of the TTO's work, are critical (Lambert 2006). In this study, however, approximately 50 % of the stakeholders identified the TTO as a barrier to knowledge transfer and do not trust the TTO's abilities. The other half did not necessarily see them as a barrier but did not praise them in any way either. This latter half felt that the TTOs could not work better given the resources that are provided to TTOs.

Complementing the time issue that TTO managers have, as referenced in Section 5.2.3 above, a German PI said that "patents are just lying around and rot". This occurs as the TTO does not have the personnel with commercialisation abilities. Another German PI explained the resentment in dealing with them by saying:

> "my employees said to me 'please just keep the TTOs off our backs'…the problem with the TTOs in Germany, and possibly elsewhere in Europe, is that they got established to show success quite quickly. But on the other hand they are employed as civil servants and that means they don't profit from their successes…the only thing they can do is peddle their importance… they don't advance things, because they lack the right motivation…they tend to do technological self-gratification and nothing else."

A lot of academics distrust the ability of the TTOs. One PI acknowledged that the TTOs "capacity to deliver" what the PIs need is not there. This lack of capacity to deliver seemed evident in both Ireland and Germany. It is also present across all universities as all excellence centres have started to employ their own personnel to replicate the TTOs' job within the centres. This in itself shows that TTOs are not perceived as great facilitators.

German industry partners who had dealings with TTOs affirmed the view that TTOs are more of a hindrance than a help. One German industry partner stated:

> "unfortunately every university has technology transfer people at this stage… they are discarded civil servants…nice people, but terrible…I did not want to deal with these people who have no idea about entrepreneurship."

Lambert (2003) reports that industry partners have issues with the professionalism of university TTOs. Poor marketing and negotiating skills (Lambert 2003, Siegel et al. 2004) plus overly aggressive behaviours in exercising IPRs (Siegel et al. 2004, Ryan, Wafer and FitzGerald 2008) are mentioned as barriers for the commercialisation of scientific knowledge. While this study confirms that industry partners have issues with the competency of TTOs, it finds that TTOs in both countries tend to overvalue the IP. Both Irish and German industry partners pointed out the overestimation of the IP's value. A German industry partner even added that this is a factor that inhibits further contact with them.

German government agents were also not convinced of TTOs' ability to help with commercialisation endeavours. Irish government agents, on the other hand, did not mention the TTOs. This might be due to the fact that Irish TTOs are financed by one of the government agencies.

In sum, TTOs are perceived as mainly dealing with the protection of IP and are either not able, or have not enough time and resources, to execute the commercialisation of scientific knowledge or to protect IP. While this might not be a problem for excellence centres, as they employ their own commercialisation specialists and IP managers, faculties will either have to do the commercialisation themselves or, more likely, the commercialisation will not happen at all. In addition, TTOs overvaluation of IP alienates industry partners, thereby preventing collaborative projects from being repeated.

Table 26: Sample findings – Societal issues (c)

TTO	• When you are talking directly with people, when you establish mutual trust and then in a sense central services [TTOs] are toxic. They are good when you need some support information but if you have to use them, and then others think for you, and even if they mean it well, do things that do not serve the purpose and without consultation, then they are crap **(Academic G11)** • I think the patents are just lying around and rot because we do not have the commercialisation abilities…we just do not have the right people. **(Academic G10)** • I don't think that [the person in the TTO] understands what we are doing. **(Academic G4)** • My employees said to me 'please just keep the TTOs off our backs'…the problem with the TTOs in Germany, and possibly elsewhere in Europe, is that they got established to show success quite quickly. But on the other hand they are employed as civil servants and that means they don't profit from their successes…the only thing they can do is peddle their importance… they don't advance things, because they lack the right motivation…they tend to do technological self-gratification and nothing else **(Academic G6)** • I have to say, honestly, the technology transfer office is more of a hindrance than a help **(Academic I7)** • I have had instances in the past whereby that process is terribly slow …In terms of earlier patents… the TTO …I think to be frank they were good generalist but not good specialist. And I can point out at least one case whereby I didn't feel their advice was good. **(Academic I6)** • The TTO … needs to be much more supportive as opposed to just an office which takes paper points or something like that….They are short skilled out there and everybody is terrified of that; absolutely it can make things very difficult… I suppose at the moment it's very much, you can't do this, you can't do that, you can't do this, you wouldn't be allowed to do that, you wouldn't be allowed to do this, so it tends to have some more negative approach than the positive. So I think we need to change that image in some ways ... But also most people in the TTO have never started the company and so they are the last people who should be there in some way; so maybe we should have other people. Maybe we should build a bigger community of people who are retired or something, with more time in there hands to help support things or whatever, it has to be beneficial. **(Academic I13)** • The TTOs overestimate the value of their IP **(Academic I6)** • Their [TTO] capacity to deliver what we need is not there. So we have people here whose job it …is to take ideas which are the basis of the inventions that were written up by PIs and the students and Post Docs and to translate them into something that are a proof of concept. And to do it in a way that understands what the market's looking for. And so their job is to basically take the idea, gather all the knowledge, suck dry all the information that's in the lab and develop what we call SOP, Standard Operating Procedures, write a manual on how to do this then develop a prototype and then try to market the prototype. And that I think is the way forward.**(Academic I8)** • It is a disaster, it is a complete and utter disaster…and my academic colleagues will raise their eyes to heaven if you mention any of our TTO offices, with the exception of maybe [name of one TTO]. They are just a phenomenal barrier; just in terms of, like, the exhaustion of dealing with them puts you off, let alone anything else…I'm sure if you talked to them they'll say…the bad one is the academic, you know. And I'm actually not bad at dealing with people and we've spent a lot of time building up good relationships and I'm getting better at understanding the different viewpoints and things like that and I really want this stuff to succeed and despite all that the progress with them it's just…arghhhh… This was the most God damn awful experience. I'm not saying they're not working hard, that they're not doing anything that's useful, it's horrendous, it puts me

off commercialising anything. **(Academic I10)**

- We do not need intermediaries, but a telephone number, which is lying somewhere on an industry partners desk, who, if he has a question, should call the professor and that professor has to pick up the phone and not some kind of technology transfer person who, after all, can only convey the question…we do not need intermediaries, but direct contact **(GOV G2)**
- Such relationships with Schering or Roche are much more effective than a Technology Transfer office can ever be. **(GOV G3)**
- The tech transfer offices …I don't think people have really decided what they want them to do yet. I am not sure they are well enough funded to do what's needed. And I think they have not been given enough freedom to go and do that as well. I think there is too much interference for what the tech transfer offices are trying to do… But what I fail to see is … the universities really making the tech transfer office as core to their business. I don't think we've seen successfully yet really senior tech transfer people from abroad being brought in who have done this successfully and are now going to drive success in Ireland by using their experience **(COMM I5)**
- Based on the poor service [of the TTO] we decided to get a proposal manager ourselves. 20 professors is probably the maximum a person can look after….you need a personal relationship with them… At the [name of university] there are what 800 professors? They cannot service them individually … There is a need to do it more individually with people who champion it, who are passionate about it…I met a few of them…some had no clue about industry, no idea…maybe they read the newspaper…and it can't work this way…Moreover, they get no percentage, so they have no interest to change it and look hard to find a partner who would buy a patent **(COMM G4)**
- We have difficulties with the Bayerischen Patent-Allianz; it doesn't work that well. Their conditions are supposed to be in favour of entrepreneurs…but they offer normal conditions…they want a big part of the cake, and that is a pity…so the negotiations are difficult **(COMM G1)**
- I perceive these offices as more of a hindrance. The dialogue is usually made complicated through licence rights before any value has been created. We do not just need the university for idea generation but also to examine and help translation and launch… The credibility of the product depends on the active usage in research and the associated publications **(Industry G6)**
- Unfortunately every university has technology transfer people at this stage…in my opinion they are discarded civil servants…nice people, but terrible…I did not want to deal with these people who have no idea about entrepreneurship **(Industry G2)**
- The IP can create barriers. It is more difficult at a dedicated patent office as opposed to a university. But there are difficulties at universities too…when they don't want to sell the rights for an appropriate price or have unrealistic expectations on the potential of the success or turnover. **(Industry G12)**
- Technology transfer office yeah that's a big question. Technology transfer office has a place but it should … not [be] in every university. There should be a single technology transfer office… Not in each university. So, for example, there's the platonic community in Ireland each creating new patents. Those patents are more valuable together than to split off to different directions. So if you've got technology transfer offices in every university, what is their success milestones? [It] is absolutely useless in the greater scheme of things **(Industry I3)**
- And so the university either spend all their time with certain people… like [name of TTO] bargaining with business people ever before you sit down and do the research. And Japanese version is completely different. Japanese version is you do the research, it changes the world and then you [negotiate], whereas here the view is you try to negotiate everything up front, talk things to death before you get off the ground. **(Industry I4)**
- I think we tried a full year to buy a patent…but they had crazy expectations. So at the end we said 'forget about it'. **(Industry G9)**
- Technology transfer offices tend to significantly overestimate the values. This then inhibits the contact **(Industry G11)**

	• Generally the question I'd ask is whether or not they are overvaluing the research assets that they have. My feeling is that in some cases they probably are and I think if I were to make a guess, I would say from the point of view of the metrics that are asked to work towards, they have to overvalue the assets that they have got. Because they have to show that they are progressing, somehow or another, various research assets along various steps towards commercialisation, even though in some cases I think an analysis would show that there wasn't really that much hope for some of the bits of technology that they're trying to push through to get the commercialisation. Or it would require much bigger effort than they actually are aware of to bring the assets to a level of maturity or depth that they are truly commercially viable **(Industry I7)** • I hope I don't sound too cynical…but I didn't expect a whole lot [of the TTO] and unfortunately exactly that happened. The transfer was catastrophic, especially the time horizon **(Industry G3)** • That is quite ambivalent…I get the impression that they are lacking experience…they need to invest money to go to external specialists to be quicker and more professional…my experience is that they are quite slow … and when we are interested in something and tell them to patent so that we can talk about licensing afterwards …it takes them 2 years to write a patent…and that is so frustrating. **(Industry G8)**

The legal framework, and particularly the IPR protection process, was identified as a barrier. While all stakeholders acknowledged that IP has to be protected, they questioned the modality. The issues with the legal framework can be broken down into three parts of the process. The first part takes place when the framework for the collaboration is being negotiated. The second part involves the protection of the IP and the third part concerns the enforcement of IPR.

The negotiations that occur before a single experiment has been conducted can be protracted. These protracted negotiations impact directly upon the validity of the research and tends to undermine the IP that is generated. One Irish PI explained that "ideas aren't static. Ideas go stale and intellectual property goes stale very quickly. By the time you protect something it's gone". An Irish academic cited a situation where an IP agreement was in place but the connected consortium agreement took another 18 months to negotiate. While there may be quite complex issues that contribute to this delay, the barrier created by these delays is obvious. When one considers this against the backdrop of the conflicting time horizons envisioned by stakeholders, as discussed at Section 5.2.1, the irritation that was evident in the interviewees' comments is understandable.

There are a number of factors that contribute to frustration with the protection of IP. One of the main factors is the unrealistic conditions that TTOs attach to IP. An Irish academic summarised it by saying that universities want a large portion of the IP and there is a lack of appreciation that having 5% of something that is successful is better than 30% of something unsuccessful. This issue is exacerbated by the TTOs' efforts to protect large amounts of IP rather than focussing on smaller amounts of IP that stand more chance of being successfully commercialised. A German multinational industry partner commented as follows:

> "The aim is to get revenues from patents…but even in the USA it is only a fraction…that means it is a misconception and it cannot be the ultimate goal…you have to view it as a whole. The contribution to society is to invest in research and get a societal return on investment, new jobs and products. But what happens is that they patent a lot and the patents are not well protected and 90% of them are never exploited. The question should rather be how do I find long-term partners, with whom I can jointly patent and can do really good patents, which are well protected, which can be developed further and grow in substance."

Another significant barrier in this area is the lack of trust that TTOs elicit from other stakeholders. The stakeholder charged with protecting IP is responsible for ensuring that the other stakeholders' interests are realised. If that stakeholder is not trusted then conflict is inevitable. The frustration expressed with the IP protection process aligns with the views expressed on the TTOs' role, as discussed above.

The third part of the process (i.e. a lack of enforcement) needs to be considered when considering the value of dedicating large amounts of resource to high-volume IP protection. In the absence of a credible threat of enforcement, IPRs will be vulnerable to exploitation by parties unconnected with the research. If this occurs then the efforts to protect IP will be entirely undermined. As TTOs spend almost all of their time protecting IP they lack the resources to investigate whether IPRs are being infringed. As a result the legal procedures that would protect the IP are not invoked.

In sum, there are several aspects of the legal framework that can constrain the formation of partnerships and the successful exploitation of scientific knowledge. The findings show that there is frustration with the current approach to this legal framework in both Ireland and Germany. Given the significant issues that arise in this area, the interviewees seem to be of the view that there should be a major rethink of IPR strategies and the time allocated for protecting IP.

Table 27: Sample findings – Societal issues (d)

Legal Framework including IP	• The IP ownership and the selling royalties' rates…that's certainly a challenge and it can lead to a long and retracting negotiations which don't necessarily add value **(COMM I6)** • I think those agreements are very complicated and what they result in is they put barriers around the projects. So they prevent companies bringing background IP into the programs. Because if you bring background IP into a program that's got half a dozen companies working in it, that company's disclosing confidential information in a very broad way. Now that's an inhibitor to the program. If we've got a single one on one relationship with a company, you've got flexibility about how you scale it. And a lot of time companies don't bring background IP. But if they do it's protected and it's ring fenced. So you've got the capacity to create customer-oriented programs…I think if the number of companies are working on the same research problem it makes sense to have a common IP agreement. But it doesn't make sense to have a common IP agreement if you've got companies working on a selection of discreet problems within a center. **(COMM I5)** • There were intellectual property barriers to it… a few different things contrived to actually stall the projects. One was the question around IP …and then the researching base came in and the company the main sponsoring company, kind of lost focus on it**.(COMM I1)** • Licensing is always an issue; it's necessary but...investors also don't like it. There are terms and conditions that can make the project unsellable. …The people that are best … it's their money and they think that the technology is good…its money that's going in and they like it to be as flexible as possible if they want to be equitable, a lot of collaborations but they do expect us to contribute. I think there has to be flexibility in licensing…. [With this project] they're all from different colleges…but everybody can't have 5% because its 5% of all of it that's the product that's what people the VC isn't going to put money in and they still want me to persuade them to do so, you know, and it will be an interesting balance and how it is balanced between the various locations or is it drawn under the umbrella of [the centre] and everybody is happy with that? **(Industry I5)** • First of all the IP agreement was a long and arduous process to get it in place. **(Industry I2)** • I appreciate that everything needs to be adequately signed off and protected and that's when we can over complicate things and even scare each other off with regards to non disclosure agreements and signing off on common agreements etcetera when the first experiment hasn't even been done. I gave you an example, I mean I actually applied for a grant once…I got the grant and the grant was accepted within, I think it was about six weeks. It took me about eight months to go through the weekly department just to get, try and accept it. And this was even before we've done a single experiment…it can take up to six months to actually be allowed to start a project that might just be a crazy idea but sort of try and… it's really important to get it right. **(Industry G3)** • The aim is to get revenues from patents…but even in the USA it is only a fraction…that means it is a misconception and that cannot be the ultimate goal…you have to view it as a whole. The contribution to society is to invest in research and get a societal return on investment, new jobs and products. But what happens is that they patent a lot and the patents are not well protected and 90% of them are never exploited. The question should rather be how do I find long-term partners, with whom I can jointly patent and can do really good patents, which are well protected, which can be developed further and grow in substance **(Industry G1)** • If a technology is perceived as interesting by an industry partner, you usually find a bad patent situation where the product or process is badly protected or later patents are inhibited through prior publications **(Industry G11)** • Countries with less tradition [in commercialising IP], such as Germany and Europe offer immediately unreasonable conditions…but they should do

	that to build up their system **(Industry G2)** • One of the things on my very long list of things we need to sort out is to rewrite a whole new IP policy on how we do all that **(TTO I8)** • [University] doesn't all the time screen whether our patent's being infringed **(TTO I6)** • The limitation in our job is that we spend a lot of time protecting the IP and we don't spend enough time trying to commercialise…it's too time consuming **(TTO I7)** • So there's typically a lot of joint activities between the universities which is advantageous for the research but it creates certain challenges particularly around intellectual property and commercialisation. I think the TTOs could standardize their processes and procedures for commercialising property out of the University. Working across four universities for four commercialisation strategies with four transfer office preferences and stuff like that so that's a challenge. It would make it easier if we had one standard in national policy to work … that would add a tremendous amount of value for commercialisation and our partners... If you talk to some of our partners, we spent a lot of time earlier on research agreements I think a year and a half and there were a lot of unhappy people at the beginning… so you have four tech-transfer offices negotiating against nine companies… so it just took a long time **(TTO I3)** • A big minefield certainly licences and patents etc. this is an entire new field for academics…from my point of view the this is the biggest barrier… at my old university they just wanted us to patent and every publication was searched whether there was an opportunity to patent something. I think you have to rely on quality not quantity **(Academic G1)** • Everything that is invented at the university has to get checked and will then according to the Employee Invention Act get used or not. I have had a few bad experiences because of that and I it annoyed me. Since then I have patented 3 or 4 more at the university…and Bayern-patent paid for them. If you will pardon my saying...this is wasted money… if a company like Samsung tries to infringe a patent I don't think anything would happen…and if we want it to be like in America things have to change **(Academic G10)** • A big problem at the moment is EU full cost accounting which leads to double the amount of research costs for industrial enterprises. This is an enormous barrier. We have huge difficulties with it at the moment, as our group has a big share of industry funding. Some industry partners have already left because of the horrendous costs **(Academic G8)** • Big impediments are the legal departments on both sides. The two aspects are IPR and liability. Liability is understandable, but IPR is not as both parties always self-display so much that they don't agitate the subject constructively anymore. The problem is that the university has a focal idea about the IPR **(Academic G11)** • In terms of internal barriers…That's down to individual universities and so there was an overall IP, a consortium agreement and IP agreement, you know, surrounding the whole thing, locally we wanted to bring in some extra fund resources …but our TTO insisted drafting a new IP agreement for them which did hold things up, so that I viewed to be barrier.**(Academic I6)** • There are definitely some hindrances in universities in terms of some universities want to have a large proportion of, own a large proportion of the IP if you're setting up a company and that can be a hindrance. They don't seem to realize that they're better off having 5% of something that makes money than 30% of something that doesn't make any money in the future **(Academic I4)** • Because there are more institutions involved, we have to sign a consortium agreement. I don't know why, because we have an IP agreement and basically what [we] wanted the consortium agreement to say: 'we all are happy to work together and we follow the IP agreement.' But the consortium agreement is now 268 pages long. But the really crazy thing is it took 18 months to sort out. So I find that crazy, I find it crazy that you can't go get one consortium agreement, one standard IP agreement or one… there is something fundamentally wrong with that system, including on

	the company side. Because lawyers have faced problems so they took us 18 months through the IP agreement. It took us two years to negotiate the consortium agreement **(Academic I10)** • Everybody is too worried about protecting IP. I think that the problem is ideas aren't static. Ideas go stale and intellectual property goes stale very quickly. By the time you protect something it's gone...I honestly think the way we are doing it now doesn't work because it's not generating the returns that people think it should generate. And the truth is most ideas are wrong they are just wrong. It doesn't matter how personally invested in them you are, they are wrong, it's just life. And what we need is lots and lots of turnover of ideas, lots of testing of those ideas and the ones that are correct we'd hit on very, I won't say quickly, but we will get them **(Academic I11)** • No I think it's rooted in the university but I'm not convinced that the university know how they should be doing it. Like I said for a long time there was this idea that we have to patent anything that's vaguely patentable. But you know what's your success rate going to be? How many, what fractions of those things are ever going to lead to anything? Would you not be better off trying to be more focused and spend more time identifying the real things? And the problem with the intellectual property people, the research office don't see is that for every invention disclosure form that's filled out, that's delaying publication of the paper which is the academic's real target. So you build up…if you force them to fill out an invention disclosure form for something that they know will never go anywhere you're building up a lot of resentment **(Academic I9)** • I appreciate that everything needs to be adequately sort of signed off and protected and that's when sometimes, and we can over complicate things and even scare each other off with regards to signing off on common agreements etcetera when the first experiment hasn't even been done… it can take up to six months to actually be allowed to start a project that might just be a crazy idea **(Academic I12)** • Actually what we should be doing is having a completely open source model of some description that would walk away from the old patent law way of doing things. Now how one would do that I don't know, but I suppose one way of thinking about it is, this is a strange analogy but it's the only one I can come up with at the moment. There is no copyright for recipes it doesn't exist, there have been attempts to copyright recipes but it just simply doesn't exist. And the reason we have such wonderful food is because you've got thousands upon thousands of chefs stealing each other's ideas and competing against each other all the time. And my own feeling is actually we should be thinking much more about how we can generate an environment like that where things can get tested regularly **(Academic I11)** • The legal framework that has to be put in place before proposals are submitted tends to be enormous…I think there's too much emphasis on intellectual property and particularly the universities may not be allowed access in some ways. And so we shouldn't automatically assume that we own everything and then try to force, to protect us, we should maybe give a little bit more, be a little more open that way **(Academic I13)**

5.3.4 Nature sphere

Nature is understood in terms of the environmental context; different societies, regions or cultures have diverse attitudes towards environmental factors (Rüegg-Stürm 2003). Issues that influence scientific-knowledge commercialisation, and especially its creation, include resources and deficits in resources, environmental intervention or other issues such as climate. The nature domain postulates the necessity to take the paradigm of sustainable development into account where relationships between firms and loci are considered (Gibbs and Krueger 2007). New economy firms see sustainable development as an essential part of their progress and economic growth. Regions such as Boston show that economic success, quality of life and 'good environment' are connected to each other. Although the theoretical underpinnings are still questionable it is an important consideration.

The study did not find particular barriers or factors in this regard. The increasing interest in life science research, however, may be an indicator of environmental impacts that lead to more research in this area. Similarly, an environmental impetus such as the Japanese nuclear catastrophe can influence future research and development in the field of generating and sustaining energy. The ecological sphere should, therefore, not be excluded when considering the contextual environment and is worthy of future exploration.

5.3.5 Conclusion on contextual spheres

As noted at the outset, the contextual spheres cannot be rigorously distinguished and a degree of overlap and interaction between the various spheres is to be expected. The results seen in the economy sphere will be necessarily linked with the speed with which the technology sphere develops as resources are generally a pre-requisite to developing the technology sphere. In the same way, the society sphere will be influenced by the standard of the technology sphere and the security, or lack thereof, which is being experienced in the economy sphere.

From the results of the economy sphere it can be seen that there are divergences between German and Irish economic backdrops. The Irish funding levels are unsurprisingly suffering from a retraction of funding levels. The German economy sphere appears to be in comparatively good shape. The consequence of this contrast is evidenced in the interviewees' views on the adequacy of current funding levels. In an Irish context these views are starker due to the demands that government agents are making in terms of commercial results. The importance of maintaining competitive levels of government funding was also evident in the comments of industry partners. A further consequence of the drop in Irish funding levels is that question marks have arisen over the Government's long-term plans for developing the knowledge economy. The apparent divergence in views between when funding should start producing commercial results is troubling.

The study showed a clear divergence in the importance of the technology sphere to different industry sectors. As life science research develops in a slower manner it is more likely to attract strategic investment and support from industry partners. The high-paced development in sectors such as ICT, however, makes long-term investment by industry partners less attractive. The timelines for generation of commercial results in ICT is relatively short and therefore represents a less attractive investment proposition for industry for long-term investments.

The results show that the society sphere is very complex. A number of different relevant factors within this sphere were identified from the interviews. The interviews showed that conflict between the Irish academics and Irish government agencies was more prevalent in Ireland than in Germany. The SFI and the HEA came in for particular criticism, with the perception among Irish academics being that the political story was not being told very well by these government agents. Conflict between these stakeholders in terms of the anticipated time horizons for generating commercial results was also very evident. Some of these divergences raise major policy questions and are discussed further below.

There seemed to be a general perception that the American system is being used as a model for European systems. The interviewees expressed strong doubts as to the appropriateness of this approach. The strong cultural differences between Europeans and Americans were cited frequently. Some interviewees seemed to be of the view that the strengths of European countries were quite different to the strengths in the USA and there was concern that these differences would be ignored. In the same way interviewees pointed to differences between European countries and noted that these differences must be borne in mind when developing frameworks for commercialising scientific knowledge.

TTOs came in for strong criticism from stakeholders. TTOs were generally viewed as ill-equipped to assist with commercialising scientific knowledge. While it was acknowledged that TTOs worked to protect IP and that this was necessary, it was noted that the methods employed by TTOs to do this represent a barrier. This is exacerbated by the TTOs failure to take positive steps to investigate if IPRs are being breached and to enforce those IPRs where necessary. Furthermore, TTOs are not seen as enabling the commercialisation process and many interviewees view TTOs as being poorly placed to act as an intermediary between industry and PIs.

The legal framework was regarded by interviewees as being overly cumbersome in its present form. Delays caused by this cumbersome framework were experienced both before collaboration commenced and at the point in time that IP is being protected. These delays serve to increase the risk that the IP generated will become stale and can, therefore, undermine the objective of commercialising that IP. There was also a lack of confidence that IPRs would be protected through enforcement where necessary as TTOs were seen as lacking the resources to carry out this task.

5.4 Most significant factors for scientific-knowledge commercialisation – Importance of relationships, interaction and networks

All stakeholders in this study highlighted the importance of relationships and interaction. There was common agreement that technology transfer and collaborative research projects depend on people. The establishment, existence and retention of relationships were perceived as important in order to have potential partners for continuous or future projects. An Irish academic and excellence centre manager pointed out that "it's all about the relationship, if they are comfortable with you and they understand what you can provide then that makes a big difference". Two other Irish PIs explained that nothing would happen without personal relationships and that there would be no access to funding, equipment or knowledge or repeated collaborative projects. A German academic summarised the importance of relationships by stating:

> "Number one is the human factor, which is always underestimated. People interact and if they do it well, you will get results. If they don't get on, you won't get results. You cannot contractually regulate interpersonal interaction. The most important factor for technology transfer is personal relationships."

Commercialisation managers, government agents and industry partners also acknowledged the importance of relationships. Commercialisation managers and government agents explained that companies retain links with researchers. An Irish commercialisation manager pointed out that it is about gaining a company's trust. Similarly, a German industry partner said that "lasting relationships are of course the nuts and bolts…because business is done with people". He further explained that it is not possible to develop something and sell it via email. An Irish industry partner even admitted that they have no interest at all in licensing, but that their main aim at the moment is to engage in collaborative research to develop knowledge and relationships with the institute and PIs. Government agents in both countries confirmed that relationship building with companies is of utmost importance. A German government agent said that "relationships with Schering or Roche are much more effective than a technology transfer office can ever be." This statement highlights the aforementioned question as to whether we should follow the American spin off route or focus on collaborative relationships.

TTO managers, on the other hand, acknowledge the importance of relationships and interaction with companies but are more concerned about the relationships with the PIs. While this relationship is necessary in order to enforce IP protection, TTO managers see building this relationship as crucial to their being an effective part of the commercialisation process. One TTO manager stated that “Ideally, they don’t just sort of engage with us and walk away. They’d stay engaged… if we can encourage the PI’s to engage with this office, this builds up a relationship, builds up that they understand what we can do for them”. This finding supports the view that TTOs are more involved in protecting and identifying IP than commercialising it and illustrates that TTO managers see their relationship with the PI as being crucial to their successful integration into the commercialisation process.

Some of the interviewees elaborated on where they see opportunities for building relationships. One Irish academic pointed to universities’ student bases a rich source of potential contacts for industry. This same academic feels that this is neglected as people undervalue the importance of the personal social relationship.

The importance of these relationships was emphasised by all stakeholders with some stakeholders pointing to the human factor (i.e. the interpersonal relationships) as being of primary importance. Those academics and universities that had long-standing relationships pointed to them as models as to how things can work. Some pointed out that scientists have networks that pre-date their involvement with their university and that these pre-existing networks are important to leverage off. In sum, relationships and interaction with stakeholders are considered to be the sine qua non for scientific-knowledge commercialisation.

Table 28: Sample findings – Importance of relationships and interaction

Importance of relationships and interaction	• We put all this time and effort into training these people, our students. But we put the cap on, we give them their scroll and it's bye-bye. But these people largely end up not in academic careers, they end up in careers out in the commercial world and we don't track them … And you find this regularly, that there are lots of these people that are not very good at continuing the relationship with them. And this is something that we really should be doing… In the end people undervalue, and shouldn't, the importance of the personal social relationship. **(Academic I11)** • It's about the relationship, if they are comfortable with you and they understand what you can provide then that makes a big difference **(Academic I8)** • Once you start interacting with an industrious sponsor ... without the funding we've gotten from them then we wouldn't be able to do the level of basic research which we have achieved to date **(Academic I5)** • Critical…going out and meeting people is particularly important and some of the minor or junior colleagues who don't know how to do that tend to be very much office based as opposed to getting out to actually seeing what's going on **(Academic I13)** • One of the issues that we also had was we didn't have good clinical networks. We are scientists, we are measurement scientists and we really hadn't developed the links into the clinical environment and the specific areas of clinical expertise **(Academic I1)** • If there isn't a personal relationship there nothing will happen. You need a good relationship with somebody on their side who would say this is worth my while going through all the hassle. So without the good relationships there, it just won't happen. A student won't get a placement, you won't get to use equipment on their side or whatever else there is so it's key **(Academic I6)** • I have a set of people that have worked with me for a long period of time and I knew them very well and I have worked with them very well. It's nice, you build a relationship and you use that relationship to develop **(Academic I12)** • Technology transfer is about relationships. If there is a poor working relationship between the technology transfer office and the team of PI's, nothing is going to happen. And equally if there are adversarial relationships between the technology transfer office and the companies on legal matters, then it slows down the process, it can make it difficult **(TTO I4)** • The only way you are going to work with principal investigators on successfully commercialising it is if you are on the ground and get to know the people … I realised that there was no point in pulling the reporting requirements, in saying all of the universities will just report to their IP. That will not work. Equally commercialisation of the specific projects won't work unless you have the researchers working with you and again if that is not here the researchers won't trust the people **(TTO I5)** • Ideally, they don't just sort of engage with us and walk away. They'd stay engaged… if we can encourage the PI's to engage with this office, this builds up a relationship, builds up that they understand what we can do for them **(TTO I7)** • When they were started, there was no real history of this collaborative research, so the main thing is to build the relationships at the beginning **…**So this is very much relationship building, it is important that the relationship between the researchers and the companies grows **(GOV I1)** • They'll often go back into the university and retain links with the university because what they [companies] want is not just a license that they get out of it, it's the link which people do really know the technology inside out…people don't understand that all of this is down to people at the end of the day. People and researchers tend to think that technology is sufficient, technology is good enough it will find a way. At the end of the day that's not true…It's all about links yeah. It's all about stakeholders… and it's networking…You gotta have the right people; if you've got the wrong people doing the right research, forget it. I know it's a bit blaspheme, it's a bit cliché but if people are doing this and they don't want to do

commercialisation it takes a lot of work **(GOV I3)**

- It depends so much on the personal relationships. And the only way to do that is slowly and over time and for people to be able to trust you that whatever you say I can do this project. They know that you mean you can do exactly what it says on the piece of paper, as opposed to give me some money and I'll go away and do some nice papers **(COMM I2)**
- It's personal links, it's always personal links **(Industry I4)**
- We're never going to be licensing anything of them. It's knowledge and relationship development **(Industry I2)**
- Relationships with Schering or Roche are much more effective as a Technology Transfer office can ever be. **(GOV G3)**
- Lasting relationships of course are the nuts and bolts…because business is done between people. A lot think that they can develop a good product in their basement and then sell it via email. This is bullshit. **(Industry G2)**
- Number one is the human factor, which is always underestimated. People interact and if they do it well you will get results, if they don't get on you won't get results. You cannot contractually regulate interpersonal interaction. The most important factor for technology transfer in personal relationships **(Academic G 8)**
- Strong collaborations are often initiated through people who might have done their PhD with us and went into a company who just have this strong link with the institute. I think this is one of the more important things **(Academic G7)**
- Our longest partner is Siemens …we don't influence it here. This is down to the personal relationships with individual people **(TTO G3)**
- Our scientists have relationships which existed before the institute **(COMM G2)**
- We should have a regular interaction channel back and forth between people **(Academic I11)**
- I think there should be much more involvement in that if possible. And I think we don't engage with industry often in the right way so we try to have people come in from industries and give talks to students **(Academic I13)**
- I don't think websites are important, like putting stuff on the TTL website, I don't think you normally get any kind of inbound activity from that. I think what's really important: you have to be proactive with this stuff. It doesn't get commercialised in a vacuum. The only way to generate license is to go out there, pound the pavement and find companies who are interested in it **(TTO I3)**
- You get people into a room and you don't even have to have an agenda. You just get people into a room and get them talking with each other, if you get them all to do five minutes high profile bios of what they do then people realise, Jesus this person's doing this, they can help me or I can help them sort of thing. And it's amazing, it really is amazing; there're institutes here in Ireland where that doesn't work. You have people sitting next door to each other, they don't know what they are doing ; they don't know what each other's doing nor do they want to actually interact with other people. And I think that's very negative and it's not good for the system and now, like, for Ireland to succeed people have to be in a situation where they're willing to work together **(GOV I2)**
- So one of the major things that came out of the strategic review was…that Enterprise Ireland and IDA plus SFI get more involved with [centre] as a group to actually promote their industrial relations to promote the commercialisation potential **(GOV I2)**
- What I would like to see is regular interaction between industry and scientists. That industry people would stay at the university to do a joint project for example **(GOV G2)**

When considering the importance of relationships and interaction the interviewees reported the need to build multidisciplinary networks. An Irish PI outlined that a project is effectively only as good as its network. According to German and Irish PIs the driver of successful knowledge commercialisation is forming multidisciplinary collaborative networks. These networks should have access to reliable sources of technical and market knowledge and enable technology testing (e.g. access to clinicians and hospitals in the life sciences or product innovation testing within industrial settings as opposed to unrealistic lab spaces). An Irish PI explained:

> "One should share the output with any company, Irish or international. Keep them, develop them as a network. Keep them informed of your progress and what you're doing, not how you're doing it…you don't have to give away the technical aspects, because at the end of the day the companies don't care how you are doing it…sharing that knowledge, getting their steer… I do think that a wider engagement is more likely to bring benefits…having interaction with industry…understand the Irish context globally. Obviously globally there could be lots of companies that may be interested in exploiting the technology and it's about communicating and networking with those. So it's about getting out there and having that interaction…Involving the right people, connecting, interconnecting…has been a real support driver…there is a knock-on effect at building those relationships."

Industry partners also accentuated the knowledge dissemination aspect and the network view was supported by all stakeholders. Some refer to it as pooling people, networking or building an ecosystem where stakeholders engage. The message is, nevertheless, that identification of commercialisation opportunities and successful commercialisation is more likely when stakeholders build multidisciplinary collaborative networks. The findings show that relationships and interactions between persons with market and technical knowledge influence entrepreneurial activity. In order to get access to people who possess commercial and technical knowledge, it is important to join or establish stakeholder relationship networks.

Table 29: Sample findings – Build networks

Build networks	• I think there should be a looser relationship… I think that one should be allowed to share the output with any company, Irish or international. Keep them, develop as a network. Keep them informed of your progress and what you're doing, not how you're doing it. What I mean, you don't have to give away the technical aspects cause at the end of the day some, so really the companies don't care how you are doing it…sharing that knowledge, getting their steer … I think that would be a useful model. And I do think that a wider looser engagement is more likely to bring benefits…having interaction with industry…understand the Irish context globally. Obviously globally there could be lots of companies that may be interested in exploiting the technology and it's about communicating and networking with those. So it's about getting out there and having that interaction…Involving the right people, connecting, interconnecting…has been a real support driver…there is a knock on effect at building those relationships **(Academic I1)** • In terms of collaborations …forming networks and forming collaborations…so sort of networking…if you're not able to network in an industrial environment …then you really are, sort of your projects won't take off… there needs to be a disciplinary collaboration and all, we collaborate with the clinicians too so it's not only industry partners we collaborate with. We also collaborate with a few of the neurologists and psychiatrists**.** Essentially you really are as good as your network and your project is as good as your network. **(Academic I12)** • There's a driver… there is one of collaboration and competition and continual testing of what it is that you think. And that gives you a more reliable source of knowledge. So basically what they needed was access to patients and they needed access to pre-clinical models etc. They needed access to research instrumentation. They needed access to a whole lot of stuff that they either didn't have or couldn't make work for themselves. And they came to us for a very simple reason, to put together the program that they put together with us would have required them in the UK to work between about seven or eight different universities. So there…we have people who are interested in patients, people who are interested in pre-clinical models that can be applied to patients etc. **(Academic I11)** • We are starting with industry partners and clinicians and it works quite well…So to be part of the network **(Academic I13)** • One thing that I think is very promising is that you try to form international networks…that you get rid of these closed research groups with walls, where no information leaves and try to collaborate with the key players on a global worldwide level **(Academic G7)`** • You need to build your own networks…there are all these publically organised networks…but they are all for one's arse **(Academic G11)** • It all depends on people. My experience is that it all depends on the people involved and that they are connected with different areas **(Academic G8)** • One suggestion would be if universities could get their academics more networked and into cohesive groups either within the university or the university with hospital or universities with industries that could be a way to attract more funds **(GOV I4)** • Research centres and everything outside the university has to be bridged. That there is networking so that the excellent researcher don't have to leave to the Max-Planck Institutes where they don't have to lecture. Closer networking with them **(GOV G3)** • Build a network, especially a local one; obviously they have international contacts…but as a first instance they need to build a nucleus there **(GOV G1)** • The most important factor is to be part of a network and to be open…to show interest in technology transfer no matter what the direction is **(TTO G4)**

	• Technology transfer is based on networks, personal networks…People say not for nothing technology transfer is a people's business **(TTO G1)** • Networks are everything **(TTO I2)** • Networking trying to research companies trying to see what they do, looking at industries **(TTO I7)** • You have to build the ecosystem, you have to engage all the stakeholders, if you look at how one of this things comes together there is an amazing degree of actors in the system that come together and collaborate this way to bring about an outcome. So, we spent a lot of time actually engaging folks within the community and folks within the [specific] industry and outside the [specific] industry cause you never know how you are going to get to a commercialisation opportunity **(COMM I4)** • You have to pool people…with industry partners…among the researchers themselves…interdisciplinary working groups to form a trusting, open atmosphere where you have the option that researchers can exchanges their information. I think this is what makes us successful **(COMM G5)** • A crucial element are networks…so that the company can develop products and services that are relevant to the market and needed by the customer and user, but also that the clinical products are quickly developed with adequate user relevance **(Industry G13)** • One of the biggest factors which accelerates knowledge transfer is just knowing what people do; knowing what, the various aspects that people are working on and just disseminating that knowledge as much as possible within the centre and to the partners **(Industry I1)** • It's building a network in a particular segment, in a particular market segment and, and that's vital **(Industry I2)** • The bundling of knowledge beyond the institutional level is important…bundling the know how of different institutions and disciplines in clusters or whatever you want to name them **(Industry G1)**

5.5 Conclusion

The interviews show that there is a high degree of similarity between the Irish and German systems for commercialising scientific knowledge. An analysis of the results, however, reveals that the contextual and interaction spheres give rise to different issues and barriers. These different issues and barriers mean that different approaches are likely to be needed to influence collaborative research and scientific-knowledge commercialisation in both countries.

In terms of the similarities that were shown up by the study, the Irish and German systems are structurally quite similar. The most acknowledged driver for innovation and scientific-knowledge commercialisation in both countries is the importance of creating relationships and interdisciplinary and interorganisational networks. The types of stakeholders in both systems are the same, both countries have charged TTOs with responsibility for commercialising scientific knowledge and the PIs are central to the commercialisation process in both countries. Criticism of the failure to implement the universities' third mission is evident in both jurisdictions, as is a criticism of universities to align incentive structures with the stated objectives of the universities. Criticism of TTOs was also common to both jurisdictions, with many interviewees viewing the introduction of TTOs as a misguided application of the American model for commercialising scientific knowledge. The introduction of TTOs does not appear to have relieved the strain on PIs in Ireland or Germany and there is a reasonably widely-held belief that TTOs are one of the most significant barriers at present as they represent a significant misallocation of resource. The current legal framework to the commercialisation process is another perceived barrier in both countries.

The high degree of similarity gives added significance to the differences that were evident from an analysis of the results. The differences in the economy sphere give rise to significant differences in other areas. In a German context, the satisfactory levels of funding appear to allow the "ivory tower" approach to persist. The availability of funding means that German scientists can more easily focus on basic research and become more removed from their industry partners. In an Irish context, however, a lack of funding has led to strained interaction issues between Irish academics and government agents. It would appear to be too simplistic to put this down to simply funding issues however. There is a strong divergence of views between these academics and government agents on what timelines are acceptable to attain commercial success from the investment in developing a knowledge economy. That similar strains are not evident between German academics and their government agents is informative.

Taken in isolation, it would be easy to misinterpret some of the differences that arise in Ireland and Germany. Taking the “ivory tower” issue in Germany as an example, it would be easy to conclude that German academics are simply more aloof than their Irish counterparts. The comparative study reveals, however, that Irish academics would also prefer to focus on basic research. When one considers the economy sphere it becomes evident that there is increased pressure on Irish academics to engage in applied science with industry partners. While Irish academics may prefer to dwell in the “ivory tower”, they are prevented from doing so by the current state of the ecosystem that they work within. In this way, it can be seen that understanding the wider contextual backdrop and the interaction of the various spheres is important before drawing conclusions. The way that the various spheres interact and the policy and a managerial implications arising therefrom are considered in Chapter 8.

Contextual spheres and interaction issues are structural and analytical guidelines that enable the analysis of the context. The ecosystem of scientific-knowledge commercialisation is complex, requiring complex interactions between all participating stakeholders. It is a dynamic context influenced by macro (economic, social, technological and ecological environment), meso (stakeholders such as university, firm, government agencies and intermediaries) and micro (individuals) factors and barriers. These factors and barriers have to be considered in order to understand the establishment and management of stakeholder relationships and the development and formation of stakeholder networks. The ecosystem postulates that scientific-knowledge commercialisation is collective. It is important to understand the variety of stakeholders and their relationships in order to achieve entrepreneurial success by virtue of enhancing the ability to develop networks.

6 The development and management of collaborative stakeholder relationship networks to facilitate scientific-knowledge commercialisation

6.1 Introduction

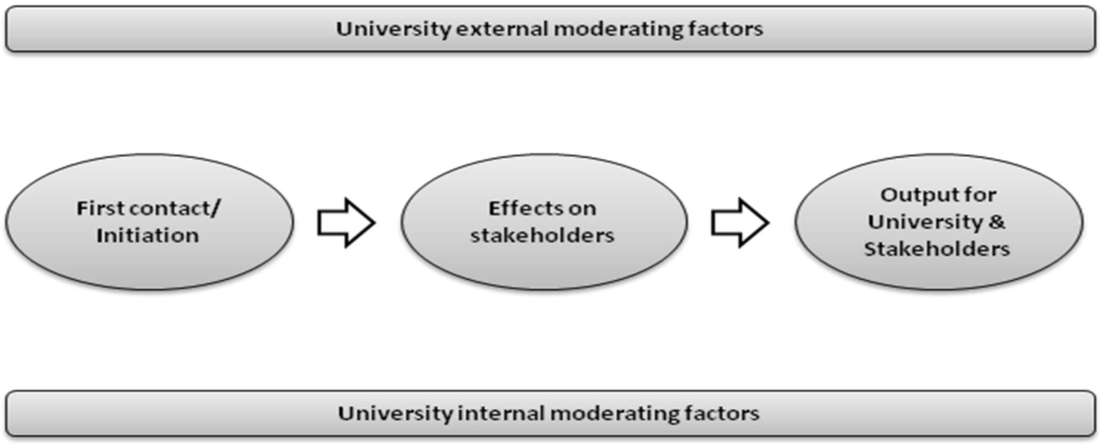
As outlined in the literature review, little emphasis is placed on the development of relationships in order to effectively build networks for innovation and scientific-knowledge commercialisation. This chapter interprets the findings by drawing on relationship marketing theory to explain how collaborative stakeholder networks develop to facilitate scientific knowledge commercialisation.

The chapter is structured as follows: Section 6.2.1 identifies the interviewees' views as to who initiates science–industry collaborations. Sections 6.2.2 to 6.2.4 set out the findings on how collaborative stakeholder networks are developed. Section 6.2.5 then shows why stakeholder networks are established and why those networks facilitate scientific-knowledge commercialisation. Section 6.3 looks at the management and maintenance of stakeholder relationships. This is followed by the conclusion in which a S-2-B marketing approach to the development of stakeholder networks for scientific-knowledge commercialisation is proposed.

6.2 Stakeholder retention success chain: The development of collaborative stakeholder networks to facilitate scientific-knowledge commercialisation

As outlined in the literature review, this study considers stakeholder retention as one of the most important objectives to relationship success. Relationship success and the objective of stakeholder retention contribute to success in innovation and scientific-knowledge commercialisation due to repeated information, physical or financial transactions and the formation of collaborative networks. It is, therefore, important to understand how stakeholder retention is facilitated. In the alliance and inter-organisational network literature, success of relationships can be assessed either objectively or subjectively (Mora-Valentin, Montoro-Sanchez and Guerras-Martin 2004). Objective measurement studies evaluate the stability, continuity and evolution of relationships (Shamdasani and Sheth 1995, Park 1996, Cyert and Goodman 1997, Davenport et al. 1998, De Laat 1999) while other studies look at subjective measurement dimensions such as the level of satisfaction of participating actors (Mohr and Spekman 1994). In this study, the functional chain of relationship marketing is considered in order to evaluate effects on stakeholders and their relationships. The principal idea of the functional chain is the meaningful linking of inter-related attributes to facilitate a more structured analysis (Bruhn 2003). The components and the linearity of the functional chain are, however, not conclusive and are only used to serve the analysis. Moderating factors, as described in Chapter 5, can influence both chain elements and their inter-relationships (Bruhn 2003; Hamburg and Bruhn 2005). The elementary components of the chain are illustrated in Figure 13 below.

Figure 11: Functional chain of relationship marketing



Source: Own conception based on Bruhn (2003) and Homburg and Bruhn (2005)

Output in the above chain should be taken as "output" in the sense that the network develops. Outputs would include retention, enhanced network capabilities and increased probability of innovation and scientific knowledge commercialisation. Hereinafter, the components and factors that facilitate the attainment of stakeholder retention, and hence the output effects for the university, will be discussed in the context of the findings.

6.2.1 Initiation – The establishment of collaborations

When looking at the establishment of science-industry research collaborations, it is important to look at the initiation of these relationships. Why do certain partners use a particular university? The findings show that both industry and university partner initiate collaborations. The PIs play an important part in the initiation of these relationships. The TTOs, on the other hand, are hardly ever seen as the initiator or the point of contact for industry partners. The manager of a German multinational stated that she rarely gets in contact with the TTOs and that the TTOs are not normally responsible for initiating contact. She further explained that she prefers having direct contact with the scientists. Similarly, for a German academic the TTO did not play a significant role:

> "I guess, if you put it in percentages, that they [TTO] would not be able to account for 10% of newly established contacts. I mean it is probably even less than that…they are not the driving force, certainly not."

The story is similar in Ireland where a lead-PI (and centre manager) stated:

> "the PI can be part of the establishment…you just can't have someone else establish it who does not know the nitty gritty of the research…I don't think it works any other way."

The involvement of the PI in the initiation of a relationship was confirmed by 79 out of the 82 participating stakeholders. Only one Irish academic pointed out that it is not his job and instead referred to the centre manager's responsibility. In addition, two recently appointed commercialisation managers explained that it is a team endeavour.

It is interesting to note that the TTO managers themselves confirmed this view, with one TTO manager stating:

> "the best relationships come from the academics themselves so these professors already have very good industry linkages."

The notion that TTOs act as contact initiators does not, therefore, seem to accurately reflect the reality. Arguably, the TTOs cannot be the point of initial or ongoing contact for industry partners as the TTOs will never have sufficiently detailed knowledge of the subject matter to perform this role effectively. This is an important point to bear in mind when considering the roles of the various stakeholders as it impacts on the allocation of work.

One difference between the Irish and German context is the role of government agents. Government agents in Ireland are more focussed on foreign direct investment. The Industrial Development Authority (IDA) therefore plays an important role in bringing multinational industry partners into Ireland. While Germany clearly seeks out foreign direct investment as well, Germany is less reliant on these investments due to the presence of more indigenous partners. Incorporating the IDA into collaborative networks would therefore seem to have a heightened importance in an Irish context as the IDA makes initial contact with multinational industry partners. The perception among industry partners appears to be that the IDA are more influential than other government agents, such as the SFI, as a conduit for initiating contact between stakeholders. Notwithstanding this perception, one Irish government agent describes the process of contact initiation as follows:

> "Industry partners might go to IDA, IDA will come to us. And then we can just turn around here's our portfolio of people working in this area you know here's specific people with specific ideas, specific concepts."

Table 30: Sample findings – initiation by university PI

Initiated by university (mainly PI and not TTO)	• [Centre manager] spent 18 months basically going around the world looking for companies who were interested in engaging...Because we didn't exist so we didn't have a name or a reputation or a background that people would come to us. We didn't exist; we had to do it from scratch. So really it was about getting out there and getting the companies involved **(Academic I1)** • Identify what does this company does, what are its needs, what area does it operate in, is that a good overlap of [the centre]? We identify hundreds of companies and then we go meet them all and we talk to them and say, what is it you're doing and they'll very often they're very busy, they say 'I can't be bothered.' We have to convince them that it's important that we can help. And what we do is we work with other companies to understand what they do for a living, we try to understand what their product development looks like, what the challenges are and then we try to identify resources that we can provide to them through us **(Academic I8)** • The PI can be a part of the establishment…yeah you just can't have someone else establish it [the relationship] who doesn't know the nitty gritty of the research…I don't think it works any other way. **(Academic I10)** • I am the central person who is responsible for planning, organising and administrating collaborative projects **(Academic G9)** • [TTOs] I guess if you put it in percentages that they would not be able to account for 10% of newly established contacts. I mean it is probably even less than that …they are not the driving force, certainly not. **(Academic G10)** • It looks like we had only one so far that was initiated by the TTO **(Academic G8)** • You obviously establish your own networks, because the publicly organised networks are all sh**…If I identify an added value I go out and try to acquire projects (**Academic G11)** • I looked for the industry partners myself **(Academic G5)** • As a manager you are not involved in initiating the projects; It's the principal investigators, the scientists who initiate the projects and collaborations **(Academic G12)** • The networks, how scientists network, I think they have to do it themselves; it does not work any other way. The centre management and the state can only contribute as an administrative entity **(Academic G4)** • The contacts…I got them myself or together with [other PI]. The university, the centre, or the technology transfer office are less active. If you look at the exploitation, the spectrum that the TTOs have to take care of is a problem. It is ranging from hard core physics to something medical or biological..thus it is quite difficult to have good contacts in all these areas. Most of the time scientists have a lot better contacts **(Academic G1)** • Going and speaking and seeking out people helps in creating networks. I think you need to be quite pro-active in doing that it really helped a lot. So in terms of actually waiting and sitting in your own little office hoping that people are going to come and speak to you might not be the best way. It's not the way I work, I mean I tend to go out and speak with people **(Academic I12)** • I would say typically, in the first instance the approach is usually from the universities. And it's usually at the level of the principle investigators or the heads of centres etcetera. And they typically would expose to us capabilities and areas of interest and expertise **(Industry I7)** • They came to us and asked whether we were interested in contributing to the research in exchange for a small financial allocation in order to get access for a future application **(Industry G8)** • Basically the professor initiated everything **(Industry G7)**

- I rarely get in contact with TTOs, I usually always have direct contacts to the scientists. That the TTO is responsible for the initial contact is very rare. **(Industry G1)**
- Often researchers approach me with concrete application offers **(Industry G6)**
- It happens both ways…they come to us and ask or we initiate it **(Industry G4)**
- Every year there is a two-digit number of people approaching me. But most of the time they are only looking to get a machine for free, but there are others who are interested in something with regards to content and then we do collaborate with them if we feel that it benefits us **(Industry G5)**
- If you are sitting in a university and you are waiting for a company to come to you it's a very passive, and I don't think a very fruitful, experience. Of course really high profile researchers will have companies come and approach them. **(COMM I5)**
- Some of the more commercially minded, entrepreneurial minded would be pushing out what they have on contacting companies and generally at the kind of technical research where they are like, they might be trying to understand exactly what is the problem that needs to be solved and they'll have done quite a bit of interacting with companies so yeah its at its value there **(COMM I6)**
- The scientists obviously have their personal contacts…and they exist beforehand **(COMM G2)**
- So it's difficult to ring up a company. Call them and say hey you are in [this area]we are in [this area]; do you want to come in and see what we do?... if they [PIs] are very hot in their space, they would already have links with them. So a lot of the contacts would actually come through the PI's kind of network **(TTO I1)**
- The best relationships come from the academics themselves so these professors already have very good industry linkages **(TTO I2)**
- Very often they [PIs] know the people; they know the exact companies to target **(TTO I6)**
- Very often the PIs have the initial contact **(TTO I5)**
- It depends where the contacts come from…sometimes maybe a technology transfer case manager identifies a technology and then we take it from there **(TTO I8)**
- Most PIs manage their contacts themselves….insofar as we rarely have to take care of it…the scientists have them. **(TTO G2)**
- It usually happens through the PIs themselves or the Centre …our task is more to be an overarching roof ; to be responsible for single inquiries **(TTO G1)**
- The most important aspect for technology transfer is people. We are a third party that only gets involved later… otherwise we would need 50, 60 technology transfer managers **(TTO G3)**
- The biggest part is that companies call and ask for a specific professor. **(TTO G4)**
- Personal contacts is how all of them start **(GOV I1)**
- Industry partners might go to IDA, IDA will come to us. And then we can just turn around here's our portfolio of people working in this area you know here's specific people with specific ideas, specific concepts. You know maybe these will be the right people to match them with that industry. And again people, you possibly match up the people that are more commercially aware with industry partners as well. **(GOV I2)**

The findings show that industry initiates the contact for two main reasons: (a) a special interest in a research area or topic to solve a problem; and (b) the reputation of the PI, which is the most important factor for choosing a centre or university.

Industry partners in both countries approach universities or centres when they have a specific problem. An Irish industry partner explained that, in his particular case, they had connected a university with his US partners as the Irish university had relevant technology available that was of interest to those US partners. The critical factor here was not the form of the university (i.e. if it was faculty based or excellence-centre based) but rather the existence of particular technology.

Similarly, it is the reputation of the PI in a particular area, rather than form of the university, that is critical. A PI (and centre manager) of one of the excellence centres stated that “when you are good, you catch people’s attention and then people will come to you, you don’t need any help”. The below sample table shows that this view is shared by all types of stakeholders, irrespective of location or type of centre. A R&D manager of a German multinational company highlighted that a special interest in a research area is tied to the reputation of the PIs by declaring:

> “it is not about universities; it is about professorships. I am not looking where a good university is, but it is a matter of where is the professor…I am looking for professors and what they know…we are looking around the world to figure out who studies a certain topic and then we get in contact with a few locations to just see who is doing what. So it is not about universities. It is always about people.”

This finding implies that it is important for PIs to publish in high ranking journals, attend conferences to disseminate their research and build their reputations. The Government also requires high-quality research from PIs as continuous funding of the centre is dependent on the quality of the PI’s work. An Irish government agent noted:

> “a lot of it is down to the quality of the work they [PIs] do. If a centre isn’t producing quality work and it isn’t internationally recognised as a leader in its field then we would have to think very carefully about whether we want to continue funding it.”

This indicates that the PI is not just accountable for his or her own reputation but that of the centre as well. The reputation of the centres, in turn, enhances the relationship of the centre (and therefore the PI) with both industry and the State.

Excellence centres have an advantage over faculties as an aggregation effect is created by virtue of the concentration of a number of PIs in one location. This is not to say that faculties cannot compete; as noted above, the reputation of a single PI can be the critical determinant. It is probably, however, fair to observe that excellence centres are more likely to meet the expertise criteria demanded by their industry partners as they can draw on the expertise of a number of PIs. One German industry partner specifically commented that "the reputation of the group of PIs in the university" is something that they looked at.

One interesting observation is that none of the industry partners mentioned that they would contact government agents when looking for a PI to collaborate with. This is not to say that this does not occur but it is worth observing that government agents were not to the forefront of industry partners' minds when they were considering how to initiate contact. Given that government agents would be expected to have knowledge of who might be an attractive PI for a given industry partner, it may be that this is a resource that is not currently fully utilised by industry partners.

Table 31: Sample findings – Initiation by industry partners

Special interest in research/area/ solve a problem	• They expressed an interest in this area originally. Then we came back to them with some areas we were interested in and some technologies we were interested in **(Academic I7)** • [Company x] approached [centre y] because they wanted to do research into a certain technology. **(Academic I9)** • They had known my work and they said 'oh very exciting can we visit your lab?' I said 'sure you would be very welcome. When would you like to come?' They said ' tomorrow morning'…and the next day at the end of the meeting they just said 'well how much money do you need to do this' **(Academic I5)** • One mechanism is that if the industry companies see what we are doing they will approach us **(Academic G11)** • Industry approaches us when they have a question…we then look at it and if it is really in our interest than we do a project together **(Academic G10)** • Companies get scientists where they are actually interested in their particular work **(Academic G2)** • So, we had an open day and at the open day [the industry partner] came in…saw the demo, he was really interested…He saw this project, he said 'hey this is interesting, this is in my area, let's do something' **(COMM I4)** • The industry partners came with… a need that they felt they wanted to get involved in…that's how the project got formed **(COMM I1)** • [Company x] came and they had a very specific problem…You don't go to a company and immediately begin a relationship. There is a long courtship period where you are really trying to define what a company wants to achieve and where do you have appropriate skills and expertise or confidence that you can maybe deliver something for the company in the space that they are interested in? **(COMM I5)** • We systematically look for somebody who is good in this area and then we also look whether the institute has already done some research in this area. **(Industry G9)** • We just google them and look for the ones who are interesting **(Industry G12)** • We either specifically look for new collaborators where we actually purposefully select the institutes we want to collaborate with. This is mostly the case for new areas we want to get into **(Industry G 5)** • Based on their relevant research results we approach scientists directly **(Industry G6)** • There was technology available in Ireland through the Institute which was starting up which was very relevant to our partners in the US so they decided to do that work here in Ireland **(Industry I6)** • Sometimes it can be some industry has got a particular problem. And they say, okay who can help us with this problem **(TTO I8)**

Reputation (knowledge, PI, Experience & expertise)	• Most of the time you know people who certainly I know and come to visit the institute they have done their homework, they have gone to the sort of website and they know who the big figures in science [x] are **(Academic I12)** • I really would emphasize that these companies are here because of the quality of the fundamental science that we do… Now how do they know we exist? Well they know we exist because we have high quality publications that's how they do it. And anybody who pretends and this is a message for the government that pretends that you can decouple publication from the process of being visible doesn't know how industry behaves. **(Academic I11)** • We got partners basically through kind of building reputation and building relationships in a number of different ways. So we would partly by building our own profile and becoming better known research wise and people got to know us **(Academic I10)** • [The centre] has got a good reputation…for the specific area of research that we do…we're pretty good in the world so if someone is related in that area I definitely think it's good…it all comes from the same thing right, the PI's reputation is built by them being on the CSET and the reason they are in the CSET is that they have a good reputation, so it's a feedback loop **(Academic I7)** • It always helps to have the reputation of [reputable university]. But I mean since I moved to [smaller university] I've been successful if not more successful. So it means that it still comes down to the individual…I had accumulated all this knowledge and expertise even before people thought it could be of any clinical value…But then all of a sudden when they realized it had huge clinical advantages, then all of a sudden that transformed the level of interest so the company was then wanting to come to us to avail that information yeah. That's why our relationship with [company x] has now continued very productively and in a mutual beneficial way for 18 years up to now and we just got five years more funding so it's gonna continue into the future. But in another situation you have Universities now running around looking for money from companies, saying 'Oh I'm doing this research and that research' but of course that research may not exactly fit the requirements of the company, yeah so you have to get the right match. You have to have the right results and the right skills and the right expertise to match the requirements of the company. And of course it has to have a market **(Academic I5)** • We have gained a certain scientific know-how and reputation, which is demanded by industry partners; that means we get contacted, even in areas where we haven't had industrial contacts before **(Academic G9)** • They purposefully pick the ones they want **(Academic G2)** • Companies approach us because they see what we are doing **(Academic G11)** • They approached my company and then they had access to the university through me…they took notice of me though my company **(Academic G5)** • So far industry has approached me in all projects that I have had…because of the expertise **(Academic G8)** • So in a special area they get a reputation. So it becomes well known that they are particularly skilled or experts on a topic. And because of that people are approaching them. **(TTO I4)** • They [companies] go around looking at different universities say yeah they seem to have the expertise **(TTO I8)** • I've done another collaboration with [university x] …that was €50 million investment and the reason that was so big was because [university x] brought together about four academic researchers and about three clinical researchers to pool the knowledge **(GOV I4)** • We have continuous contacts with strategic relevant and reputable collaboration partners **(Industry G11)** • Mostly it depends on the reputation or personal contacts **(Industry G5)** • It is not about universities; it is about professorships. I am not looking where a good university is, but it is a matter of where is the professor…I am

	looking for professors and what they know…we are looking around the world to figure out who studies a certain topic and then we get in contact with a few locations to just see who is doing what. So it is not about universities. It is always about people **(Industry G14)** • The most important aspect is expertise in areas where we are seeking them in **(Industry G1)** • We approach scientists directly **(Industry G6)** • The reputation of the university, the [PIs] experience in a particular area, publications from them and how they advance the research topic **(Industry G10)** • When we are looking for a partner…we go to research institutes…the ones you know from the literature, who are leading in their field **(Industry G9)** • [Why did you go to the university?]…The reputation of the group of PIs within the university. **(Industry G12)** • The research, financial aid, own network etcetera…ultimately it depends on the attractiveness of the two partners. **(Industry G13)** • We contacted the PI because we searched for one in this area **(Industry G15)** • Making a partnership with people who know what they were doing in the area that you are not familiar with…They do it well here…they've got good expertise, good facilities…it’s the access to this kind of expertise **(Industry I2)** • Of course really high profile researchers will have companies come and approach them. **(COMM I5)** • Obviously they publish quite a lot as well and so industry and company can contact them through a publication so, contact [does] come in through the researchers **(COMM I6)** • Companies pick us because we are visible, we publish well, we have very good scientists and this visibility is critical…when you are good, you catch people’s attention and then people will come to you, you don’t need any help...but this reputation doesn’t accrue from nothing, it ultimately depends on achievements. **(COMM G1)**

Furthermore, there was consensus that the PI has to show a willingness or desire to collaborate in order for industry partners to consider working with them and therefore the centre. A German TTO manager referred to the issue as follows:

> "As a matter of principle, and what is elementary to transferring or commercialising knowledge, is a fundamental willingness to continue working on a certain topic and not to say: '*Great I have a patent and now I'll do something else*'".

An Irish government agent affirmed this by saying that "there's no point if the technology is good but the people aren't interested in doing commercialisation". This is not a view shared by just government agents and TTO managers but was also expressed by 15 out of 22 industry partners. Those industry partners pointed out that this was one of the most important issues for them. As one would expect, willingness on part of the PI was important regardless of whether the PI worked in Germany or Ireland. It was also irrelevant whether they worked in an excellence centre.

When asked about the initiation of collaborations, all stakeholders pointed out the role of previous contacts. This underscores a repetition or retention aspect to relationships. Industry partners and academics alike outline that knowing people beforehand through personal relationships, having worked with them before or where industry partners are alumni of a university contributes to the initiation of collaborative projects. The results show that it is an advantage for PIs to have worked in industry. As one commercialisation manager put it:

> "A lot of researchers actually are ex-industry as well and so some of them have been in industry and they'd have quite a contact base. They always keep it going, they present job papers of different conferences and all the rest and you know industry or often at those conferences and they come and they contact with them there and then."

Similar sentiments were expressed by a large number of Irish and German stakeholders that were interviewed and this view therefore seems to receive common consensus.

Table 32: Sample findings - Willingness to participate & previous contacts

Interest & willingness/ Commitment of PI	• The success of a project… is determined how goal-oriented and ambitiously the topics of the projects are pursued…difficulties occurred where the partner was not interested in listening to us rather the opposite. **(Industry G7)** • Every year there is a two-digit number of people approaching me. But most of the time they are only looking to get a machine for free, but there are others who are interested in something with regards to content and then we do collaborate with them if we feel that it benefits us..we collaborate if they come to us early and show real interest. **(Industry G5)** • The [centre] has a high technological capacity and besides their interest in basic science they have an open ear for our 'earthy' problems **(Industry G6)** • You have to be quick because if not the scientists have a new interest…Commercial interest is only related to one out of 20 or 50 people…and if you do not see an echo then you have to leave it **(Industry G3)** • I have come across a few individuals in the Irish system, very nice guys to deal with or to talk to, to have a technology discussion. When it comes to the point of interacting, it's pretty clear they are not usually interested in direct collaboration. We probably just have another better round to working with them. So I haven't, personally I haven't come across the stage of there being relationships where I said oh geez! That really went badly wrong because a lot of those folks would have been filtered out a lot earlier **(Industry I7)** • If there's a willingness and a flexibility on both sides **(Industry I5)** • The university is still a group of academics whose primary concern is academic things. They are not their primary concern isn't industrial things … Academics have a tendency to take the government money and back off into their ivory towers and you can't get the door open **(Industry I4)** • [Centre] is very good. They're very flexible …[centre] have in large part bent over backwards to try and be flexible and eliminate those stumbling blocks **(Industry I1)** • As a matter of principle and what is elementary to transferring or commercialising knowledge is a fundamental willingness to continue working on a certain topic and not to say: *Great I have a patent and now I'll do something else* **(TTO G5)** • A lot will come down to sort of the interaction with the academics and because some academics don't want to talk to industry and some academics only want money to do research and they don't want to focus on the bigger problem that the company has **(TTO I8)** • You could ask for 100% funding for a company to work with you. But if they didn't feel that you would deliver something at the end they wouldn't bother. Because it's not just the funding to fund the research; it's the management time, it's the interface time, it's the energy they have to put into maintaining the relationship. And you can't motivate people by just putting money on the table… So there's no question it can be very difficult to get some of the graduate students or even some of the PIs as excited as the company would like them to be about their problem **(COMM I5)** • Technology transfer has here a novercal existence… loads are not even interested in transferring results into some products or services but rather to publish as many publications and get citations as possible **(COMM G4)** • If it's something they're [academics] not interested in really getting involved in industrial led research then, then don't **(COMM I1)** • We don't say to the researcher you have to collaborate. The researchers have to want to do it themselves **(COMM G5)** • Part of it is who's going to do this commercialising? I mean I'm a professor of physics, I'm not trained or qualified and truth be told, I am not interested in starting a company; others are, I'm not. So who's going to do it? Perhaps the post docs, perhaps the post grads, they don't know

	anything about it... publication of the paper is the academic's real target…if you force them to fill out an invention disclosure form for something that they know will never go anywhere you're building up a lot of resentment. **(Academic I9)** • If industry approaches us and asks if we are interested…We unhurriedly look whether it really is in our interest **(Academic G10)** • There's no point if the technology is good but the people aren't interested in doing commercialisation **(GOV I3)** • Let's say you take a single investigator…At that level what tends to happen is either the researcher has their own initiatives either the researcher is actually able to think outside the box for themselves, take proactive steps and go to their TTO office and say 'right I've got this idea what do you think? Should we patent it and should we submit an invention disclosure? What do we do going forward?' A lot of other PIs are very reluctant to move from that next comfortable area where they are doing their basic research into that commercial development. So a lot of them, a lot of them, are not interested... we can't drag them into the TTO offices. But we want them to become more aware of what they're actually doing… people's time commitment once they switch their time and their focus then and that's lost **(GOV I2)**
Previous contacts	• In certain areas you just know each other. In one particular area we were working with a company because over time you get to know each other **(Academic G1)** • We contact industry from our side too. This is usually done with partners that we know, where we have collaborated before. **(Academic G9)** • We work with our spin outs. They come to us with some special questions **(Academic G6)** • If I look at all my strong cooperations…they often are established through people who did their PhD here and went into a company and continued a strong link with the institution…I think that is more important than location. **(Academic G7)** • It is personal networks where alumni are taking within a company and mentioning that he can do it **(Academic G10)** • Seeking out…based upon previous experience because myself I spent a large part of my scientific career in fact more of my scientific career in an industrial setting than in an academic one. So I have a lot of links and industry. **(Academic I12)** • I suppose I knew the people both professionally and I knew them also socially because there were people who we've worked with and still working for a long fine…we continued doing some research with them **(Academic I4)** • Our biggest collaboration is with company [x]… Well they came to us because, partly because there was a personal history with me and one or two of the people that worked in [company] **(Academic I11)** • Basically it was like [US multinational company] went shopping, so they came to Ireland and they went around everywhere and they found things that they were interested in. A whole lot of people were interested in and they kind of weeded and weeded and weeded down. And really, it was a personal relationship that brought the headquarters over to [university x]. So person [x of university] is an ex [US multinational company] person and they were very comfortable…[university] has got a good reputation and they decided they wanted the headquarters here. **(Academic I10)** • Well in fact that's how I started…I was saying I've got a very good working relationship with [person x] whose the lead on the project and it started out as discussing about this and talking about it. And then it became very clear that you know we should consider working with these people and we did **(Industry I1)** • I used some of the participants in [centre] because I had been out at couple of presentations and I had worked with [x] over a number of years and we had worked together way back **(Industry I5)** • The [type of] industry is quite a small industry so everyone sort of knows everyone else and it's Ireland, everyone knows everyone else anyway. And so it happened that an acquaintance of mine. A friend of mine from years ago another organization industry got a job here at [university]. So

	actually we used to talk about stuff and eventually stuff turned into a research project. **(Industry I4)** • We've always known each other through circles right...community. **(Industry I3)** • The trigger was personal contacts at the start. **(Industry G1)** • I know Prof. [x] for nearly ten years. We always had a business contact in the past, as he has his own company and has been active in this market for years. In the last five years we are working closely on a collaborative project **(Industry G6)** • If we want to do something in an area we are already working on then we use our network that we build up over the years…personal contacts from prior projects. **(Industry G 5)** • A lot of researchers actually are ex-industry as well and so some of them have been in industry and they'd have quite a contact base. They always keep it going, they present job papers of different conferences and all the rest and you know industry or often at those conferences and they come and they contact with them there and then. **(COMM I6)** • A lot of that has been done in collaboration with [company]...we've known them for a long time. **(COMM I2)** • We knew some people from the company beforehand… The initiative, however, came from the company, they approached [person x]. **(COMM G1)** • The scientists obviously have their personal contacts…and they exist beforehand **(COMM G2)** • We cannot say you have to cooperate…it is down to the researcher to do it. That means they have contacts for years. Maybe it is an alumni who decides to cooperate. But ultimately the researchers have the contacts **(COMM G5)** • Some of these had personal connections to some of these people and then you know through various networks other people get pulled in other partners until we have the partnership that you see here **(TTO I3)**

The findings show that the PI plays a key role in the initiation of collaborative projects with industry. This is achieved by: (a) showing their own interest in collaborating, transferring or commercialising knowledge; and (b) contributing to their reputation or the centre's reputation by publishing in high ranking journals. These findings add to prior research on the motives of PIs for exploiting technology and participating in research. Finding (b) is quite likely to be achievable as it accords with PIs' motives that have been identified in prior research. That prior research indicates that scientists' major motive is typically recognition within the scientific community (Siegel 2003, Siegel et al. 2003a, Siegel et al. 2004). Therefore, encouraging scientists to publish should not be difficult. Encouraging an interest in collaboration, however, is more difficult to achieve as it may not be an important motive for researchers. O'Connor and McDermott (2004) report challenges firms face to elate their employees to engage in collaborative radical innovation projects. This study outlines that the university encounters a similar necessity to encourage PIs to work towards collaborative projects in general. It was also observed that PIs with industry experience have an advantage in the contact initiation process as their previous experience will have generated a ready-made list of relevant contacts.

In terms of contextual differences, Ireland's dependence on foreign direct investment was evidenced by the particular role that the IDA plays in initiating contacts. However, government agents from the funders of scientific research in Ireland, such as SFI, were less likely to be involved in initiating contacts according to industry partners. It would appear that, in both Germany and Ireland, government agents' networks of academic contacts are currently being underutilised.

A further contextual difference is that excellence centres have an advantage over faculties due to the aggregation of contacts and expertise. While a faculty can rely on the reputation of a single professor, in general terms it is true to say that excellence centres offer a broader range of contacts and expertise. It follows that excellence centres therefore have an advantage in terms of their ability to initiate contact and in terms of eliciting contact from industry.

6.2.2 Effect: Stakeholder satisfaction

Looking at the effects on stakeholders, there was general agreement that relationships between stakeholders play an important part in retaining stakeholders. An Irish industry partner summarised this by stating that "it all depends on the relationship, how it works and are things delivered." A German industry partner said that they were really satisfied with their relationship with the university at the start but that position changed due to people leaving the research centre. He believes that it is down to the relationship with the people. The findings show that satisfaction with the relationship, achieving agreed project objectives and the quality of work is important for industry partners. Government agents, on the other hand, have to remain unbiased. Nevertheless, peer reviews for additional funding depend on the satisfactory attainment of targets (publication number and quality, number and quality of collaborations etc.).

In research, several approaches exist to explain and define the construct of satisfaction (Homburg, Becker and Hentschel 2005). For example, Wilson (1995) defines performance satisfaction (both product-specific performance and non-product attributes) as the level at which the business transaction meets the business performance expectations of the partner. Thus, numerous studies draw on the confirmation/disconfirmation paradigm (Day 1977, Oliver 1980, Woodruff et al. 1983, Backhaus and Bauer 2001). Satisfaction can also be understood as a result of a cognitive evaluation process, whereby an expected or desired normative output is compared to a perceived actual output. Thus, satisfaction is achieved if the actual output equals or exceeds the expectation. Conversely, the result of an evaluation process where expectations are not fulfilled is dissatisfaction. Discrepancies exist, however, as to whether exact fulfilment causes satisfaction or whether satisfaction is only attained through over-fulfilment (Homburg, Becker and Hentschel 2005). In addition, scholars argue that satisfaction may not merely be built up during the course of a single major transaction, but rather through an iterative process of evaluating experiences.

More recent attempts at explanations take the affective view of satisfaction into account as well (Werani 2004). In this respect, satisfaction can be understood as an emotional reaction to a cognitive equation process. In B-2-B markets, particularly, satisfaction is defined as a positive affective condition which does not emerge by virtue of single transactions, but through business relationships (ibid).

Both the affective and cognitive approaches are based on the evaluation of all aspects of a business relationship and embrace economic and psychosocial perspectives of satisfaction. Economic satisfaction shows the extent to which economic expectations are met in business relationships. Psychosocial satisfaction is assessed through relational aspects such as reciprocal support, mutual appreciation or amicable relations.

The case study findings illustrate that industry partners, academics and government agents evaluate the expectations of the collaboration in terms of the deliverables, service and quality of the interaction with the other parties. A German cooperation manager of a multinational company explained the issues as follows:

> “It is a combination of the whole [cooperation]. First aspect is always the subject matter. We wouldn’t do a project which wouldn’t be of interest to us with regard to contents. It just costs too much. If you know what you want to do you are going to look for potential partners who a) have the competence and b) you enjoy working with – who are reliable partners.”

Similarly, an Irish industry partner acknowledged that they evaluate their expectations by stating that “when people have clear goals and they can deliver and exceed in those goals then that makes everyone happy and the relationship grows very, very well.” The ability to deliver is also evaluated by government agents.

The findings also reflect the context. While German academics and partners have a favourable attitude towards their interaction with government agents, Irish academics are unhappy. They claim that their involvement is too frequent, time-consuming, arduous and too metrics driven. German government agents, on the other hand, only expect yearly (as opposed to quarterly in Ireland) reports and have little or no involvement. German government agents expect excellence in scientific outputs. Commercial applicability or outputs are desirable but not the sine qua non.

It was acknowledged that the different motivations of industry and university partners have a bearing on what the respective expectations from collaborating will be. Whether or not achieving those expectations will result in satisfaction for all of the collaborators is also impacted by these motives.

Ignoring any one stakeholder's motivations is likely to lead to that stakeholder being dissatisfied. One Irish academic stated that:

> "We really had done something quite good and the industry was satisfied, Science Foundation Ireland were satisfied. But I would have to say that for the first year of the project nobody was satisfied…In the first year, if I'm honest, I suppose we perhaps allowed ourselves to be influenced by…the way industry worked and allowed ourselves to be encouraged to work in an "industry" way which is completely diametrically opposite to how academic research is worked."

Thus, it can be seen that achieving the expected project objectives is not the only determinant in evaluating satisfaction derived from the project. The point the Irish academic was making was that if stated objectives are imbalanced in favour of any one particular stakeholder then dissatisfaction will inevitably manifest over time. One commercialisation manager put it as follows:

> "So we [centre & company] both want to see value come out but we are both looking to demonstrate value in different ways to our stakeholders. So I think there are different … metrics and I think that's actually one of the big challenges in getting a successful research program going with industry is to get the balance. Industry needs to provide the academics with the scope to publish and to do great work and at the same time the academics need to realise that if they don't deliver a core value for the company then the program won't continue and won't be seen as successful."

The ultimate affective condition from the evaluation process is, thus, not determined simply by meeting project objectives. The likelihood of a positive affective condition manifesting in all stakeholders will be dependent on agreeing objectives that satisfy all stakeholders' motivations for engaging in a project. Conversely, poorly considered or imbalanced objectives are likely to result in a negative affective condition even in a situation where the project objectives are met. One Irish industry partner stated that a centre's ability to listen to what the objectives of the industry partner were was a key differentiating quality.

The findings also emphasise the importance of setting realistic objectives. While optimistic objectives may assist in initially forming a partnership, this same optimism can be detrimental to the mid- to long-term success of that partnership. One of the German industry partners interviewed acknowledged that this problem is not one that is solely created by the university partner by saying "the problem was the expectations of both parties. Both could not judge them right from the start".

The findings show that stakeholder satisfaction in S-2-B markets is arrived of in a similar way as in B-2-B markets. Satisfaction is a positive affective condition. It does not emerge through a single transaction. But rather through ongoing business relationships with the stakeholders. Stakeholder satisfaction is, thus, an affective condition that emerges through the evaluation process of all aspects of the business relationships.

Table 33: Sample findings – Stakeholder satisfaction components

Affective Condition	• I am extremely happy about the situation. Working on the application of things and getting suggestions for applications… **(Academic G5)** • Pretty satisfied. I mean, it's a pretty difficult process to engage in directly but I would say that attention needs to be given to it, which is important **(Academic I7)** • We really had done something quite good and the industry was satisfied, Science Foundation Ireland were satisfied. But I would have to say that for the first year of the project nobody was satisfied…In the first year, if I'm honest, I suppose we perhaps allowed ourselves to be influenced by…the way industry worked and allowed ourselves to be encouraged to work in an "industry" way which is completely diametrically opposite to how academic research is worked **(Academic I9)** • So our working relationship with our clinicians in the hospital…has been very good **(Academic I13)** • In the end, you know, if you're going to get into bed with somebody for five years you better like them; otherwise it's going to be a very unpleasant experience for everybody **(Academic I11)** • [The company] was satisfied … so our first goal is to meet the commitments that we've made. So we met our commitments and that's satisfactory. **(Industry I2)** • We are satisfied in the fact of the first five years to go into the next five years which obviously says quite a lot…There is an element of customer satisfaction there. I mean [the centre] has a number of, if you like, customers that it has to keep happy **(Industry I1)** • I think it is amazing how good they are. They listen. I mean, they know it's important they listen and they do as much as they can to try and facilitate, absolutely… [the company] are extremely happy with our engagement with [the centre] and that was our first kind of tester project **(Industry I2)** • [Centre] and ourselves have both been growing together. To tell you the truth it has been quite easy to do that relationship so far **(Industry I6)** • Very satisfied, they've always been good partners, we value them very highly… So they provided a service which was very valuable **(Industry I3)** • We are thinking about them as preferred partner that means that we preferably would look to do something with them instead of somebody else **(Industry G1)** • In the first few years we were very satisfied. We are not satisfied anymore for the last 2 years. In my opinion it always depends on the people. **(Industry G11)** • To be honest, not at all. At the start we were very euphoric about the project…but now we are very disappointed. **(Industry G8)** • Gut instinct… For us gut feeling counts extremely **(Industry G2)** • There is a combination of things…We look for partners who a) have the competency and b) we like working together; who are reliable partners **(Industry G4)** • When it came near the end I would say I was probably dissatisfied with the way in which the companies actually interacted **(COMM I1)** • Surely the first criteria is satisfaction **(TTO G1)**
	• Expectations have completely been fulfilled **(Industry G1)** • We don't see the targets and hopes that we had as fulfilled. **(Industry G7)**

Evaluation of expectations	• We have certain expectations and if they are not fulfilled and it looks hopeless than we have no problem with calling it off **(Industry G9)** • We did not get what we expected… Obviously it is a question whether we formulated our expectations in a concrete way…because frustration can occur on both sides, but whether we continue working with them, it is still discussed **(Industry G10)** • They should think about what industry expects, which requests they have **(Industry G4)** • The speed of the development at the [centre] are exceptionally fast and by far better than our experiences **(Industry G6)** • [our expectations] are covered as the university fulfilled the scientific components and the service related ones **(Industry G12)** • We knew what was going wrong in our last one so our expectations for the new project [with different university] were really high **(Industry G15)** • The problem was the expectations of both parties. Both could not judge them right from the start **(Industry G8)** • We had expected that from our collaborators and you realise that the research laboratories clocks tick differently…we learnt to accept that you should not expect too much, because usually they bring good results **(Industry G9)** • In most cases at this stage, inside the research system, we would tend to be at least formally required to rise up some kind of statement work prior. So, some written outline of what the expectations are **(Industry I7)** • Our expectations in the beginning weren't based on developing our own IP or licensing stuff... But based on what we required from [centre] the partnership has worked extremely well…[and has it met your expectations?] absolutely yeah **(Industry I2)** • There's always expectations, there's no point doing work unless you have expectations…and [the centre] have always delivered **(Industry I3)** • The expectations that it can work like this have exactly been fulfilled **(Academic G5)** • The expectations I have …the expectation to apply our results…that would be very nice…and of course some financial aid **(Academic G8)** • Usually you want to fulfil certain political expectation that the university is asked to do…that means we obviously cooperate for these reasons with industry. Industry expects us to do our project work…and that we find alternative solutions if unexpected problems arise. This is a critical point. On the other hand we obviously expect that the industry partner is fulfilling their side **(Academic G9)** • Success of a project; having clear objectives, aims and milestones at the start of a project and as you move along you tick things off **(Academic I12)** • You just have to be honest and to make sure objectives are clear in both sides **(Academic I6)** • Well the actual outcomes didn't match [expectations] because obviously it got stalled **(COMM I1)** • So we [centre & company] both want to see value come out but we are both looking to demonstrate value in different ways to our stakeholders. I think there are different metrics and I think that's actually one of the big challenges in getting a successful research program going with industry, is to get the balance. Industry needs to provide the academics with the scope to publish and to do great work and at the same time the academics need to realise that if they don't deliver a core value for the company then the program won't continue and won't be seen as successful. **(COMM I5)** • [They continue the relationship] if everything runs smoothly and they get what they had expected **(TTO G2)** • Different expectations make it difficult to get together and undertake a nice project. But there are projects where both sides want it to work within certain timelines, one side extends it; the other shortens it and then it works well **(TTO G4)** • The expectations of the CSETs are not always well aligned with the expectations of either industry or indeed state agencies. You need to make sure that the expectations are set early on. And I think expectation setting is probably another area where some work needs to be done **(GOV I5)** • We expect that the researchers …work together on an interdisciplinary basis **(GOV G3)**

In terms of the evaluation process, certain evaluation factors appear to be peculiar to industry partners. The analysis shows that industry partners appraise the collaboration based on: (a) professionalism; (b) time management of stakeholders; (c) industry and market awareness of the centre and PIs; and (d) realistic evaluation of IP and feasibility. A lack of professionalism (e.g. a lack of management experience among PIs) was mentioned by about two-thirds of the industry partners.

A German industry partner acknowledged:

> "There are different professors, and I am always talking about professors and not universities, which are really good in managing. Where you know they deliver…and then there are some who just don't 'come out of their theories'… So there are different professors where I say 'god they could actually be a manager in industry'"

As noted in Section 5.2.1 and 5.2.3 above, one of the biggest causes of tensions between stakeholders are the time horizons for completing projects. Industry partners outlined the failure to meet timelines as one of the factors they evaluate. Industry partners criticise the slow execution of collaborative projects. One German TTO manager summarised the time issue as follows:

> "On the industry side…they have far too short time horizons and too high expectations...the different expectations make it difficult to get together and undertake a nice project. But there are projects where both sides think that it can work within a certain timeline, where one side extends it and the other shortens it and then it works well."

While the lack of management experience among PIs and failure to meet timelines were important, the findings of the study (outlined in Chapter 5.2.3) show that the speed with which scientific knowledge is commercialised is probably inhibited by the time constraints of both PIs and TTOs, rather than a failure to understand the industry partners' objectives. It can therefore be seen that an understanding of the context that the PIs work in is important when interpreting the root cause of the issues raised by industry.

Almost all industry partners mentioned industry and market awareness of other stakeholders as being important. There was general agreement that academics, centre managers or university principals do not spend enough or any time in an industrial setting. While industry experience was an important issue for initiating contacts (see

Section 6.2.1) market and industry awareness was also considered important for understanding industry related problems. This view was expressed in both Ireland and Germany as well as in both types of centres. One German industry partner outlined how he evaluates a centre by its market awareness by saying:

> "a question would be how strongly are the institutes market oriented? If they are only interested to get funding then I look for something else. As a rule you can say that the collaboration and technology transfer is that much better the higher the industry participation at a certain institutes."

Ironically, it was a commercialisation manager that captured the point best when he said:

> "a lot of the principle investigators and funders would have been informed mainly from an academic or a clinical perspective. So there would typically be interested in pursuing research that is academically interesting ….However, they were not always balanced with the commercial reality …The commercial reality is typically while you might have the best product in the world and it's doing a really good thing. If it isn't doing it for a lot of people in a way that really influences and changes the way in which the clinical outcome transpires then it's not going to be a success."

There were concerns expressed that such a lack of awareness is likely to lead to inherently unrealistic initial evaluations of feasibility. Some industry partners spoke about significant overestimations when TTOs assess the IP situation. Others held the PI responsible for being overenthusiastic and naïve about the feasibility of a project. A commercialisation manager of one of the CSETs stated:

> "they [PIs] have to be careful and realistic in the negotiations around IP. Really in terms of putting values on…. They have to be more professional in managing the relationships. They have to see the world from the industry perspective and I think they need to be more flexible and, dare I say, honest. In that if it's something they're not interested in, really getting involved in industrial led research…then don't."

Both Irish and German industry partners mentioned the need to be realistic in terms of evaluating the feasibility of projects. While this does not, therefore, appear to be solely an Irish issue, only the Irish government agents, commercialisation manager and academics acknowledged it. According to the industry partners in both countries, being overenthusiastic and naïve about the feasibility of a project may lead to disappointment and dissatisfaction. As highlighted in Section 5.2.1, the key problem is likely to lie in accurate identification of when collaborative research is feasible.

Table 34: Sample findings – Industry relevant components of the stakeholder satisfaction evaluation process

Professionalism & management	• There are different professors, and I am always talking about professors and not universities, which are really good in managing. Where you know they deliver…and then there are some who just don't 'come out of their theories'… So there are different professors where I say 'god they could actually be a manager in industry' **(Industry G14)** • You need a good management on both sides. And on the academic side, a good management is often quite poorly developed. The second thing is really good operation excellence….a good alliance management at the university and research institutions where people who are recognised within the scientific community have the task and the ability to implement this **(Industry G1)** • Having a modern project management in the universities would have helped a lot **(Industry G7)** • Academia is viewed can be viewed more of kind of… a playground right with less project management kind of focus **(Industry I3)** • The external interactions have to be well managed to ensure that everybody's comfortable **(Industry I1)** • They have to be more professional in managing the relationships. They have to see the world from the industry perspective **(COMM I1)** • There are differences in engineering …they are used to people from industry visiting them. …then all the professor and the assistants are wearing suits. In IT it's completely different. They all run around in slovenly clothes. Everybody the assistants and the professors and if somebody visits they don't dress up. Why would they? Only saw that last week again **(COMM G4)** • They obviously have to build up a professional management **(GOV G1)** • I think there's a whole pile of stuff that could have been commercialised but isn't. And an awful lot of that is because relationships aren't managed properly. So like I said there is areas for improvement there **(GOV I5)** • The best combination is where you have people that you like who share similar thoughts and agendas where getting decent work is concerned, and your ability then to deliver on it **(Academic I11)**
Timing	• Surely they could look more after the adherence of timelines **(Industry G7)** • I was thinking we could do loads of collaborations…but I had to learn that the time constant is completely different. In universities it's about years and remote future here it is about days and near future **(Industry G3)** • We expect that they are fast…and there you realise that the clocks in research institutes tick differently. We were really surprised how slow everything is as we came from the science side as well **(Industry G9)** • One of the most important aspects is that the main contact person has enough time **(Industry G5)** • Central points are that it is time oriented, milestones and the results **(Industry G13)** • Time is an important factor; time-to-market. This way of thinking does not exist at the university at all. Time is an aspect in education, getting students through the system, but not in research. Time doesn't play a role in research. **(Industry G8)** • The primary issue that we face is in terms of the speed, getting stuff done…we operate and they operate on two different time scales in terms of project delivery. For us projects need to get results, substantive results; is significant research is coming out in terms of having publications, demonstrations, prototypes and experiments? In many cases we want to stop projects in a year, maximum two years. If you look at what the university does, they're operating on three to four year time scale with the PhD students…that's the mismatch there. That sometimes can cause issues in terms of being able to ramp up and execute on a program before our own strategy has actually changed or evolved **(Industry I7)**

	• There is a clash of interests there. Academia it’s all about science, research development, knows no time records. Whereas in business it does, it’s very important. So there's always that clash in time and deliverables **(Industry I3)** • Expectations…Industry partners have a strict time plan, that has to be followed rigorously **(Academic G9)** • You have to satisfy someone with good achievements ….and a certain speed **(TTO G1)** • Small companies have a lot shorter time horizons. If he starts collaborating with the university in January then he wants results in April or June, with which he can enter the market **(TTO G4)** • Industry is fundamentally totally different from the universities in their time lines **(TTO I6)** • Generally companies have shorter time frames than researchers **(COMM I2)** • Speed of response is a big thing you know and not just like replying to an email and actually getting work done. They work through a completely different time table down the academic speed of response. So that's a big thing that's you know that's one of the off putting things for industry to get involved with academia. It was like you know it has a reputation of not being so fast **(COMM I6)** • The company satisfaction in what we are doing? If they didn't feel that you would deliver something at the end they wouldn't bother. Because it's not just the funding to fund the research, it’s the management time it’s the interface time, it’s the energy they have to put into maintaining the relationship **(COMM I5)**
Market & industry awareness	• Academics… don’t spend any time in an industrial setting at all… they don’t understand industrial things and they need to get out of that mind-set…and the people at the top don’t have enough industrial experience too **(Industry I4)** • [I would recommend them because] I think it’s that they are industrially aware or commercially aware **(Industry I1)** • I’d said maybe if it’s 20% or 25% of the time the PI would be in the best position and they are the ones that…. have the finger on the pulse and know what is happening in the industry. Very much on top of their academic game but also are quite aware of the movements in the industry. I would say maybe a quarter of people. We then have maybe another 50% of researchers who would have some awareness of who is out there and are willing to make a contact and help us out. Writing names and maybe trying to make industry links **(Industry I7)** • Having a relation to reality in terms of awareness that an industry partner wants to develop something that needs a market…something that has a practical and economic benefit. And this market awareness could be more pronounced **(Industry G10)** • A question would be how strongly are the institutes market oriented? If they are only interested to get funding then I look for something else. As a rule you can say that the collaboration and technology transfer is that much better the higher the industry participation at a certain institutes **(Industry G4)** • Depending on the type of university whether they are more into basic science or technical market oriented topics. That means you are automatically more attractive to the industry **(Industry G9)** • They need to be able to understand the needs of the industry partners **(Industry G8)** • Commercial feasibility, cost efficiency, durability; these were all topics that hadn’t been dealt with in any form **(Industry G5)** • A lot of the principle investigators and funders would have been informed mainly from an academic or a clinical perspective. So there would typically be interested in pursuing research that is academically interesting ….However, they were’nt always balanced with the commercial reality…Commercial reality is typically while you might have the best product in the world and it’s doing really good. If it isn’t doing it for a lot of people in a way that really influences and changes the way in which the clinical outcome transpires then it’s not going to be a success. **(COMM I1)**

	• You possibly try to match up the people that are more commercially aware with industry partners as well **(GOV I2)** • The questions that industries are concerned with play a role. Understanding the problems and questions that industry is facing **(Academic G9)**
Realistic evaluation & feasibility	• They are industrially aware or commercially aware. They…. not massively but certainly they're not really, really naïve. And they do know that if they have an idea people won't just… academics, all academics tend to think their idea is brilliant and if they have an idea for what they think might be a product they think this is going to be a billion dollar sell out and things like this. And [centre]'s vision is tampered with a bit of reality I think where they know that, I mean, a good test doesn't necessarily make a good product but a good product doesn't necessarily sell a huge amount anyway. So I'd said they're aware certainly more of the commercial realities **(Industry I1)** • There are some conflicting views on the reality of that. Personally I don't think that that's possible in a five year time frame. And when you see how long things take even if you are on doing a one to one partnership developing a product. So I am trying to tamper the expectations because I think they are important that everybody knows what is possible. So with the academic partners to know what's feasible for [company] to provide with the resource that's available which became much more restricted in last year and a half or two years of the project. And for me to be able to go back to the management in [company] and say if you are looking for products and customers in the next 18 months that is not a reasonable expectation. If you are looking to prove principles and have doors opened this is… that's possible with what we have here **(Industry I2)** • Let's put it this way…the art of research and how it is evaluated is quite different…You have to say that you get the impression that it is often overpriced. This is very often the case **(Industry G4)** • It becomes more and more difficult, because research institutes or universities have ideas about IP rights or what can be earned which are completely illusory, absolutely illusory. If I am completely evil I would say that professors and university administrators have absolutely no idea…they believe they just have to open their hands and they get showered with money just because they had an idea….I think it's a question of reality checks **(Industry G9)** • In some cases the evaluation of an innovation/discovery/invention by universities can be quite difficult. That means the technology transfer offices tend to significantly overestimate them **(Industry G11)** • I get every two to three days telephone calls from professors who claim that they just had the big breakthrough in the world…we would like to get an open and honest information what a technology can and cannot do **(Industry G10)** • We clearly told them what risk factors we see on doing the project and asked them to evaluate the risk…And the people in the institute were not really cooperative, but rather every time they saw a difficulty they saw a new opportunity and went off and did something completely new… Industry needs assurance that they don't completely waste their money…this shows that the project should have further been evaluated by the PIs…they might have excuses…but they should have been more honest from the start…They have to be more realistic in evaluating projects and perspectives **(Industry G8)** • The bottom line is that maybe there should be a better due diligence form the funding agents. An analysis what a project can actually do…What the institutes believe are real fantasies, nothing more **(Industry G5)** • Another advantage is the university who is open to industry collaboration and don't put up too many stumbling blocks to industry collaboration or maybe too expensive for industry to collaborate with industry with academia. What I mean by expensive is, you know, realistic terms and conditions of the research agreement and the licensing agreements **(GOV I4)**

- If somebody says my research is great and they may be right but they could be completely wrong **…**The PI beside you is there going, well yeah could be in maybe five years. And they're going Jesus. So to be honest in some cases what we would do, we would prefer if the PI didn't go you know we'd like the TTO there, you know so generally if we meet the company, the TTO will be there because it's their technology. And in some cases we would prefer if the PI wasn't there **(GOV I3)**
- The way [the centre] is evolving…a lot of the platforms that they have created to be licensed off or and turned into commercially viable products now within the next five to ten years. So that for me is kind of a realistic time frame… especially with the fact that they are focused in the life science area. The commercialisation in the life science areas is a lot slower process. There is a lot of regulatory bodies that are in place. And the regulatory bodies will only approve something once they have seen very strong clinical validation. For something to get clinical validation you need to do a very stringent and a very well thought out and comprehensive clinical study and to do that takes time **(GOV I2)**
- Whenever you look at later stage funding of [centre] it is a very broad range of stuff that gets looked at it's not just outputs…Improvement in the future is going to come from setting expectations [about the output] appropriately **(GOV I5)**
- During the process where I was dealing with two companies, two big companies with very different sort of agendas and attitudes and philosophies and everything and trying obviously then to fulfil the sort of technical objectives that we set out, it was very tough. It was, I can, I probably had the toughest time in my career in terms of those interactions and everything else. And I think obviously that was compounded by being in an area that was new to me and everything else. So if you take on that point of view it was a tough activity. However what we have learnt and what, where we have come from is immeasurable in terms of positivity. I've learnt to understand so many things about different companies, how they operate, different philosophies, different technical commercial objectives and I'm a lot less naïve about what say I would say we can do and what we can't do and how we would ever go about formulating any interaction again in the future **(Academic I1)**
- You generally seek to do what you say you are going to do… Try to... if you are going to work collaborative with somebody…you need to be honest about what your capabilities are…in the early days because I think basically the IDA had sold corporations this idea that you get all these university researchers who are going to work with you for free and we had to stand our ground and say well you know we are not here to work on problems that have no publication potential… we just had to be honest and to make sure we our objectives were clear on both sides....in general universities overestimate the value of their IP. People at the TTO, how much money is this worth, how can we gain exposure etcetera and in truth a lot of the IP flowing out the university groups is quite poor probably because it's not interacting with industry enough. But even still the university thinks that universities should get more money out of this **(Academic I6)**
- I had a company that wanted to license something from us and it was a big American multinational and then [the university] said 'the price is 40,000 Euros' and they said that they can buy it for 7,000 off these other guys. They said 'goodbye'. That was the end of it. That was it, done. It wasn't even an exclusive license it was just unbelievably stupid…The whole ego of the place is more protecting IP rather than using IP **(COMM I2)**
- I think they [PIs] have to be careful and realistic in the negotiations around IP. Really in terms of putting values on…. They have to be more professional in managing the relationships. They have to see the world from the industry perspective and I think they need to be more flexible and, dare I, say honest. In that if it's something they're not interested in, really getting involved in industrial led research…then don't **(COMM I1)**

While certain evaluation factors appear to be peculiar to industry partners, all stakeholders stressed the importance of: (a) communication; (b) research output and quality; and (c) relationship quality. Open and honest personal communication was an important prerequisite for dealing with expectations, feasibility and any dispute resolutions that might arise. The existence of open, honest, personal and, in particular, frequent communication was believed to be a factor for all stakeholders' evaluation of the success of collaborations. The importance of being honest when setting expectations was a recurring theme in the interviews. Setting unrealistic objectives is equated with being dishonest. One Irish academic summarised the position thus:

> "People have different viewpoints. They feel they have different immediate concerns and needs and those needs may not be exactly the same for the other partner and it has to be a win win and so you have to help people understand that. What do you need and what do I need and if that conversation doesn't happen the partnerships are doomed to fail."

Dishonest in this sense does not require any instance of malevolence. Ignoring one's own interests when setting expectations can, for example, mean that long-term objectives are unrealistic.

The evaluation of research output and quality was obviously a major factor for all participants. Given the different motivations of the various stakeholders, however, different outputs were important to them. TTO managers often mentioned research output for industry and universities but when asked what is important to them referred to the generation of IP. While only one Irish government agent directly referred to the importance of research outputs, claiming that "whenever you look at later stage funding of CSETs it is a very broad range of stuff that gets looked at it's not just outputs", the contextual findings indicate that Irish government agents are quite research-output oriented. Similarly, German government agents did not mention research outputs. While the contextual findings imply that they are not as involved in the process as the Irish agents they evaluate the results only every year on a broad set of deliverables.

The majority of industry partners were concerned with the applicability of results. Industry partners explained that research quality and output was a central evaluation aspect for satisfaction. A German industry partner referred to the research output as needing to be "realistically solved and not theoretically", but added that it is equally interesting if new theoretical applications are found and that this might result in further research projects.

What academics consider as valuable research output differs to the industry partners' idea of valuable research output. Academics evaluate the possibility to publish or gain further funding opportunities. The findings in terms of evaluating research output are, thus, in line with the contextual findings on differing interests and concerns (Section 5.2.1). While academic research outputs and industry research outputs might appear to be antithetical, the contextual findings suggest that industry partners recognise the need for basic science and that it might be down to the correct identification of when a collaborative project should start and the type of output that should result from the collaboration (i.e. basic or applied research).

Relationship quality is a factor that was identified in the interviews which should not be underrated. The case study findings are unanimous with regard to the importance of relationship quality. A German industry partner explained the reason why they left a former collaboration partner to work with the current one as follows:

> "The main reasons that it did not work are these interpersonal things…and if the communication is wrong and it's not working on an interpersonal level then everything is more difficult….If there are interpersonal difficulties it has a direct effect on the content and that's how it was."

Similarly, an Irish academic explained the importance of relationship quality by stating that they had an "amicable relationship" and that the collaboration wouldn't have continued without it. Government agents, on the other hand, while acknowledging the importance of relationship quality among the other participants, did not highlight relationship quality with the government agents as a particular factor for their collaboration in the funding process. This is not to say that it is not essential in any business relationship to have a good quality relationship but perhaps illustrates a different weighing that government agents attach to the personal side of the relationship.

Table 35: Sample findings – Relevant components of the stakeholder satisfaction evaluation process for all stakeholders

Open and honest personal communication	• You place the emphasis on the communication...that you talk openly and directly with each other **(TTO G1)** • Part of keeping these guys happy is keeping our communication channels open. Within the centre we are much more proactive going out and asking and making sure we understand what each of these companies is looking to achieve and we are helping to do that so we are matching them up **(COMM I4)** • The first thing they need to do is they need to listen to the companies. What [centre] has proven to do very well and it sounds very simple is to respond to the direction of the companies... A lot of researchers as individuals or even of the centres get companies in to trigger funding and then they go and do what they want to do. And I think you have to really listen out to the signals that the companies are giving you and to make sure your programs are responding to that. So I think that’s the most important thing **(COMM I5)** • Disputes… that would have been maybe, from what I saw at the later stages a drying up of communication. **(COMM I1)** • Communication… That's one of the key things. I want to keep that open and honest and yeah I know so far it's been quite good yeah **(COMM I6)** • To meet over and over again and to propose, build and guide projects **(COMM G2)** • If they work close together…if they sit together at the table and talk to each other daily….it is a dialectic process where you get things done. Such a process only works if I get feedback in each phase, in effect daily, of the technology development **(Academic G5)** • Honesty it’s the first thing I suppose and we have monthly management meetings and I personally…maybe I go to far with this, but I speak my mind in these meetings, and I think while that can be extremely annoying, I think it also helps to build trust because they know that I will say what I feel. So, I think that perhaps they can trust me **(Academic I9)** • People have different viewpoints. They feel they have different immediate concerns and needs and those needs may not be exactly the same for the other partner and it has to be a win win and so you have to help people understand that. What do you need and what do I need and if that conversation doesn’t happen the partnerships are doomed to fail **(Academic I8)** • Maybe someone wants to develop a drug, but there's another party just wants to publish a paper. So having that written down in a sense or even discussed up front…Discussing those things up front can be helpful with this sort of moving forward **(Academic I12)** • Sometimes you have to be honest with them and you say look I’m not happy with the way the project’s going .You know you have to say look you know I’m not happy with the way the way the report is going **(GOV I3)** • [Is there any factor that explains the stability of a relationship?] It’s communication and commitment to that relationship **(Industry I7)** • I think that's one of the things that works extremely well the communications are open there is an amount transparency. There is no conflict because the industry partners have a very different area that they operate in and I think that's really important **(Industry I2)** • Constant communication so that people are constantly talking and collaborating, teasing the problems as they arise as opposed to really do a lot wherever you are you leave us alone and we get back together in two months to see what we’ve done. So I think its collaboration, building a team…If it is from an industry partner and from a college or an institution. The team is fairly integrated **(Industry I5)** • There are communication problems….a lot depends on the communication **(Industry G4)** • If the communication is wrong and it’s not working on an interpersonal level than everything is more difficult….If there are interpersonal difficulties it has a direct effect on the content and that’s how it was **(Industry G15)** • Admittedly, one wants a really open and honest communication…open communication what a technology can and cannot do. A communication via

	telephone and email will never work, but rather to stand together in the lab. Just as well the university partner has to show up in the company…the nuts and bolts is a direct, close communication channel **(Industry G10)** • An important aspect …is regular communication…the possibility to meet personally **(Industry G1)** • You have to talk more. The communication is important. A good, open and transparent communication **(Industry G8)** • Experts from different cultures have different experiences. Therefore they behave differently. The central thing is to put a communicative culture in place so that you can solve these differences **(Industry G13)**
Research output & quality	• Where we are really happy is if we solved something and I mean realistically solved not theoretically...then we are really happy. But if new things are found they might be equally interesting and we can continue researching in this area. Things like that happen too **(Industry G14)** • That's the primary thing at the end of the day, the quality of the investigators and the staff that I have under me. The two of those need to be strong or it's just a waste of time **(Industry I7)** • [Company] are extremely happy with our engagement within the [centre] and that was our first kind of tester project because it provides a set of facilities that we don't have in house, a set of skills that we don't have in house….They do it well here they've got good expertise good facilities. And that's why [company] are still involved it's the access to this kind of expertise **(Industry I1)** • Success of the first program…at the very end of the first program [centre] had introduced a new technology which offered even further improvements **(Industry I6)** • The project itself, I mean the piece of technology does it fit in…. and I wouldn't be able to evaluate that fully **(Industry I5)** • Look for potential partners who a) have the competence and b) you enjoy working with – who are reliable partners **(Industry G4)** • The [centre] has a high technological capacity **(Industry G6)** • If the results are right and the collaboration works smoothly **(Industry G10)** • We value the knowledge transfer and the knowledge we get **(Industry G15)** • For instance we've had a three year program we've now got, we are one year into a four year program. So you know they came back and they renewed their commitment for another four years basically just do that on the basis of success. And there is a number of parameters to come into that….and the most important is certainly the quality the research team that you can bring together…I mean there's a whole lot of parameters there, but at the end of the day it's all driven by they will only come back if they feel that you've been successful **(COMM I5)** • We had a project here that did not work out that well because the results were not the ones that they expected. But that result is a result too as they might have saved some money **(Academic G10)** • We have received signals from industry partners that they ceased another collaboration in order to work with us. There are signals that the quality plays a role **(Academic G9)** • The outputs are extremely important; the personal relationship is a necessary but not sufficient condition. I think that the best combination is where you have people that you like who share similar thoughts and agendas where getting decent work is concerned, and your ability then to deliver on it **(Academic I11)** • One of the reasons that they stay, I mean I think they stay… this sounds like a very lame thing to say. I think the research here is very, I think there is very good quality research in it and that is why they are stay. I mean they're not saying actually because of the commercial opportunities I think

in the sense; they're staying because the research is good **(Academic I10)**

- It depends how well the work was done. If the results are right and if it's working well at a personal level then they continue and it is usually the beginning of a long-term cooperation **(TTO G3)**
- First criteria is certainly output **(TTO G1)**
- They get quick knowledge…It is very difficult for any one company to explore and research and develop all the science and technology they need and there are many companies have to pick the universities to be a source of innovation and expertise **(TTO I4)**
- I would think that you measure the success of the project as to whether you achieve the deliverables. So if at the onsets of the deliverables was to generate the potentially profitable IP and then you do generate this IP and we do our evaluation as it is and it is justified that you will eventually commercialise it, And if one of the aims of the project is to find the license that you find or the aim of the project working with industry is to create new IP based on our background and their background without taking a license and you achieve that's brilliant. So in my opinion achieving success is achieving your deliverables, what you set out for **(TTO I5)**
- If a project produces some IP and then its patented and then we license it and that would be a very successful outcome. So you know I mean it's easy to file patents and then they have to go through a long examination process but if a company sees the potential in the research or the technology that you've developed and then that's the real kind of metric basically that's the real achievement of a project **(TTO I1)**
- Because it was so good. Well, it's because it's, the y…particularly if they came here say looking for an answer to a specific problem and they went away with the answer they were looking for. You know we solved the problem that they had. They will come back again **(TTO I8)**
- Whenever you look at later stage funding of CSETs it is a very broad range of stuff that gets looked at it's not just outputs **(GOV I5)**

PIS /COMM evaluate PUBLICATIONS:

- We would look for really high quality research. It's very important that the research is published high quality papers. We then share some goals with [company] we would also build around the development of Intellectual property the development of licensing and commercialisation. And we would have some sense of public sense; you know for us it would be very important that the state would see that the program had provided value. **(COMM I5)**
- It's, again it's always a little bit of a balance and the balance has shifted a little bit more towards is it being commercialised but as you go through the project with some more softer less economically relevant measure such as the number of the publications. The number of citations from those publications. The quality of the journals the publications have been referred to in, the number of students and the quality of students that have been generated through the project. So it's, there's a few softer measures **(COMM I1)**
- Publishing papers it's kind of the major bench mark but also there's research goals **(COMM I3)**
- Personally, meeting societal needs. That there is a benefit for humans. Success is also to publish your work in a good journal. To patent something is success too **(COMM G1)**
- The counting the amount of publications is important; there we don't need an external evaluation to see the excellence **(COMM G6)**
- Well, the cooperation where joint publications are produced. I think the research benefits and therefore the research teams and this has an impact on the centre…as the institution is linked to the scientists' publications **(COMM G5)**

	• The success is obviously also measured in form of publications **(COMM G2)** • Scientific results that are reflected in publications and patents and in PhD theses **(Academic G8)** • The impact in the scientific community **(Academic G7)** • My success is easy to measure; the amount of publications and the quality of the publications **(Academic G1)** • We didn't get any publications from any side work or anything like that, you know we didn't file a patent application. We didn't have any inventions disclosures from that work. So those key indicators they just weren't there **(Academic I2)** • I would certainly have the two sides of the things, I mean for me the projects is successful if there's like good publications or good international research profile but I really would love there to be some centre spinouts that are really identifiable and then licensing or whatever, I would like that **(Academic 110)** • Well, publications for me is the key thing, in the end that's the only reason anybody knows I'm here. If the papers aren't out there well then nobody knows we're doing the work….I think there is a needless effort to protect IP that is actually contrary to the nature of what a university is about. The reason that the companies are with us is because we published, and central to publication is the tested viability of your data and ideas **(Academic I11)** • The success will definitely be from the academics side of things, so if there is a publications coming from this or it leads out to more funding where we can get more commercialisation or more academic output. So can we get an academic paper out of it for example has been able to fund the students and has other things happen, that will be the success **(Academic I13)** • Graduation of PhDs is very important. Successful graduation of PhD, publications quality and quantity, intellectual property secured, intellectual property licensed or [spin outs] and I would say finally although it's not necessarily an output, it's an input. It's funds raised and that's important because without that then things stop happening. So those are how success is measured. **(Academic I6)**
Relationship quality	• The quality of the interaction would be one of the questions that would be, people would ask informally. It's not something that gets recorded formally, but it certainly would be discussed informally. When we discuss in circle leaderships here, why did you keep going there **(Industry I7)** • Part of the evaluation I think would be working with the teams…Like all relationships the first part is the product, or service whichever you want. So the product of the service is wrong the people were nice, the environment was nice. So I think if you get sort of combinations…I think it all depends on the relationship, how it works **(Industry I5)** • The main reasons that it did not work are these interpersonal things…and if the communication is wrong and it's not working on an interpersonal level than everything is more difficult….If there are interpersonal difficulties it has a direct effect on the content and that's how it was **(Industry G15)** • Obviously the relationship plays a role….if a project ends and it was interesting and you might have jointly achieved something, then you obviously try to cooperate with this group or the same people again. Ultimately it depends on both the topic and the people **(Industry G7)** • If the results are right and working together works smoothly **(Industry G10)** • Look for potential partners who a) have the competence and b) you enjoy working with – who are reliable partners **(Industry G4)** • [Meeting my needs as an industry partner?] It always depends on the individuals. Universities have difficulties with the continuation of programmes so there are always new ones **(Industry G6)** • Well it comes down to the social relationship; they realized that we were people they could work with who wouldn't mess them around. The outputs

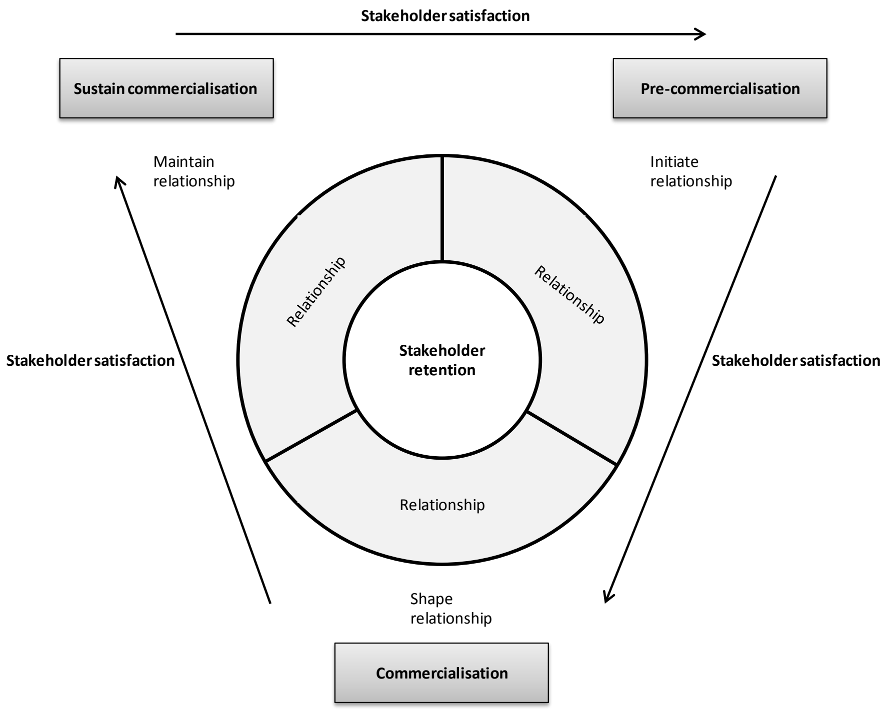
	are extremely important… I think that the best combination is where you have people that you like who share similar thoughts and agendas where getting decent work is concerned, and your ability then to deliver on it **(Academic I11)** • They were very easy to deal with where you just maybe on the same wavelength you know? And one of the industry partners from that company she used to work up in Dublin and I used to work with her so but that was fine you know? But the, the American company we're just were very tough you know so to a point where they could be quite rude. So it's very, very stressful **(Academic I2)** • I remember review they turned up like they were like: we are the serious like we world experts coming to help you little people in Ireland. Now, I don't think they meant it, that's how it came across… …But that relationship was changed and that's what being really, really interesting. So it started like they were the masters of the universe and we were the underdogs. That really has gotten even. And that was why we stayed… now it's very, very evenly mutually respectful relationship **(Academic I10)** • I think if there isn't a personal relationship there nothing will happen **(Academic I6)** • I must I must say we've had a very sort of amicable relationship. Obviously if we didn't then it wouldn't have continued this way **(Academic I5)** • I'm only interested in partnerships which are on par. Companies came to us because we had built up good partnerships in the past **(Academic G11)** • Excellence in research is an aspect …but also the question: With whom do I want to collaborate? **(Academic G7)** • As far as I know I think they have quite an open relationship…I think he's got a very good professional relationship with people [in the company] there too **(COMM I3)** • If there isn't a relationship there a personal relationship with the organization you won't even get the initial project started. And most personal relationships are based on some level of mutual respect and trust. And I think to have a second or third engagement which we have with a number of companies the trust needs to be maintained **(COMM I5)** • Why it's important to maintain relationships with… Like at the end of the day it comes back to any decision making or it comes down to the people first. You know you can have the best scientist in the world working side by side but if they don't communicate and they don't have a good relation with each other. It will…that's all there'll ever be is a good scientist **(COMM I1)** • We are pushing the research from one direction to the other to make sure they are happy with our engagement **(COMM I4)** • It's been pretty positive so far. You know generally it's been like that the technology didn't do what we hoped it was going to do. But this is research you know you are going to have that. But I guess it's down to the relationships then **(COMM I6)** • [How do you explain this long-term relationship with the companies and why do they continue working with you/university?] Personal contacts. I think that is the basis for it. The success is important too. If a project is not successful it properly won't work either, but if things work and you have these good contacts then… **(COMM G5)** • It depends how well the work was done. If the results are right and if it's working well at a personal level then they continue and it is usually the beginning of a long-term cooperation **(TTO G3)** • Well you know technology transfer is about relationships and too far it is relationships within the university are very important. If there is a poor working relationship between the technology transfer office and the team of PI's, nothing is going to happen. And equally if there are adversarial relationships between the technology transfer office and the companies on legal matters, then it an slow down the process **(TTO I4)** • I think it's important for the centres and the projects to be visible outside a particular person or chain of command within the company. So for example…that the relationship becomes valued **(GOV I3)**

With regard to the commercialisation of scientific knowledge, the exchange and transfer of knowledge or products and the commercialisation process are the foci of interest. In this context, satisfaction of stakeholder demands becomes a relevant aspect. The success of scientific-knowledge commercialisation, and successful exchange and transfer of technologies, relies on the fulfilment of specific expectations. This success is also dependent upon the perceived quality of the technology and service. As this study is concerned with stakeholder relationships which are based on business relationships, the B-2-B market perspective of satisfaction is taken into account. Consistent with the findings, stakeholder satisfaction can, thus, be understood as both a cognitive and affective evaluation process of technology and service (commercialisation process) and relationship quality. Stakeholder satisfaction results from an assessment of economic and/or psychosocial aspects of the business relationship between stakeholders and a university. Relationship quality, as added value, becomes particularly important when other universities are able to provide similar knowledge and competencies. A centre manager (and lead PI) summarised it by saying:

> "It comes down to the social relationship; they realised that we were people they could work with who wouldn't mess them around. The outputs are extremely important… I think that the best combination is where you have people that you like who share similar thoughts and agendas where getting decent work is concerned, and your ability then to deliver on it."

Holistic stakeholder satisfaction (see Table 14 below) indicates that stakeholder satisfaction is determined by an evaluation of the pre-commercialisation, commercialisation and post-commercialisation processes and the relationship in general.

Figure 12: Stakeholder satisfaction



Source: Own conception based on Bergmann (1998)

After the clarification of the stakeholder satisfaction construct, the effects of dissatisfaction were examined. One German industry partner summarised the dissatisfaction aspect as follows:

> "To be honest… At the start we were very euphoric about the project…but now we are very disappointed…[The continuation] I am sceptical. It possibly won't continue… If the targets aren't met and it's just not working well you have to terminate it and admit that you could not achieve your goal."

Similarly, academics will terminate research collaborations. An Irish academic explained that if you do not develop good relationships then collaborations will "fall through". Government agents also acknowledged the dissatisfaction aspect (in terms of terminating funding) where their expectations are not met. The findings are consistent with the literature. A dissatisfied stakeholder will possibly leave, complain or detract from to the university's or industry partner's reputation through negative word-of-mouth.

The findings also show that the Irish dissatisfaction and disenchantment with the government agents does not have such a direct impact as the Irish academic community is relying on the government agents' funding and no alternative exists.

Table 36: Sample findings – Dissatisfaction effect

Dissatisfaction	• [If we are unsatisfied] we will terminate the project without huge engagement **(Industry G6)** • We are more unsatisfied **(Industry G7)** • We terminate a project if we are unsatisfied **(Industry G2)** • We are more unsatisfied …I am not sure if we want to stay with the centre. We don't see the targets and hopes that we had as fulfilled. **(Industry G7)** • Whether we continue working. I cannot answer this at the moment…I have to say we are disappointed. We did not get what we expected **(Industry G10)** • It did not work at all, so we ended the collaboration with the university and looked for a new university to work with….the main reason are interpersonal things, which did not work there **(Industry G15)** • We have left several projects before. There we are ruthless. **(Industry G9)** • To be honest, not at all. At the start we were very euphoric about the project…but now we are very disappointed….[The continuation] I am sceptical. It possibly won't continue… If the targets aren't met and it's just not working well you have to terminate it and admit that you could not achieve your goal **(Industry G8)** • If you are dissatisfied you have to talk to each other first…Either you try to turn it into a positive thing so that you say 'ok we are satisfied' or if it does not work then you know that they are not the partners for the next time **(Industry G14)** • They weren't engaging particularly well, I'm not so sure about one or two people on the team, yeah, I think we'll just let this one slide **(Industry I7)** • If there is no harmony projects will discontinue **(Academic G8)** • The two companies just did not warm to each other, and they did not develop a good relationship and it just all fell through **(Academic I1)** • If we are unsatisfied we don't allocate any financial resources to the project anymore **(COMM G1)** • Dissatisfaction exists where the people had bad experiences with the TTO that existed until 2006 and they say 'we don't want to work with them anymore. **(TTO G5)** • If a project got into difficulty say one of those projects where everything went wrong then [government agency] reserves the right basically to terminate funding **(GOV I3)** • IRISH ACADEMICS NOT SATISFIED WITH GOVERNMENT AGENTS…. SEE CONTEXT ANALYSIS SECTION 5.3.3

6.2.3 Effect: Stakeholder loyalty

Satisfaction might entail positive word-of-mouth or loyalty (Homburg, Becker and Hentschel, 2005). There is theoretical consensus that loyalty primarily results from satisfaction with a product and/or service (Hermann, Huber and Braunstein 2000). Similarly, loyalty can evolve from satisfaction with the technology/knowledge and/or commercialisation process/service.

Numerous studies postulate a positive relationship between the constructs satisfaction, loyalty and retention and empirically confirm this (Oliver 1980, Mooradian and Olver 1997, Patterson, Johnson and Spreng 1997, Mittal, Ross and Baldasare 1998, Rust et al. 1999, Olsen 2002). Albeit taking different functional forms into account, the prevalent empirically-observable relation function is a progressive or saddle-shaped curve (Homburg, Becker and Hentschel 2005). These functions show that in the convex part, a small increase in satisfaction has a strong positive effect on loyalty.

Loyalty is the result of a psychological evaluative decision process where different alternatives, in consideration of relevant criteria, are judged (Homburg and Bruhn 2005, Weinberg and Terlutter, 2005). A favourable attitude is regarded as a subjectively perceived suitability (Kroeber-Riel and Weinberg 2003). It reveals profound emotional and cognitive judgments (Weinberg and Terlutter 2005). Thus, the assessment is based on saved opinions and the knowledge of the university and partners.

Another influential factor on loyalty are switching costs. Long-term stakeholder orientation is more cost efficient because retaining and maintaining stakeholders costs less than acquiring new ones. These costs consist of three types of costs (Plinke and Soellner 2005). Direct costs refer to costs associated with the search, initiation and arrangement of new business relationships, as well as potential investments in them. Sunk costs are previous irreversible costs or investments that were made in order to benefit from the relationship. As these costs are specific to the particular business relationship they cannot be transferred to another and are therefore lost.

The third type of costs are opportunity costs and relate to the lost net benefit of the deserted relationship. The higher each of these costs are, the more likely it is that a tendency to persist will accrue. In order to maintain and retain stakeholders and to establish long-term relationships, it is of utmost importance to satisfy them and gain their trust. The more successful a partner (e.g. the university) is in doing this, the sooner the stakeholder becomes committed and loyal (Kleinaltenkamp 2005).

In terms of loyalty the findings show that there is a general consensus that if the results are right then loyalty will evolve. A German excellence centre manager indicated that loyalty to him means getting new requests to collaborate and solve problems together. An Irish CSET director affirms this by saying that the industry partner "came back and they renewed their commitment for another four years, basically, just do that on the basis of success". Likewise, an Irish academic highlighted that becoming loyal is a developmental process:

> "It depends on the partner, so somebody like [company x] and [company y] will be very loyal to us now…. I do think a loyalty develops."

When being asked to explain how to build a state of loyalty, interviewees referred to the collaborative process of working together and spending time on a first project. Stakeholder loyalty comprises trust, a favourable attitude towards the other stakeholders and stakeholders' acceptance regarding the high performance of the university research centre's participants or industry partners. The stakeholders become committed and have "an enduring desire to maintain [the] valued relationship" (Moorman, Zaltman and Deshpandé 1992 p316). At this point the industry partners show a reduced willingness to change their university partner and are more likely to recommend or reuse the service. Likewise, the other stakeholders want to continue collaborating with the industry partners.

The construct of trust has been discussed by several authors (Moorman, Zaltman and Deshpandé 1992, Moorman, Deshpandé and Zaltman 1993, Morgan and Hunt 1994) and is regarded as the key to facilitating exchange relationships. Trust exists if a customer believes that a relationship partner is "reliable and [has] a high degree of integrity" (Hennig-Thurau, Gwinner and Gremler 2002 p232). In the commitment-trust theory, trust is believed to be a key mediator between antecedents and relational outcome (Morgan and Hunt 1994). Sole trust approaches, however, see trust as an antecedent to relational outcomes (Moorman, Zaltman and Deshpandé 1992). Individual, interpersonal, organisational, inter-organisational or project related factors influence the establishment of trust (Moorman, Deshpandé and Zaltman 1993).

In relation to trust, the findings show interesting results. The case study participants were asked if they share all information with each other. A German industry partner stated that "we're not that open about it; we only share new ideas with the people we trust". Most industry partners, however, while having a similar view on sharing information and trusting the partners, mentioned that they have IP agreements in place protecting information. Trust, nevertheless, was important to industry partners. Setting up a contract prior to doing collaborative research cannot always cover all eventualities. One industry partner said that "it is 90% trust and 10% contracts". Similarly, another industry partner said that "a contract is a legal security, but personally I don't care, I work with people I trust." He further acknowledged that you have to know them for a long time in order to trust them, but that you can start with a small project and see if trust develops. Trust is both a necessity to start collaborating in the first place but a requirement to continue working. A German industry partner of a multinational company said:

> "the point is to build trust. And if you have created mutual trust, then they [academics] know that they can rather come to us and say *'look I have an idea, are you interested in it?'* And then trust and reliability are fundamental aspects, because if not they [academics] would just go to somebody else… and if we ultimately are known to be a reliable partner and have shown that you can collaborate well with us, then we will profit from it, as they come to us first, in the long-term."

Academics and centre managers views reflect the industry view. Both German and Irish academics and managers referred to an initial level of trust as the antecedent to collaborating and negotiating. They suggest that relationships with a company are like personal relationships and are based on a level of mutual respect and trust. They further believe that you have to maintain and build this trust in order to have a second or third engagement with industry partners.

An Irish commercialisation manager summarised it by saying:

> "I think in our old engagements we have just pretty good levels of trust. Actually I don't think you'll even begin an agreement unless there's a level of trust. The first time, companies it's like anything. If there isn't a relationship there, a personal relationship with the organisation, you won't even get the initial project started. And most personal relationships are based on some level of mutual respect and trust. And I think to have a second or third engagement which we have with a number of companies the trust needs to be maintained and the research needs to be effective they are the drivers."

On the other hand, only some of the technology transfer managers and government agents acknowledged that trust plays a role. Most, however, believe that IP agreements are the sine qua non. This is not to say that they do not believe trust is important for building a good relationship. While TTO managers and government agents agree on the role that trust plays in building the relationship between a university and industry, they view industry partners as economically driven. They do not believe that industry partners become loyal. In their view industry partners will go to another university if they can offer better terms. This view contradicts the strategic benefit that industry partners see in becoming loyal and trustworthy partners.

Government agents, as stakeholder themselves, cannot be viewed as loyal or committed to the university as they have to remain unbiased. Distrust and a bad attitude have, however, an impact on further funding opportunities. Similarly, TTO managers do not become committed to a research centre as their main remit it to provide a service for the whole university. TTO managers do, however, associate trust and a favourable attitude with a higher chance of working more closely with certain PIs.

Table 37: Sample findings – Stakeholder loyalty components

Favourable attitude	• And I don't think you can put a value on that; there was a kind of understanding of everyone wants this to work so let's see how we can make it work within the constraints **(Industry I2)** • They have always been a good partner, we value them very highly **(Industry I3)** • [Centre] and ourselves have both been growing together. I think, to tell you the truth, it has been quite easy to do that relationship so far **(Industry I6)** • Well I suppose at the beginning it was trust. I was very fortunate in that the academic I was working with Sharon, she had worked with me before so she had done her stint in industry **(Industry I4)** • We are thinking about them as preferred partner that means that we preferably would look to do something with them instead of somebody else **(Industry G1)** • When you are happy then we certainly would try to do something again **(Industry G2)** • If you think it is good then there is nothing to be said against developing and strengthening it [the relationship] **(Industry G15)** • If there's not that element… of liking between the two parties then the chances of it succeeding are not nearly as great **(GOV I1)** • I mean there had to be some building of trust done with those because it's a new company so it was, it was the trust that had been built with the original founding members of the [old company] that was able to relay and portray the institute in a good light with the management of [the company who took them over]. So again they were coming with a positive attitude and they were able to come and see that the positive attitude was justified **(COMM I1)** • I think if the results are right then loyalty will evolve. Loyalty means that you get more requests and that you continue working, continue to solve problems together **(COMM G4)** • It depends on the partner, so somebody like [company x] and [company y] will be very loyal to us now…. I do think a loyalty develops **(Academic I10)** • First of all it's the human factor which is always underestimated. If they get on well, then something will come about, if not it won't work. You cannot stipulate human interaction **(Academic G8)**
Commitment	• They [company] had their people and their people were very committed to a very sort of deep engagement with [centre]. And they are still engaged **(Academic I1)** • Let me see, so the first contract was three million, the next contract was seven million, that's ten million and six million… so it will be about 20 million I guess **(Academic I10)** • It's the usual things; communication and commitment to that relationship **(Industry I7)** • Commitment and enthusiasm is also needed. If somebody feels committed to the cooperation then I can improve processes and communications. The enthusiasm needs to be there on both sides; the management within the company and the academics **(Industry G1)** • We try to get the academics for projects and an important aspect is clear psychological commitment. Money and time is one thing but you need to have this commitment **(Industry G3)** • Very few technologies are commercialisable without the academic behind it. So if they are not committed to it they won't do it **(TTO I2)**

Trust	• Previous experience would definitely help but also even more than that I guess, they trust us, they showed that they trust us in the same way we show that we trust them so they exchange. They give us stuff and we give them stuff so there is, it’s not just a one way relationship. It’s a two way relationship… I think there is trust, yeah definitely. The IP agreement just gives confidence for that trust and sets the boundaries **(Academic I7)** • A lot of it was based on trust actually… there's was an NDA signed. But everything was based on trust and building I suppose a good working relationship with particularly the managing director there…So we felt there was good confidence and I think respect on both sides to move things along a little bi**t (Academic I13)** • It’s a period of working together, trust a bit of long-term knowing one another **(Academic I12)** • I think it’s such an evolutionary thing. Well first you've got to build up relations with people … get a working, get some trust going…So without the good relationships there, it just won’t happen… on our side, if we don’t trust the guys then you may even work with a different partner or we just do some self-contained work **(Academic I6)** • My guess would be that they trust us…we trust them **(Academic I9)** • We've been through an awful lot of ups and downs and that's all contributed to us being quite close and they are being good kind of relationships and trust **(Academic I10)** • I suppose we established trust because we were working with these people through research projects when they were in universities. So then when they spun out their companies and they wanted to do research projects they just sort of looked at the universities and the people they had carried out research projects with before **(Academic I4)** • Of course, everything that is based on personal mutual trust is obviously more resilient. As soon as this is the case, everybody is profiting. And I am happy if they call me and think about me if they have an idea **(Academic G11)** • Trust is essential. You agree things by contract but you cannot prosecute a claim. Trust is the number one. And it was the case in a lot of projects. There was a trustworthy collaboration with the people involved and that’s what made it successful **(Academic G8)** • I believe that such trusting and functioning relations develop over time. It does not happen overnight. Even if you sign something there is still the question what you get out of it **(Academic G7)** • There is huge trust, which partially grew over time… It has to grow and it takes a long time … These contacts don’t come from the start. I realised that trust has to develop **(COMM G4)** • Clearly there is loads of trust **(COMM G1)** • I mean there had to be some building of trust done with those because it's a new company so it was, it was the trust that had been built with the original founding members of the [old company] that was able to relay and portray the institute in a good light with the management of [the company who took them over]. So again they were coming with a positive attitude and they were able to come and see that the positive attitude was justified **(COMM I1)** • It depends so much on the personal relationships. And the only way to do that is slowly and over time and for people to be able to trust you that whatever you say I can do this project. They know that you mean you can do exactly what it says on the piece of paper as opposed to give me some money and I’ll go away and do some nice papers **(COMM I2)** • I think in our old engagements we have just pretty good levels of trust. Actually I don’t think you’ll even begin an agreement unless there’s a level

of trust. The first time, companies, it's like anything. If there isn't a relationship there, a personal relationship with the organisation, you won't even get the initial project started. And most personal relationships are based on some level of mutual respect and trust. And I think to have a second or third engagement, which we have with a number of companies, the trust needs to be maintained and the research needs to be effective; they are the drivers **(COMM I5)**

- I think there's probably some personal trust involved because [scientist] has been working in this field for a very long time…He's developed also some personal trust and also there is some symbiosis there **(COMM I3)**
- They [company] have to try and trust us that we are not going to try, and you know, reverse engineer and go out and try and commercialise. It's absolutely built on trust **(COMM I6)**
- What is happening within the [centre] has been a challenge so…we are trying to do a lot better on communication issues between the different parties **(COMM I4)**
- Trust is the basis for collaborations. On both sides **(TTO G1)**
- Scientists and industry researchers build up their certain network which depends on trust. I suppose trust is the nuts and bolts of technology transfer. You don't do a research cooperation with somebody you don't trust **(TTO G2)**
- It's a relationship, and if people don't feel that there is trust there, the company is not going to stand up and say okay it releases this technology. We are going to pay you this amount of money and if we don't perform you know you're going to take it back or we are not going to sign the license until we're happy…Can we trust that you will deliver on this? …So you build up that kind of trust, it is the basis of all relationships **(TTO I8)**
- You have to trust each other and you have to do what you are doing. But it would be absolutely, more than foolhardy to ever start a project without having a legal agreement behind it because trust can break down or we can forget and you have to have something. And I mean this is totally important because if you ever want to commercialise your intellectual property you have to make sure you do your due diligence to make sure everything has been complied with and dealt with **(TTO I5)**
- Everything's trust so here's a pragmatic answer… I had a researcher who was heavily cynical towards a lot of this stuff and all I did was, he was putting the proposal in for funding, he had a big commercialisation section to write so I wrote it, I wrote a big chunk of that I took a Saturday off to write it. Threw it in to him and said to him do you want it or don't, so all of a sudden he's going from, "I'm not sure what this guy is like, I don't know what the hell he wants" to "Shit, he did something for me, that was quite decent so I'll be decent back." So over time…you're competence and you're credibility, over time, build a relationship **(TTO I2)**
- Mainly it depends on a basis of trust. Then contractual things take a back seat, because it is most important that you can communicate with the professor, openly talk about things; when you have the same pragmatic approaches **(Industry G15)**
- In an era of compliance… have contracts. Grey zones do not exist anymore. However, trust obviously plays a role too. How quickly and practical these contract negotiations are done and how detailed things are pinned done **(Industry G7)**
- Well, of course a trusting collaboration and open communication is really important. It is important to maintain contacts, which is not always the case **(Industry G8)**
- A contract is a legal security, but personally I don't care, I work with people I trust…Either I know them very long and then trust is there or I don't and when you get to know something then you have to do something small first…and you get to know each other by working together…then you realise whether you can work with them or not. Then you realise whether you fit together …and if you have a topic that fits then you think about

	them **(Industry G14)** • Trust is the absolute basis. Paper doesn't blush. So you have to gain a partner's trust and that is a really important precondition for a collaboration. Without mutual trust you will never be successful…The point is to build trust. And if you have created mutual trust, then they can rather come to us and say 'look I have an idea, are you interested in it.' And then trust and reliability are fundamental aspects, because if not they[academics] would just go to somebody else…and if we ultimately are known to be a reliable partner and have shown that you can collaborate well with us, then we will profit from it, as they come to us first, in the long-term **(Industry G1)** • You cannot put everything into contracts. To be honest trust is essential too. You just have to trust the people that they don't run around telling everybody **(Industry G5)** • It is 90% trust and 10% contracts **(Industry G2)** • We only share all information with the people we trust. Trust is there…after 7 years of collaborations…it depends on the people **(Industry G12)** • I would say there tends to be a high degree of trust between individuals. I would say that it's the corporate entities are still taking the line that they want to have an agreement in place that defines what happens when things go badly wrong…The high trust helps is in organic development and allocation of resources brought to the projects. What tends to happen where there is a high trust environment is that people tend to allocate more resources to the engagement; therefore it tends to be more successful. Where there is a low trust environment issue is the very sharply defined, and I want to give you this, this and this and nothing more. Where there is a more trusting environment, things get adjusted to make this successful **(Industry I7)** • Trust comes out of experience…We'd just work together and if people do what they say, not in a very rigid sense, but are open, progress is made and people do what they say **(Industry I5)** • There's a lot of trust there. I mean I do trust [the centre] **(Industry I1)** • There had been at that point a level of trust built up between…all the stakeholders from the government organisations to the different partners within the centre. And I don't think you can put a value on that; there was a kind of understanding of everyone wants this to work so let's see how we can make it work within the constraints **(Industry I2)** • There's two sorts of trust. There's legal trust and there is personal trust but if you don't trust the people it doesn't matter what that the paper says that's it. It doesn't happen. So you don't even have the conversations as it happens. So you have to have that personal trust first and then your actual legal trust depends on what everybody's lawyer says **(Industry I4)** • You're not going to be able to move forward in any endeavour unless there's an element of trust and there's an element of common goals. Genuine common goals and those are only really exposed through building a relationship. You know, I think it's probably mostly down to trust. I mean even though you have the agreements, even though you have this. You would have research consorts, you would have agreements where it's pretty well defined and that's important for industry as well that things are pretty much defined. If there's not that element of trust and even liking between the two parties then the chances of it succeeding are not nearly as great **(GOV I1)** • Trust is established by good relationships with people you know. And again it comes down to just a general level of honesty and if people are honest with us…I find honesty and a good relationship with the PIs is possibly the best way to create an environment **(GOV I2)**

In summary, one could say that loyalty is an extremely uncertain construct that is difficult to plan. Loyalty develops based on trust and a favourable attitude resulting from first experiences of working together on a project. If the results are right then stakeholders will become committed and have a desire to continue the relationship. Loyalty exists if the stakeholders show the first signs of a lower intention to change and if they consider using the service of the university or working with the industry again. This manifests where industry partners continue to want to collaborate with a certain PI or centre. This is also the case for TTO managers who want to continue working with certain PIs. Likewise, PIs are committed and have an enduring desire to maintain valued relationships.

6.2.4 Effect: Stakeholder retention

The transition from stakeholder loyalty to stakeholder retention takes place when the favourable attitude, acceptance of the university, trust and commitment, actually result in recommendations or re-use of the service. The findings show that all but two participants have re-engaged or re-used the university research centre they are based in or have collaborated with. The two participants who mentioned that they have not recommended, and would not recommend, the research centre were industry partners. They explained their behaviour by stating that they were dissatisfied with the service that they had received. In contrast, the other industry partners' views confirmed that stakeholder retention manifests if they plan or have repeated a joint project. An Irish industry partner said that they are continuing collaborations because of the previous interactions. Similarly, a German industry partner confirmed the retaining aspect of repeat collaborative activities by stating:

> "We did another project with them because we had a very good experience with them. We worked with them on another project a couple of years ago and it was so good that we decided to do it again."

The TTO managers and academics, irrespective of country or centre type, also highlighted that industry partners continue to collaborate with universities they were satisfied with and, thus, retain. A German academic further explained that they have long lasting relationships and that, in order to activate a new research project, "it just takes an email or a phone call and then the whole thing runs".

Recommendations, on the other hand, were, while acknowledged to happen, not the main contributing factor to stakeholder retention. Industry partners mainly recommend universities to colleagues within the company or subsidiaries and, thus, enable a potential for further collaborations. Nevertheless, if companies do not see a possible competitive threat they have recommended universities to suppliers. One Irish academic gave an example of this saying:

> “[Company x] came on. [company x] is kind of a friend to [company y] because [company y] was a customer of theirs so we kind of got introduced to [company x] through [company y]”

Although not commonly given, the view appears to be that personal recommendations are valuable where received. One TTO manager provided the following example of this:

> “He says they met all his needs they were incredibly good and very supportive and especially the research group. And he’s now standing and talking to a peer group… that’s publicity you just couldn’t buy. So here’s a guy who’s had a positive experience coming by and saying, hey, do deals with these guys”

Table 38: Sample findings – Stakeholder retention components

Re-use of service/Repeat collaboration	• So because we had done research with them for a large period of time then they were happy to continue doing research with us **(Academic I4)** • The same reason why I will go and work with them again, it's probably successful projects, being able to work with someone relatively easily through ups and downs of the projects **(Academic I12)** • They are still part of [centre] and will be in the future and want to come back and work on [specific research] again…So [company x] for instance they have really remained part of [the centre] cause they see value and potential in it in the long-term for them **(Academic I1)** • The first projects…the most interesting is probably the second one and so for example this company we've licensed the [x] system to them and that's progressed quite nicely. What they liked about that is that we had done all the background work and it's taken them 3 months to get a good production in their company which would have been maybe taking a year before and now we've got it under three months, so that is very useful. Now, we are looking at a new project so they would come back with something completely different and they'd like us to take a look at that in a different way. So we think the next one is going to be very interesting **(Academic I13)** • About 18 years ago …But of course since then we've had several contracts renewed and the last contract we got was for seven million and we've just negotiated a new contract for another five years **(Academic I6)** • [We are] looking at existing companies how to grow the relationship from maybe a small project to a much bigger project…It's a dialogue, right, so they start out very small or maybe we are making some measurements for them and then join the course to making measurements to say well this is here are the results and this is what we do in addition to this…and then if that's successful then you would be able to develop the bigger project **(Academic I8)** • That was originally three years and it was renewed for one more year and then renewed for another year. And [company a] came in with [company b], originally it was an [company b] only program, and that worked very well **(Academic I11)** • We have long lasting relationships…To activate a new research project just takes an email or a phone call and then the whole thing runs **(Academic G8)** • I have contacts with company x and their subsidiaries for over 15 years and they come back for collaborations all the time. **(Academic G10)** • We put a lot of time into developing a good cooperation and maintain it **(Academic G2)** • The great thing is that if you have established a good contact and if the first project went well then it is often the case that they come back to us because everything went well in the past **(Academic G11)** • We want to extend the cooperation with the company [after the first project is finished] **(Academic G12)** • We contact partners that we already know and have collaborated with **(Academic G9)** • This particular collaboration was initiated because it was an existing relationship with our company. It is an established network **(Industry G13)** • We have just started the third generation of a joint project **(Industry G6)** • We did another project with them because we had a very good experience with them. We worked with them on another project a couple of years ago and it was so good that we decided to do it again **(Industry G9)** • If something works repeatedly well and you would try to go back and do a know-how transfer etc. **(Industry G2)** • If a project ends and it was interesting and you might have jointly achieved something, then you obviously try to cooperate with this group or the

same people again. Ultimately it depends on both the topic and the people **(Industry G7)**

- If we ultimately are known to be a reliable partner and have shown that you can collaborate well with us, then we will profit from it, as they come to us first, in the long-term…we have indicated the interest in continuous engagement and the other side to. So it's a continuum. **(Industry G1)**
- I would say it is often the case that companies do a second project if you have done this one successfully; they would then think of you too **(Industry G5)**
- The benefits…why it is working so well is the human factor. This is one of the crucial points why we continue working with the institute **(Industry G15)**
- You have to do something small first…and you get to know each other by working together…then you realise whether you can work with them or not? Then you realise whether you fit together **(Industry G14)**
- We were continuing that relationship and bringing it to the next level and are working on four or five new projects with [the centre] **(Industry I3)**
- So we are continuing, because of our interaction with [the centre] previously...So another five years **(Industry I2)**
- We have had more engagements than with others and continued on. It tends to come down to a few things…And if you have those things then you'll generally find some way for collaboration along the way…the initial contact is, you get the quality of the people that they have…As you are going through, technically, you might set up…you start small and then you build up. At first obviously you'll say okay I'll supervise something. Or let's have a look at how this little small problem turns out. And then you build on it more from there **(Industry I7)**
- And I think it is a lot easier if you had been in two, three times in contact with them before, met them personally or else wise. Then you can call them and just say 'are you interested in xyz...all the online stuff and databases that are technology transfer cemeteries. The establishment of contacts and networks are eminent. The people I have met before, I can just call and they come back. **(TTO G5)**
- If they came here say looking for an answer to a specific problem and they went away with the answer they were looking for. You know we solved the problem that they had. They will come back again…So it's building that sort of long-term relationships so it doesn't just become a simple transaction, but become the base of something… it can only be on the basis that you've got a good relationship between the company and the university **(TTO I8)**
- They are going forward so four [out of 5] of the original partners are going forward and the two new partners are going forward as well. Yeah so that's they obviously feel it's worthwhile and secure and the process and stuff that was set up **(TTO I1)**
- So I have a project that's successful so the guys' coming back to do another project **(TTO I2)**
- Companies who have successful relationships with the universities and they come back for more of the projects **(TTO I4)**
- Loyalty means that you get more requests and that you continue working, continue to solve problems together **(COMM G4)**
- Company would have to sit down and evaluate whether it makes sense to participate in the second round if they are not really getting any value of it. Nobody has indicated they would like to drop out and [Company x] has done multiple projects with us **(COMM I4)**
- They came back and they renewed their commitment for another four years basically just do that on the basis of success **(COMM I5)**
- They'll often go back into the university and retain links with the university cause what they [companies] want is not just a license that they get out of it, it's the link which people do really know the technology inside out…people don't understand that all of this is down to people at the end of the day. People and researchers tend to think that technology is sufficient, if the technology is good enough it will find a way. At the end of the day that's not true…It's all about links yeah. It's all about stakeholders… and it's networking…You got to have the right people if you've got the wrong

	people doing the right research, forget it. I know it's a bit blaspheme it's a bit cliché but if people are doing this and they don't want to do commercialisation it takes a lot of work **(GOV I3)** • I suppose it's like anything, if you have a relationship you would stay with the relationship that you have. But that would be my personal opinion and, and in here when we come down to making decisions you have to really take the personal element out you know. With the centre and now that that centre's producing good stuff and then another proposal is put in for a centre who proposed to do equally good stuff. These guys have proven themselves, these guys haven't. You know so and next it would make it more difficult for these guys to get off the ground. You know so and then the fact because these you know because the group that is up and running because they're in existence and there is a centre already within that area **(GOV I2)**
Recommendation	• I have recommended them especially if it is a technically renowned person **(Industry G6)** • I've recommended it internally… and actually a couple of people have contacted me … based around an article that we wrote …different companies and different academics would have contacted me looking for more information whatever. And I would have directed them to [the centre] **(Industry I2)** • [Company x] came on. [company x] is kind of a friend to [company y] because [company y] was a customer of theirs so we kind of got introduced to [company x] through [company y] **(Academic I10)** • Personal endorsements and personal recommendations are incredibly strong…This guy was one of the speakers and he stood up and he said he had three experiences with the universities. The one he's kept it anonymous was unsatisfactory because the university didn't want to give over the technology and they felt the owned it… The second one didn't lead to anywhere because they was general apathy and third the experience with [our university] was outstanding. He says they met all his needs they were incredibly good and very supportive and especially the research group. And he's now standing and talking to a peer group…So I'm going like, well that's publicity you just couldn't buy. So here's a guy who's had of a positive experience coming by and saying, hey, do deals with these guys **(TTO I2)**

Repeated collaborations elucidate the retention of stakeholders. The findings show that all but two industry partners repeated or plan to repeat projects with their present academic partners. The industry participants acknowledged that they were satisfied with the service, quality of the work and the relationship with the partners. They explained that the only reason for not repeating a collaborative research project would be an entire change in company strategy. The academics confirmed that companies that did not continue to collaborate, and thus left the network, did this because of strategic or leadership changes. Researching the context, however, reveals that multinationals that do not have an affiliation or allegiance with the country consider leaving a university due to funding support. This indicates that contextual factors can influence stakeholder, satisfaction, loyalty and retention. This contextual point is particularly relevant in Ireland given its reliance on foreign direct investment.

Government agents, conversely, cannot be viewed as being retained. Being satisfied with the accomplishment of collaborations, however, potentially influences these agents' recommendations to industry partners. Nevertheless, two government agents mentioned the significance of retaining industry partners directly, with almost all of them referring to this issue at least indirectly. One of the government agents stated that:

> "[Companies] often go back into the university and retain links with the university because what the companies want is not just a license that they get out of it. It's the link with people who really know the technology inside out…people don't understand that all of this is down to people at the end of the day…It's all about links yeah. It's all about stakeholders… and it's networking."

The academics' views also show that stakeholder retention is a product of establishing good contacts and demonstrating the ability to successfully accomplish commercialisation or knowledge-transfer processes. One German academic's understanding of this was:

> "The great thing is that if you have established a good contact and if the first project went well, then it is often the case that they come back to us because everything went well in the past."

Understanding the criteria that influence of stakeholder retention, and how to satisfy those criteria, is the sine qua non for stakeholder relationship success and meeting the objectives of stakeholder retention. This, in turn, contributes to the success in innovation and scientific-knowledge commercialisation which arises from repeated transactions in the areas of knowledge, technology and finance.

One Irish academic explained the salient benefit of retention as follows:

> "In fact, when I decided to move over [to a new university] the [company] immediately terminated the contract with the [other university] and said we support Professor [x] wherever he goes and that's what happened."

This quote shows that stakeholders are not necessarily loyal to a university but can be loyal to scientists. Industry partners frequently mentioned their loyalty towards PIs rather than towards universities. The importance of universities retaining their best scientists is therefore highlighted.

Despite the importance of the PI's role, the issue of retention is not limited to PIs. When one considers how a network's benefits develop over time, the benefit of retaining the wider group of stakeholders can be seen.

With this in mind, stakeholder retention embraces all activities that a university can undertake in order to influence the stakeholders' intended and actual behaviour or to improve the network's knowledge base and capabilities. The objective of these activities is to maintain and expand relationships in the future. Stakeholder retention exists if repeated knowledge transfer, technology transfer or financial transactions occur, or are planned, between the industry partner and the university research centre. Stakeholder retention is regarded as the most important objective to relationship success. Relationship success and the objective of stakeholder retention contribute to successful scientific-knowledge commercialisation by resulting in repeated transactions.

Stakeholder retention can be differentiated through either "dependence" or "solidarity" type relationships (Georgi 2005). Solidarity refers to a voluntary retention. The stakeholder acknowledges the advantages that the relationship with the university has and weighs these against the non-existence of that relationship. Two influential aspects are the above mentioned transaction quality (i.e. the evaluation of the technology and commercialisation process) and the relationship quality (i.e. a positive affective condition which results from an assessment of economic and/or psychosocial aspects of the business relationship, as well as from trust and commitment). The likelihood of successfully retaining a stakeholder rests upon a high quality of overall business relationship. This quality includes the interaction behaviour in the form of flexibility in providing the outputs, quality of the personnel involved, interaction and openness of the selling party (Homburg 1998).

Retention through dependence exists for a certain period of time. Although the stakeholder enters the relationship voluntarily in the first place, his or her decision making will be restricted due to certain parameters such as contracts. While stakeholders, in the context of scientific-knowledge commercialisation, can be economically bound (through the establishment of economic switching barriers) and legally bound (through contracts) it is difficult for the university to technically/functionally bind them. Establishing switching barriers, as a university internal moderating factor, can help to increase the dependent retention. The switching costs outlined in Section 6.2.3 are an example of switching barriers.

Table 39: Sample findings – Stakeholder retention

Retention	• They'll often go back into the university and retain links with the university because what they [companies] want is not just a license that they get out of it, it's the link with people do really know the technology inside out…people don't understand that all of this is down to people at the end of the day. People and researchers tend to think that technology is sufficient, if the technology is good enough it will find a way. At the end of the day that's not true…It's all about links yeah. It's all about stakeholders… and it's networking…You got to have the right people; if you've got the wrong people doing the right research, forget it. I know it's a bit blaspheme, it's a bit cliché but if people are doing this and they don't want to do commercialisation it takes a lot of work **(GOV I3)** • It's like anything, if you have a relationship you would stay with the relationship that you have **(GOV I2)** • So because we had done research with them for a large period of time then they were happy to continue doing research with us **(Academic I4)** • We follow up, and somehow I mean it's like dating right? I mean you go out the first time you barely know the person, you begin to get a sense of what their interests are and then it's a relationship and you have to build and maintain the relationship. If you have friends that you don't call for five years, you can call them your friends but they've really gone away and so you have to maintain the relationship. And so we have people that are constantly talking to industry **(Academic I8)** • In fact when I decided to move over here [company] immediately terminated the contract [other university] and said we support Professor [x] wherever he goes and that's what happened **(Academic I5)** • One could ask the same question about any relationship; how do you build relationship with your pet, your parents, or your girlfriend, boyfriend or a husband. It's a period of working together, trust a bit of long-term knowing one another. All projects, whether they are scientific or building a house or any project will come across its difficulties. It's not when a project is running smoothly, it's actually when a project is not running smoothly, that's when you know who you can collaborate with **(Academic I12)** • We have really good contacts with the spin offs…we maintain the contacts and invite them to our Christmas parties. So that works brilliantly. Even the companies started to develop cooperations although they have completely different products. So a real network developed. And the patent lawyers are even former students **(Academic G6)** • The great thing is that if you have established a good contact and if the first project went well then it is often the case that they come back to us because everything went well in the past **(Academic G11)** • It is always the researchers who have the contacts with the industry partner and who establish and maintain them…the relationship with company [x] dates back far before I started **(COMM G5)** • Retention depends on mutual gains **(Industry G11)** • There are more projects. So it's a continuum. **(Industry G1)**

6.2.5 Output for university and stakeholders – Stakeholder network development and access to network capabilities

Aside from the quality of the transaction and the quality of the relationship, the benefits that a relationship yields influences stakeholder retention and the formation of a stakeholder network. Relationship benefits are those which a business partner obtains from long-term business relationships that endure beyond initial expectations (Gwinner, Gremler and Bitner 1998). The abovementioned strategy aspect, which the industry partner gains, is one relational benefit. Relational benefits for all stakeholders are the development of an improved network and access to the inherent network capabilities. Table 40 should be read in conjunction with Tables 41, 42 and 43 below.

There appears to be agreement among interviewees that the development of networks results from stakeholder retention and, thus, derive from repeating collaborative projects. One German TTO manager pointed out the repetition aspect of building networks by stating that “collaborative projects are often handled by the scientist and then there are succession projects…scientists and the industry partners build certain networks.” Similarly, an Irish industry partner outlined the benefit of repeating collaborations by saying:

> “I would say it is often the case that companies do a second project if you have done this one successfully; they would then think of you too …if there is a certain structure behind it and you take notice which partners complement one another…That’s how you get a network”

The findings show that network development is therefore a corollary of stakeholder retention.

Table 40: Stakeholder retention effects – Relational Benefits

Relational benefits of stakeholder retention	• Having already established links I think it's critically important and showing that you have done it once there is a potential for another project… We have a very big project with [multinational company] and that's been a… very beneficial project…beneficial in the sense that everybody knows who [company] is and it brings a lot of weight and power which is good. And using that name has allowed us to meet other companies both big and small which has been very beneficial. And allowed us to be able to meet people that we wouldn't have been able to meet had we not been working with them. So that's been hugely beneficial **(Academic I13)** • If you get on well with a company and everything is running smoothly then you will work with them again…That is your network. **(Academic G10)** • Networks depend on mutual gains **(Industry G11)** • One benefit of networks is word-of-mouth and then getting access to others **(Industry G12)** • I would say it is often the case that companies do a second project if you have done this one successfully; they would then think of you too …if there is a certain structure behind it and you take notice which partners complement on another you get a network **(Industry G5)** • This particular collaboration was initiated because it was an existing relationship with our company. It is an established network **(Industry G13)** • We have better relationships for collaborations with the network we created ourselves than all these network initiatives **(Industry G15)** • They'll often go back into the university and retain links with the university because what [companies] want is not just a license that they get out of it, it's the link with people do really know the technology inside out…people don't understand that all of this is down to people at the end of the day. …It's all about links yeah. It's all about stakeholders… and it's networking. **(GOV I3)** • Being in such a collaborative environment worked out to the benefit of the companies because they have done other business to business relationships with companies that may not have been in their particular project or they may have been in a particular project but they did other things with them as well. **(TTO I1)** • Collaborative projects are often handled by the scientist and then there are succession projects…I would say scientists and the industry partners build certain networks based on trust and trust is the nuts and bolts for technology transfer **(TTO G2)** • [They come back] because there is a mutual interest **(TTO G5)** • The whole benefit of being in a consortium or in a partnership is that everybody brings different skill sets, different ideas and different resources to the table (**COMM I1)** • It is the network that has benefits…industry contacts enable access to research funds **(COMM G5)**

The importance of stakeholder relationships and networks for collaborative scientific projects and scientific-knowledge commercialisation is evident. Fifteen industry partners explained that access to knowledge is not the only important capability and that improved evaluation and generation of ideas is also important. This view is shared by almost all industry partners, ten PIs and all TTO managers that were interviewed.

The industry partners' view is almost unanimous. They see the network as a success factor because of the access to a multidisciplinary and mutliorganisational knowledge. One German industry partner, of a multinational company in the life sciences, stated that it is most important to have complementary knowledge in order to enable idea generation in a mutually synergetic way.

The reasons PIs see networks' capabilities as beneficial for innovation and commercialisation are twofold. They agree with the industry partners on the access to multidisciplinary knowledge base that networks enable. While industry partners refer to academics as the added knowledge base, academics refer to other disciplines within the universities. Academics acknowledge the ability to get access to "knowledge of real needs". An Irish PI stated that:

> "you get a real understanding of … what the real problem is because otherwise you are starting with … an impression of how things work rather than a real understanding, whereas with … a few different projects you could really get to understand how a company does what it does and then … there is a real chance to … make some real change … and all the time you are innovating the technology or you are innovating the approach and so I do think there is definitely a benefit in a network".

While industry partners are interested in generating new ideas and absorbing the knowledge, PIs are learning the ability to judge the commercial viability by virtue of being part of the network. The PIs therefore perceive their improved ability to assess the commercial viability of their work as being a personal benefit derived from being embedded in a network. This accords with the resource-based view of entrepreneurship (Alvarez and Busenitz 2001), the knowledge-spillover theory of entrepreneurship (O'Gorman, Byrne and Pandya 2008) and adds to the view of relational resources and capabilities for major innovation (O'Connor and DeMartino 2006, Story, Hart and O'Malley 2009). It suggests that PIs, who are not necessarily fully conscious of how to commercially exploit the technical knowledge, should be integrated into networks where other stakeholders possess the necessary entrepreneurial knowledge.

In addition, Shane's (2003) view that social networks are important to the entrepreneurial process is corroborated. Shane's view was that entrepreneurship does not happen in a vacuum. This view was supported in the interviews. As one of the interviewees put it:

> "I think the industry involvement really has some very interesting input into a problem…We want to know that because it informs us in our thinking. So it doesn't stop us thinking long-term but it really gives us this practical view of what really happens. So I think industry can inform you in that way as well, and they can give you practical viewpoints… I'm a really big believer though that real breakthrough will come at the intersection; the boundaries you know the intersection of disciplines. And yeah it's I think the reason why breakthroughs might come more easily"

The value that the different motives of stakeholders add to the network is also acknowledged. These different motives result in different stakeholders approaching issues in fundamentally different ways. By combining these different approaches networks facilitate a more successful outcome from collaborations. Whilst different motives can, as noted previously, result in certain problems, the benefits brought by these different viewpoints should be recognised. One industry partner surmised the point by saying:

> "They are part of a good network of people. It's very easy to get the samples because of the clinical context…I think there is a lot to be said for the continuity and the networking which comes out of it. Within [centre] I mean my own work on this platform has arisen solely because of the networking with one or the other industry partners. And as time progresses you become, you become more and more integrated as part of that network….This sort of familiarity actually it eases the interaction but it deepens it and it promotes identifying more opportunities"

Table 41: Sample findings – Stakeholder networks act as conduit for innovation and scientific-knowledge commercialisation (a)

Idea generation & opportunity identification (Access to information & social capital)	• So the advantages to me are very simple, I get access to compounds that no other investigator has access to. So there's all sorts of, and this is one of the good things about the pharma industry, they've got a massive compound library consisting of millions and millions of compounds. They don't know how they work genuinely they don't know what they do. But many of these are really useful compounds for understanding mechanisms …And getting access to those is very hard, it's really difficult …So I can go to pharma company X and say have you got a compound that affects the following thing? And they'll do their screen and they'll say oh yeah, and that's the big advantage **(Academic I11)** • I network with far more by actually speaking to my neighbours and actually trying to kind of get a hold of a couple of senior people who have been in the company for a long time or the institute for a long time, and we are actually more or less going to get mentors, which is also important …And that's why we are over 40 and we actually understand and bring about the discovery of sort of new mechanisms within that disease area to generate drugs and compounds. To regulate those mechanisms needs collaboration, we are good [type of scientist a] and [type of scientists b] but we are not good [type of scientist c]. So if you need a compound med you go to the [type of scientist c] **(Academic I12)** • Having companies there brings many different elements to the project …I think breakthrough ideas come off from interaction between people who are working on slightly different areas. So that's where breakthrough ideas come. So you've got someone working on some subject and someone working on a slightly different subject and when they talk they say oh you know some person doesn't see one element. The other person doesn't see the other element but together they see how a specific, how two specific ideas can come together to form a breakthrough in either one of their areas or even begin a completely different area…And that's where a lot of breakthrough has happened in my area over the two or three years, is by people taking stuff that was well known in the area [x] and applying it to [area y and z] **(Academic I4)** • Doing engineering research without the knowledge of real needs and application is a waste of time. So to have a chance to work with a company to tell you what their real problems are is a huge benefit to my opinion **(Academic I6)** • [In a network] you get a real understanding of what the real problem is because otherwise you are starting with kind of an impression of how things work rather than a real understanding whereas with a few different projects you could really get to understand how a company does what it does and then there is a real chance to break some and make some real change and all the time you are innovating the technology or you are innovating the approach and so I do think there is definitely benefits in a network **(Academic I7)** • I think the industry involvement really has some very interesting input into a problem…We want to know that because it informs us in our thinking. So it doesn't stop us thinking long-term but it really gives us this practical view of what really happens. So I think industry can inform you in that way as well, and they can give you practical viewpoints… I'm a really big believer though that real breakthrough will come at the intersection; the boundaries you know the intersection of disciplines. And yeah it's I think the reason why breakthroughs might come more easily **(Academic I10)** • I think there's huge chance of breakthrough ideas…Industry like scale, they like size because they understand what they are buying into…They have access to facilities or resources, expertise that they wouldn't get if you're dealing with a school and so for them it's just so straight forward that it's much easier to work in an institute. But also what we do is we provide this interface to all our partners schools too, right? So that's the role of our investigators these are people in the schools who we bring in to help us sort problems of industry so if industry says we have this problem and we say, okay well actually when we look at the problem. We say well we can address 70% of that. Well maybe we find a partner somewhere in either [university x] or elsewhere that can help us address the rest and we bring them into [centre] **(Academic I8)** • Probably we could spend a lot more time sitting around each other, talking to each other over cups of coffee which is really where ideas come out **(Academic I9)**

	• The network basically has the benefit of …secondarily I have excellent contacts to people in the field where you can start a lot of collaborative projects…you get to know who can do what and together you can do excellent things **(Academic G2)** • Links are obviously really important, because you are nearly 'forced' to listen what other people in other areas do….and you do get some good ideas from here or there **(Academic G3)** • I believe you have to bring people with different 'couleur' and different school of thoughts together to get new ideas. There are lucky chances and I know some Nobel prize winners who were able to have the right ideas for their problems, but you cannot assume that this is always the case. A cluster of intelligence is always bigger as an individual intelligence. If I get the right cluster together then it can spark great things that I would not be able to do if I was sitting in a cubbyhole **(Academic G5)** • It is important that research is not done in the ivory tower…Real problems are extreme valuable information to identify challenging questions **(Academic G7)** • [Benefits] for the scientists are thought-provoking impulses in relation to existing problems. A lot of impulses come from praxis. Problems in industry trigger such impulses **(Academic G8)** • The access to the facilities and to the expertise primarily… I think that all of the real breakthroughs come when you have this interdisciplinary grouping…And so that kind of combination of discussions I think that's where real breakthroughs happen **(Industry I2)** • They are part of a good network of people. It's very easy to get the samples because of the clinical context **…**I think there is a lot to be said for the continuity and the networking which comes out of it. Within [centre] I mean my own work on this platform has arisen solely because of the networking with one or the other industry partners. And as time progresses you become, you become more and more integrated as part of that network….This sort of familiarity actually it eases the interaction but it deepens it and it promotes identifying more opportunities **(Industry I1)** • Individual investigators on our side, a mixture of principle investigators and post-docs might sit down and have a more in depth discussion about the different technology spaces. When you get at that point there's a two-way street, there's a lot of stuff going over and back and sometimes ideas are identified on their side, sometimes ideas are identified on our side; then it becomes a question of do we go forward with this or not **(Industry I7)** • The possibility to identify break through ideas is higher as university and industry see something from different angles **(Industry G11)** • There are certain benefits. You get very quickly information **(Industry G9)** • Networking…we can see that we get a partner for this particular topic and one for the other topic **(Industry G5)** • We have several contacts…very close ones. The scientists give us the information, what they want to research in the next 3,4,5 years **(Industry G2)** • The possibility to get to information **(Industry G4)** • The network is a success factor for us but also for the other cooperation partners…we profit from the experience, innovative force **(Industry G13)** • The question why you think about innovation sourcing is that knowledge is limited. Therefore there is the question how can I wisely add to my knowledge base. It is important that it is complementary…a result is that ideas are generated mutual in a synergetic kind of way. One is advancing an idea and the other is contributing to it **(Industry G1)** • We also have cooperations with our suppliers. They have R&D departments too…why do we do that? We cannot cover everything ourselves. Some topics are too big. That's why we look for people who have dealt with these topics **(Industry G14)** • We need to collaborate to cover the wide area of expertise **(Industry G8)** • Access to know-how…Interdisciplinary research is the key to generating and identifying ideas…our research only exists because physicists and

biologists worked together **(Industry G12)**

- Access to information and trends **(Industry G10)**
- The whole benefit of being in a consortium or in a partnership is that everybody brings different skills sets and different ideas to the table and different resources **(COMM I1)**
- The translation of interesting ideas into something of value is far more likely in this environment. A lot of the schools have researchers that have developed good ideas. The problem is they are creating solutions to problems that nobody has. So what we do is we’re able to contextualise the research in a way that we are able to understand where the value of it might be **(COMM I5)**
- The other group, some of the people involved are strong researchers and probably the overall project would be further advanced if they decided to work together **(COMM I3)**
- The best stuff that has been coming through, has not necessarily been something that was on the original plan, but it was struck up; it was developed during conversation in the hallway, somebody had an idea and they followed up on it; we want to maximise those types of interactions **(COMM I4)**
- This is real excellence; to get people networked who possess different abilities in order to generate new things **(COMM G1)**
- We get access to information…benefits of having different partners is that you can cover certain areas and find people with different knowledge **(COMM G4)**
- You get access to a conglomerate of people, not just industry, with diverse knowledge… Being able to produce ideas might be possible in your office. The evaluation of the feasibility and possible risks is better if you discuss it in a bigger circle **(COMM G6)**
- You need very big cooperation, lots of partners …you need partners, who bring …expertise and know-how to jointly enable projects **(COMM G2)**
- The great thing is that ideas develop for applications…where people from different areas meet and generate ideas **(COMM G5)**
- There's an expression that says nobody's perfect but a team can be, that when you have got a group of individuals collaborating then this stimulates additional innovation among themselves. That innovation needs to be directed and that's where I think the industry is important **(GOV I5)**
- It's amazing how many collaboration come off workshops; get people into a room and you don’t even have to have an agenda. Just get people into a room and get them talking with each other, get them all to do five minutes high profile kind of bios of what they do; then people realise ‘Jesus this person's doing this; they can help me or I can help them’ Iit really is amazing there are institutes here in Ireland where that doesn’t work **(GOV I2)**
- Be part of a bigger group to get ideas from different disciplines and to see his [PI’s] works used in other disciplines to get ideas from the disciplines as well **(GOV I1)**
- Especially networks, where people can compete and communicate daily have very big successes. Our experience is that scientists have to establish networks at universities to communicate with and look at something from different aspects in order to create an added value **(GOVG1)**
- The essential task is that there is a coordinated action so that researchers talk to each other, that they are more than just the sum of single projects. Not a single genius scientist should research a question but should look left and right. What else exists at my university? How can we establish a research focus? I research x, but my neighbour the geneticist is researching something similar…or my physicist beside me is looking at [x] that is something I could use too. That there is interdisciplinary knowledge; that is very valuable **(GOV G3)**
- [Network success] relates to the multi-disciplinary teams or the academic teams…So there could be a team of five and then maybe only one person from industry. So obviously the industry would come forward with their ideas and stuff but I think probably they’ll, like a lot of the industry partners, have basically said that one of their best parts about [centre] is the fact that everything [i.e. different disciplines] is in one place **(TTO I1)**

Access to resources was probably the most important issue for most PIs. They stated that it is very important for them to get funding for their research, particularly in Ireland where industry collaboration has increasingly become a prerequisite to accessing government funding schemes. This finding accords with the contextual findings and one of the reasons why Irish PIs seek out collaborations with industry. Notwithstanding the different funding system in Germany, German PIs also mentioned the importance of access to additional funding. Access to funding is provided by industry partners, national governments and the EU. The empirical evidence shows that industry partners make further investments as a result of satisfactory relationships and continue collaborating with other partners. The findings indicate that these additional investments enable the creation of further opportunities. By being part of the network the likelihood of expedient recognition and exploitation is enhanced and spillovers to others reduced.

It is not just academics that see access to resources as an important part of forming and developing collaborations. Industry partners also acknowledged the benefits of having access to financial resources and the infrastructure in university laboratories. These benefits relate to the ability to jointly finance equipment or researchers, get government and EU funding and use existing facilities.

A centre manager highlighted the importance of network effects which allows the centre to offer potential partners a wide range of researchers from different disciplines. The centre is able to more effectively tackle larger-scale problems. He believes that his centre is more competitive in bidding for funding as a result of being part of a wider network. A commercialisation manager of an Irish CSET summarised network capabilities as follows:

> “The main thing is that no one company can do everything and therefore the whole benefit of being in a consortium or in a partnership is that everybody brings different skills sets and different ideas and different resources to the table”.

The centre manager above noted the differences between centres and faculties in terms of ability to attract funds more competitively. Faculties can lack the profile to attract partners in the first place. The findings confirm that, not unlike the entrepreneurial process outlined in Shane (2003), scientific-knowledge commercialisation is facilitated by access to information, social capital and financial resources. The collaborative network is seen as a success factor to sourcing innovation.

Table 42: Sample findings – Stakeholder networks act as conduit for innovation and scientific-knowledge commercialisation (b)

Access to financial resources	• Network, yeah. It seems like a lot of their funding decisions arise from people having a good track record of collaborations right, they need to be able to show that. So there's definite value in that. **(Academic I7)** • [Being in a network] well certainly from non exchequers funding it's going to be more important than ever before. And for the work that we do in designing things for the benefit of medicine and science it's impossible without companies. We need to engage them all the time…The only way to do that is through companies...More so now that the funds for researchers are certainly changed and all projects need to have a commercialisation aspect. It definitely makes a difference, absolutely makes a difference. It does, it's usually and certainly if you're applying for European funding investments, you certainly would benefit from having a bigger company because they'd certainly be reviewers for the grant **(Academic I13)** • People decided to work on this project because its interesting and these other divisions are paying their people to work on this project you know because if its successful then [they] gain credit...that's all based upon networking **(Academic I12)** • In terms of getting research funding. I mean you're not gonna get any research funding as a sole trader, as an individual researcher those days are more or less gone… now there's a lot more research in the area, there is a lot more companies, maybe six or seven companies in Ireland that work in the area. But it's been a reasonably small network **(Academic I4)** • Supplementary funds coming from EU funding, Enterprise Ireland and direct industry funding so they're all proposal based…it is an advantage to be able to say you're involved in this large program **(Academic I6)** • [The centre] certainly helps, so I just got a big European grant and the referee reports came back and definitely they were aware of [the centre]. So [the centre] has been an advantage, same with my last big SFI grant. Being in [the centre] was definitely viewed as being an advantage **(Academic I9)** • Being part of [the centre with big network] enables easier access third-party funds **(Academic G10)** • The positive aspect here, although clusters have more money than other research initiatives anyway, is that the industry contributes to positions or project related things **(Academic G12)** • I get funds for research from [government agent] only because I have a network of companies **(Academic G5)** • The network basically has the benefit of primarily getting money **(Academic G2)** • I think all the proposals are dealt with on a case by case basis. Yes it's helpful if the PI can already point to a networked background research that is appropriate to what I'm looking at. It's much easier for them to justify that yes we can actually build on these assets…rather than somebody coming in to us and saying well I have an idea **(GOV I5)** • If universities could get their academics more networked and into cohesive groups either within the university or the university with hospitals or university's industry that could be a way to attract more funds **(GOV I4)** • [Benefits are] that you can buy two, three giant equipments, which you use conjointly **(GOV G3)** • We will put in the equivalent of a scientist and a quarter of a million dollars' worth the equipment. But as part of that program we'll get the services of three other scientists plus [name of a PI]. So it's, there is a big multiplier in terms of people **(Industry I1)** • [The company] has a new philosophy which is leverage the world. So take advantage of all the resources available. So there is guys in the US, they can work on something else while we in Europe and can work in and other aspects of this synergy (**Industry I6)** • You have to build up a network. If you want to get project funding you need to have a network, because if you are alone you don't get anything.

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You need partners and if you have such a network then it is relatively easy **(Industry G14)**

- It is easier for the universities to get funding if they collaborate with industry partners and vice versa **(Industry G11)**
- To get funding it is important to have a university on board **(Industry G15)**
- Access to good financial terms and conditions **(Industry G12)**
- Access to funding and the infrastructure at the university are the central benefits **(Industry G6)**
- The network is a success factor for us but also for the other cooperation partners…we profit from …financial funds. It is a good thing for all parties involved **(Industry G13)**
- Our collaborations…there always has to be a big part of academics as it would not get financed otherwise **(Industry G5)**
- The whole benefit of being in a consortium or in a partnership is that everybody brings different skills sets and different ideas to the table and different resources (**COMM I1)**
- I don't think there's any question there are network effects to getting additional funding coming in. So it's...for funding agencies there's a risk mitigation strategy that where if they…They can give money to a single lone academic or they can give money to a centre with a whole lot of critical mass behind it and anecdotally what we've seen is that we've been very successful in our funding diversification activities. So it seemed to prove the point that there are a lot of advantages **(COMM I3)**
- I think we are able to put forward the case more competitively than a school, because we bring together a range of researchers from different disciplines. So we're able to tackle larger scale problems and we are able to do that more effectively. So I think we are more competitive for a research funding but that's not necessarily because we are an institute it's because we are a well-organized collection of researchers **(COMM I5)**
- It is the network that has benefits…industry contacts enable access to research funds **(COMM G5)**
- Putting a network in place enables you to get access to money, other technologies, other measurement methods with different perspectives **(COMM G1)**
- Research works differently nowadays…you need very big cooperation, lots of partners because of financial reasons…you need partners, who bring financial resources…to jointly enable projects **(COMM G2)**
- One benefit is that our industry partners contribute financially **(COMM G6)**
- If you try to get research funds you have to point out your selling point; your unique selling point, why me? And if you are able to point out the network and that your ideas are better because of the network then you have an advantage **(COMM G4)**
- Getting funding is never easy…so if you had like [PI name] for instance and he is looking for funding you know it's better that he has the [networked centre] behind him rather than just him being [PI] and looking for funding. So obviously...when you have a mass of 120 people or something and an institute behind it's easier to get funding than if you're an individual kind of PI **(TTO I1)**
- In some respects it is easier but only if the research outputs are good and then they usually get the money. The individuals here isolated to these programs have to build up a track record themselves over many years in their particular area of expertise and its only because that they have that reputation, track record by the way of publications or citations, that they are then accorded by people like Science Foundation Ireland **(TTO I4)**
- All research funds like to see universities work with companies…they really like that. I would say the bigger the network that is presented in a proposal the better it will get evaluated and the more they prefer it **(TTO G4)**

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A “demonstration effect”, whereby previous network success is leveraged, is also evident from the interviews. This effect refers to the ability to build improved collaborative networks where stakeholders show a higher willingness to invest and create new knowledge due to satisfaction with the previous relationship and process. PIs and centre managers acknowledge that companies are only interested in engaging with PIs and a centre if they have previously demonstrated a certain set of skills, competencies or a certain level of infrastructure and/or expertise. Emphasis was placed on the continuous need to generate new ideas and new innovations. These new ideas and innovations allow the stakeholders to plan how a program might evolve after the initial two or three years of a project. One centre director summarised this “demonstration effect” as follows:

> “They came back and they renewed their commitment for another four years, basically just do that on the basis of success.”

The understanding that success will lead to repeated projects and further innovation and commercial possibilities was shared by the industry partners. The industry partners said that if you are satisfied with the service or product you received then you will continue working with them. Similarly, a bad experience has the potential to end a working relationship.

This accords with the above contextual findings where industry partners are willing to make strategic investments in order to progress developments (e.g. life sciences) with a view to gaining from future developments that flow therefrom. These investments are both financial investments (and the investments in equipment and infrastructure arising therefrom) and investments of time in the creation of long-term relationships. These investments develop research and relationships and with the expectation that these developments will increase the chances of competitive advantage in the future.

Table 43: Sample findings – Stakeholder networks as a conduit for innovation and scientific-knowledge commercialisation (c)

Success builds on success	• It provides a show case, if companies are having successful outcomes from working in a particular university then it show-cases that university…It's a reputation and it also attracts high quality researchers and high quality students **(COMM I1)** • Companies only are interested in engaging with you, if you've demonstrated that you've a certain set of skills or a competence or a certain level of the infrastructure or expertise. If all you can do for them is one particular problem and when you finish that problem you have nothing else to offer, then the program ends. So you continually need to be generating new ideas and new innovations that allow you to plan with the company about where a program might go beyond two or three years. **(COMM I5)** • There are synergy effects enabled by these networks **(COMM G5)** • Having already established links is critically important and showing that you have done it once there is a potential for another project in different domain could have some commercial success, it's important. We have a very big project with [multinational company] and that's been a… very beneficial project…beneficial in the sense that everybody knows who [company] is and it brings a lot of weight and power which is good. And using that name has allowed us to meet other companies both big and small which has been very beneficial. And allowed us to be able to meet people that we wouldn't have been able to meet. So that's been hugely beneficial **(Academic I13)** • I've contacts with [company x] and their subsidiaries for over 15 years and they come back for collaborations all the time… If you get on well with a company and everything is running smoothly then you will work with them again…That is your network. **(Academic G10)** • Networks develop and I've recently been contacted by somebody in [government agency] with regard to a technology that he'd seen somewhere else…would I be interested in it? So I think again it's as they get more, more knowledge of what companies are doing and what they're interested in then they'll start leveraging those networks more…this networking capability **(Industry I1)** • Things grow and morph over a couple of years, I came in and my primary interest was [research A]…But as soon as I got any understanding of [research B], I began to realize that you couldn't do this unless you understood the other. I regard [research B] as the new black **(Industry I4)** • It's easier to get initiatives like that up and running because you know exactly who to go to and you have already working relationships with those folks and you can build and mould any new initiatives that way **(Industry I7)** • One benefit of networks is word-of-mouth and then getting access to others **(Industry G12)** • This particular collaboration was initiated because it was an existing relationship with our company. It is an established network **(Industry G13)** • We have better relationships for collaborations with the network we created ourselves than all these network initiatives **(Industry G15)** • I mean once somebody does it [entrepreneurial activity] and the other people see oh look you can actually do this. I think that certainly starts it and keeps going. And you will see that more in a centre cause people work closer in the centre**(GOV I1)** • Our experience is that in these collaborative network projects generate big successes **(GOV G1)** • There is certain regularity where spin outs happen every two years because there is a promotive environment…and centres where they are surpassing others in terms of activity, they have more collaborative projects, spin outs etc.**(TTO G1)** • [They come back] because there is a mutual interest. It is a lot easier if you had been in two, three times in contact with them before, met the personally or else wise. Then you can call them and just say 'are you interested in xyz...all the online stuff and databases that are technology transfer cemeteries. The establishment of contacts and networks are eminent. The people I have met before, I can just call **(TTO G5)** • They [companies] were a little bit concerned about having such an open collaborative environment but it's actually worked out to the benefit of the

	companies because they have done other business to business relationships with companies that may not have been in their particular project or they may have been in a particular project but they did other things with them as well. So having kind of all the industry partners together working close enough together and even though companies would perceive it as a risk initially and you know unless they're bringing in their crown jewels really into the[centre] then it's the benefits really that outweigh the risks **(TTO I1)** • I think it comes back to the network dynamics being able to maximize these opportunities for these interactions **(TTO I3)**

As indicated in the above tables the existence of a stakeholder network is significant as it acts as a conduit for: (a) entrepreneurial idea generation; (b) identification of opportunities; and (c) access to resources. Furthermore, stakeholder networks act as a base for repeated success and innovation. All interviewees agreed that network capabilities are one of the most beneficial outputs. Resources and network capabilities are both the raison d'être of establishing collaborative networks and the desired outcome. These resources and network capabilities enable: (a) further innovation; (b) discovery or creation of opportunities; and (c) the exploitation of these opportunities. As a result, collaborative networks create potential for further scientific-knowledge commercialisation.

As outlined above, the benefits of networks are the different skill sets, ideas and resources. As major innovations are infrequent, require routines and depend “on people over processes” (O’Connor and McDermott 2004 p27), the importance of stakeholder retention in forming and developing networks with inherent network capabilities and aiding innovation and scientific knowledge is evident. Conversely, it is implicit from the interviewees’ comments that the cessation of a collaborative network results in a loss for all stakeholders. Aside from the tangible losses that occur on termination (e.g. loss of access to resources), intangible losses arise. These intangible losses include the loss of tacit knowledge which cannot be transferred. Furthermore, the interruption or cessation of the relationships formed within the collaborative network is a likely intangible loss. As these intangible losses are likely to be increase with the age of the collaborative networks (e.g. routines are more developed, tacit knowledge is more significant), the disincentive for stakeholders to change networks will increase proportionately as the network develops.

6.3 Management and maintenance of stakeholder relationships within networks

There has been a plethora of research investigating the individual institutions within collaborative stakeholder networks (university, TTO) and how they facilitate commercialisation. It is surprising, however, that there has been little research on the management of these relationships. At present, there would appear to be inconsistent views in the literature on the role of the various stakeholders in scientific-knowledge collaboration. A substantial literature review by Rothaermel, Agung and Jiang (2007) reports conflicting findings on the role of universities and TTO in scientific knowledge collaborations. In one sense this confusion is not surprising since the findings are likely to vary depending on who is asked. On the one hand, scientists and industry partners will often criticise government agencies and TTOs as being well meaning but ineffective. On the other hand, industry partners and TTOs often criticise academics for their lack of understanding of the commercial world. This Section provides findings on how and by whom stakeholder relationships are established and managed.

According to the literature, TTOs' remit is to manage the transfer of knowledge by scouting and negotiating IP and by building and managing links with industry (Siegel et al. 2004). When asked to explain the stability of a relationship with a university research centre a German industry partner said that "relationships always depend on people and their relations with each other". The central role that PIs play in the establishment of collaborative networks, as evidenced in Section 6.2.1, has to be taken into account when looking at the overall management role. It is the PI who is either the main initiator or contact point for industry partners. The case study findings are also close to unanimous with regard to centrality of the PIs in the management of the key relationships in the networks. An alternative to the PI-lead management structure is the team-lead management structure that has been proposed by a small number of recently appointed commercialisation managers in Ireland. The importance of the PI in managing the relationships, however, was pointed out by other Irish commercialisation managers. One stated:

> "at the end of the day, somebody has to be the leader. There always has to be a leader and typically within [the centre] the leader is one of the academic PIs. So, I guess, in terms of ensuring that the projects are managed appropriately, really, it is the PI should be taking the responsibility for that".

While acknowledging the central role played by a PI he deals with, an Irish industry partner from a multinational company explained the importance of this management role as follows:

> "I guess it's just people building relationships and experience. So if you have some rocky patches along the way and you see how people deal with those and how we resolve those…you can see that the relationship works."

The management task is confirmed by 20 PIs who acknowledged their involvement in managing relationships. One German PI explained that he is not involved in all the details of the daily work as much as he would like as he has to take care of communication problems and operational problems that arise. He said that he acts as a guardian in evaluating and reconciling conflicting interests. Similarly, another German PI said that he acts as a "mediator, sort of a scientific pastor" to enable reciprocal benefits from the relationship.

It is interesting that the TTO's role in managing relationships is less important. Almost all industry contacts confirmed that the collaboration and on-going contact is with the PIs and not the TTOs. A German faculty PI summarised the issue as follows:

> "I only do research 5% - 10% of my time. Of the 35 people I have, only six are funded by the State. The rest, that is 29, are funded through third-level funding, of which 23 are funded through industry third-level funding. That means you can view it as a small business. I have to jump around quite a bit and you have to be agile when you are talking directly with people, when you establish mutual trust and then, in a sense, central services [TTOs] are toxic. They are good when you need some support information but if you have to use them, and then others think for you, and even if they mean it well, do things that do not serve the purpose and without consultation, then they are crap".

Another PI from an excellence centre in Germany said that networks exist without TTOs, as these overarching constructs, and that the only function of these overarching constructs is to motivate and educate some scientists with respect to potential commercialisation. This issue is further enforced by a government agent who believed:

> "we do not need intermediaries, but a telephone number, which is lying somewhere on an industry partner's desk, who, if he has a question, should call the professor and that professor has to pick up the phone and not some kind of technology transfer person, who after all, can only convey the question…we do not need intermediaries, but the direct contact."

In Ireland, the remit and role of the TTO is perceived similarly. The manager of an excellence centre stated:

> "engaging with industry, creating, really, a vehicle for the research that goes on within a school or within a faculty to be contextualised for industry; if you want to do that you need the centre to have...its own business development people, its own intellectual property people, its own funding people. We duplicate a lot of the functions that exist across the college because we need to operate effectively; we have to have the local resource here. And I think that's absolutely the model that's needed if you want to create a critical mass of researchers that are going to engage effectively with industry."

An Irish PI referred to the TTO as follows:

> "it is a disaster, it is a complete and utter disaster…and my academic colleagues will raise their eyes to heaven if you mention any of our TTO offices, with the exception of maybe [name of one TTO]. They are just a phenomenal barrier; just in terms of, like, the exhaustion of dealing with them puts you off, let alone anything else…I'm sure if you talked to them they'll say…the bad one is the academic, you know. And I'm actually not bad at dealing with people and we've spent a lot of time building up good relationships and I'm getting better at understanding the different viewpoints and things like that and I really want this stuff to succeed and, despite all that the progress with them, it's just…arghhhh".

In effect, TTO managers endorse this view by agreeing that the "best relationships come from the academics themselves" (see Section 6.2.1 and Table 30). Similarly, another TTO manager confirmed:

> "professors who have top-class industry cooperation do it themselves…I mean they look after their contacts and take care of the technology transfer and the closure of projects themselves".

Table 44: Sample findings – Role of the PI

Role of the PI – A jack of all trades	• At the end of the day somebody has to be the leader. There always has to be a leader and typically within [centre name] anyway the leader is always one of the academic principle investigators. So I guess in terms of ensuring that projects are managed appropriately really it's the principle investigator should be taken responsibility for that **(COMM I1)** • [Who manages the relationships?] It's the researchers; it's certainly not anybody in the TTO or anybody in the university system **(COMM I2)** • [Who manages all the relationships?] That's [PI X's] responsibility because it's his IP and those are his contracts with [company Y] so that's definitely him…. he's known them and been closely aligned with them for a long time **(COMM I3)** • The single projects, with their own projects, it's the PIs and me **(COMM G1)** • [Who is responsible for managing the contacts?] We have several professors researching on this task but one of them is the central communication point **(COMM G6)** • It is always the researcher who has the contacts with the industry partner and who establish and maintain them…the relationship with [company x] dates back far before I started **(COMM G5)** • Ultimately the researchers have to be able to talk and interact and keep collaborations, relationships going…I don't think it works any other way **(Academic I10)** • I am responsible for managing my relationships **(Academic I5)** • [And who's responsible for managing the relationships with the two companies?] Probably me. I'm responsible for the overall project and then I've like researchers who work on the project, who will work with me and come along to the meetings and who will maybe do more of the work in the lab **(Academic I4)** • We have a silly model here. The model is that we actually have the ability to have people who do world class research, who go and take that research and maybe spinout then maybe go on and do wonderful things in their businesses. And that's true, there are some PI's who have that certain capability to be able to spinout a business. But that's rare… The way I want to use our PIs is I want our PIs doing world class science, publishing science in Nature and Nature Materials and all those good places. And I want to leverage that to work with industry. **(Academic I8)** • It was [lead PI], yeah. So he would have managed the project, he would have been the individual, the project manager, the project leader everything. And maybe that's just too much **(Academic I2)** • It tends to be that the academic, in my experience anyway, the academic actually is establishing a contact with the company…[Ok, that is establishment, what about the management of your relationships with industry partners or clinicians?] It's all us so it would be the laboratory that would do that as opposed to the TTO, and it depends on the laboratory. So I have been fortunate that the people that I would have, tend to be very managed. And as a result are very good at having action points and following up **(Academic I13)** • It has to be managed at every level. There would be a project leader within industry, there will be a scientific project leader in [centre], in this case myself with [person x] and there will be the centre manager and everybody has a role to play in conflict limitation **(Academic I9)** • So far industry has approached me in all projects that I have had … You cannot outsource direct contacts. You have to be able to personally talk to industry partners to do a project. The administration can be done by others **(Academic G8)** • We use the time very intensely to build up a good collaboration and to maintain it **(Academic G2)** • We want to develop the cooperation further…and this was triggered by the principal investigators **(Academic G12)**

	• I only do research 5% - 10% of my time. Of the 35 people I have, only six are funded by the state. The rest, that is 29, are funded trhough third-level funding. That means you can view it as a small business. I have to jump around quite a bit and you have to be agile when you are talking directly with people, when you establish mutual trust and then, in a sense, central services [TTOs] are toxic. They are good when you need some support information but if you have to use them, and then others think for you, and even if they mean it well, do things that do not serve the purpose and without consultation, then they are crap **(Academic G11)** • I am the central person who is responsible for planning, organising and administrating collaborative projects **(Academic G9)** • Most PIs manage their contacts themselves….insofar we rarely have to take care of it…the scientists have them… we only offer a service and the PIs can say 'no I do it myself' …there are often repeated projects; The scientists and industry partners build certain networks **(TTO G2)** • The most important aspect for technology transfer is people. We are a 3rd party that only gets involved later… otherwise we would need 50,60 TTO managers **(TTO G3)** • Contacts to big companies usually exist with the professors... Companies call and ask for a specific professor …[or] I try to get in contact with small companies…everything else is then left to them…the professors on-site **(TTO G4)** • It usually happens through the PIs themselves …our task is more to be an overarching roof; to be responsible for single inquiries **(TTO G1)** • A lot of connections are made with the PI's giving presentations or presenting papers at conferences. The PIs have a big role of managing the relationships because at the end of the day the PI has to actually deliver on the projects he has to make it happen. So they are the main drivers of the pragmatic day today relationship… it's pretty much a team effort between the PI, research performers and the transfer people **(TTO I4)** • We're trying to get the PI's to do most of the interaction. We could be involved on IP committees, we could be involved, it really depends on the project and what the company, how they engage with the PI **(TTO I7)** • The lead PI coordinates…that works pretty well…there may be tension going forward; how PIs balance all these different activities **(Industry I6)** • Ultimate success depends on people doing the actual research. Primarily that falls to the PI in these teams and not the directors… But surprisingly there was very little engagement as well after the project, that's a little bit worrying….We are trying to develop a relationship… So it's a lot to do with how you get on personally with the PIs and if you can explain to them why it's not going to be patented, it's a matter of keeping that relationship strong because who knows, the next idea might be brilliant **(Industry I7)** • Maintaining relationships is important, it's the key people… the key people around certain technologies and assuming they continue with developments that will be obviously essential to see where the next step, the next phase is going **(Industry I5)** • It is not about universities; it is about professorships… It is always about people…and it depends on the PI whether you will go back and work with them again **(Industry G14)** • The first thing you look at is does it work from a people perspective, can we work with them …in this case the professors. **(Industry G15)** • Cooperations are always directly managed with "acting individuals" [PIs]; "administrators" [TTO] are irrelevant **(Industry G11)** • I find honesty and a good relationship with the PIs is possibly the best way to create an environment **(GOV I2)** • If the PI goes generally the grant goes with them **(GOV I3)** • We do not need intermediaries, but a telephone number, which is lying somewhere on an industry partners desk, who, if he has a question, should call the professor and that professor has to pick up the phone and not some kind of technology transfer person, who after all, can only convey the question…we do not need intermediaries, but the direct contact **(GOV G2)**

Evidence from the cases (collaborative projects) suggests that the PIs are responsible for the initiation, management and maintenance of relationships and that the TTOs act as an accompanying service in relation to IP issues. This finding is further affirmed by a TTO employee who stated that they are all too busy protecting the IP and so there is no time for further activities. As indicated in the context findings (Section 5.2.3/Table 21), the time issue was also acknowledged by another TTO manager who said that they spent most of their time protecting IP and do not have enough time to commercialise the IP. This study finds that approximately 50% of the stakeholders identified the TTO as a barrier to knowledge transfer and do not trust the TTOs' abilities. The other half did not necessarily see them as a barrier but appeared to be ambivalent about the role that TTOs play in the process. This latter half felt that the TTOs could not work better given the resources that are provided to TTOs.

Researching the context (Section 5.3.3/ Table 26) revealed that PIs also query the role of TTOs in IP protection. In general, there is a negative perception of TTOs. A lot of academics are not confident in the abilities of their TTOs and their "capacity to deliver" what PIs want. This lack of capacity to deliver seemed evident in both Ireland and Germany. It is also present across all universities as all excellence centres have started to employ their own personnel to replicate the TTOs' job within the centres. This in itself shows that TTOs are not perceived as great facilitators. German industry partners who had dealings with TTOs agreed with the view that TTOs are more of a hindrance than assistance. German government agents were also not convinced of TTOs' ability to help with commercialising scientific knowledge. Irish government agents, on the other hand, did not mention the TTOs. This might be due to the fact that Irish TTOs are financed by one of the government agencies. On the whole, TTOs are perceived as mainly dealing with the protection of IP and are unable, due to either insufficient time and/or resources, to execute the commercialisation of scientific knowledge or to protect IP.

In sum, the role of the PI in establishing and managing relationships is evident and similarly perceived by all participating stakeholders. Given that this is qualitative research, there is no measure of statistical significance. Multiple stakeholders agreed on this issue, however, and such agreement was present regardless of organisational size, type and geographical location. It is very clear that the PIs play a leading role, not just in the initiation, but also in the management and maintenance of these relationships. The findings suggest that the PI is best placed to bridge the gap between industry and academia and not the TTO manager, as proposed by several authors (Siegel et al. 2004; Wright et al. 2008). The PI has to have the ability to initiate and manage relationships and thereby create an environment for successful commercialisation and hence further possibilities of repeated knowledge transfers, or commercialisation endeavours. It is recommended that greater emphasis should be placed on PIs as boundary spanners in the scientific-knowledge-collaboration process.

6.4 Conclusion

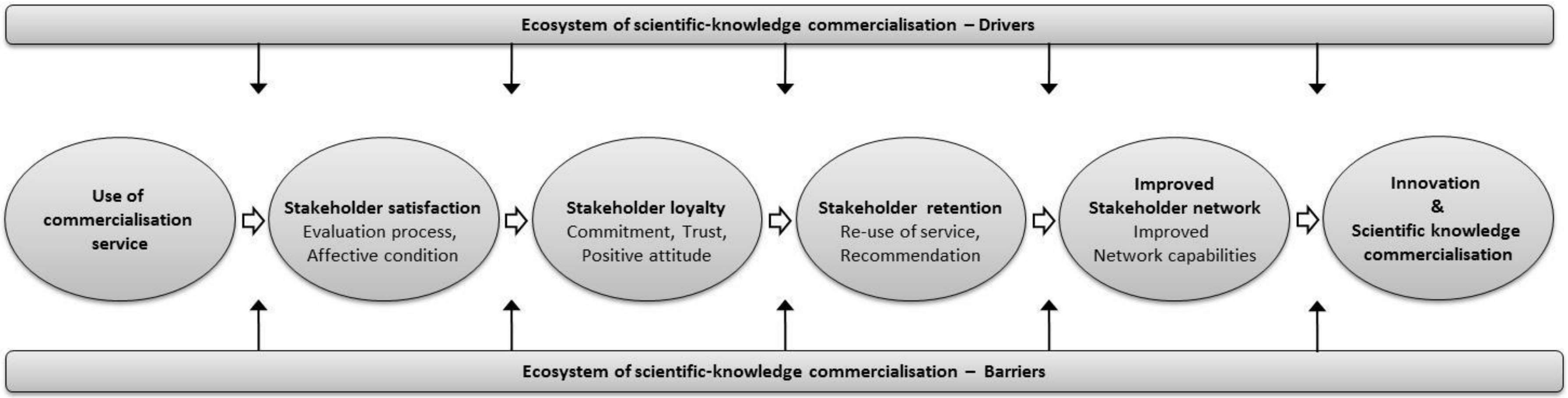
This chapter shows that it is the PIs who initiate contact or cause the initiation of the contact as they are the key reason that industry partners start the relationship. In addition, the research found that relationships are established if the PIs show a willingness to collaborate with industry. The study also shows how relationship quality, knowledge base and commercialisation service contribute to stakeholder satisfaction. It proposes that trust, commitment and a favourable attitude contribute to the creation of loyalty. Loyal stakeholders will, in turn, repeat collaborative projects or recommend the institution to somebody else. Stakeholder retention thus influences the development of advanced collaborative stakeholder networks due to repeated collaborations. Innovation is facilitated by routines and people. It is through these routines (in the form of repeated collaborations) that the success of innovations and commercial results is enhanced.

As outlined in the literature, university entrepreneurship is not able to explain the complexity of the scientific-knowledge-commercialisation process. Entrepreneurial opportunities can either be discovered (exogenous opportunities) by those involved or created and recognised (endogenous opportunities). Network resources and network capabilities enhance the likelihood of recognising and exploiting both endogenous opportunities (through the commitment of investment to create new knowledge and recognising its value by being part of the network) and exogenous opportunities (through the provision of social capital). The findings indicate that collaborative stakeholder networks are a conduit for innovation and create potential for scientific-knowledge commercialisation. The findings indicate that these benefits arise due to network capabilities.

In summary, the findings suggest that stakeholder retention is a catalyst for developing improved collaborative networks. These networks facilitate the commercialisation of scientific knowledge through repeated projects. Stakeholder retention results from stakeholder loyalty. Stakeholders become loyal and are committed because they trust their partners and are content with the overall relationship, commercialisation service and quality. Network resources and capabilities are the main reason stakeholder networks should be established. The study also shows that collaborative stakeholder networks are a conduit for innovation as both innovation and scientific-knowledge commercialisation result from networks' capabilities and resources. The demonstration effect indicates that networks' capabilities improve by way of repeating collaborations. It can be implied from this is that the value of a network increases with a network's age and that this value acts as an increasing deterrent to stakeholders leaving the network.

The components and the linearity of the functional chain are, however, not certain. Moderating factors and barriers, as described in Chapter 5, can influence both chain elements and their inter-relationships. Incorporating the findings on influencing factors and barriers from the previous chapters, the functional chain (Figure 15) concludes with the development of advanced collaborative stakeholder networks due to repeated collaborations. The functional chain continues with further successes from repeated collaborations (successes are maturing the network). Innovation is, thus, facilitated by routines and people and it is through these routines and people that the success of innovations and commercial results is enhanced.

Figure 13: Stakeholder retention success chain



Source: Own conception based on B-2-C success chain (Homburg 2005)

Arguably, the primary finding relates to the role of PIs in networks of scientific knowledge collaboration. Taking the contextual findings (Chapter 5) and findings on the initiation of relationships (Chapter 6.2.1) into account, the PIs play a leading role in founding and maintaining academic industry relationships. The centrality of the PI's role in the network is recognised by almost all interviewees in this study. These interviewees represent multiple stakeholders in the process, including PIs, industry partners, TTO managers and government agents. This view persists irrespective of research centre size, type and geographical location. Thus, a multi-stakeholder analysis serves to clarify this important issue in the research.

The findings shed light on the key role of PIs at different stages in the development of networks. In terms of establishing collaborative networks, the PI is either directly responsible for making the contact himself or herself, or it is his or her reputation that attracts the attention of potential industry partners. At this stage in the process, reputation is critical. Academic research is increasingly being incorporated into the global market for knowledge and the global search for professors with expertise in relevant research domains has become a well established industry strategy. It is also clear, however, that PIs must also show a willingness to engage with industry.

Once the initial contact is established, the quality of the PI's work remains critical to the success of the partnership but increasingly it is the PI's ability to manage and negotiate with partners that determines the development, success and sustainability of the network. Thus, not unlike the entrepreneur, the PI can be seen as 'a jack of all trades', taking on the roles of project manager, relationship manager and negotiator. These roles are in addition to the traditional academic role of PIs (i.e. teaching, Ph.D. supervision and mentoring, administration and resource acquirer) (Sabatier, Carrere and Mangematin 2006).

The role of the TTO in networks for scientific-knowledge collaboration is generally negatively perceived. The TTO is viewed as an overarching support structure fulfilling an informational and educational role only. This raises the question as to whether TTOs should be a central service or whether research centres should employ their own personnel to deal with IP issues. Proximity to the research projects and intimate knowledge of the particular IP that is being commercialised appears to be necessary for such commercialisation to be successful. These requirements mean that a more local-based support structure appears preferable. This reflects the actual organisational structures in place in the research centres, and particularly the excellence centres, where networks are effectively managed locally. The findings are consistent with those of Colyvas et al. (2002) who noted that the TTO activities are only needed where existing links are weak. This questions the ability of TTOs to act as boundary spanners as proposed in prior research (Siegel et al. 2004, Wright et al. 2008). At a minimum, the results suggest that the role of the TTO needs to be re-evaluated so that it can better support PIs in their role. This research suggests that PIs are better placed to act as boundary spanners between science and industry.

7 Discussion

7.1 Introduction

Scientific-knowledge commercialisation is a heterogonous process requiring the participation of different stakeholders. The literature review revealed that there are several conflicting findings on the different roles of stakeholders. A deeper understanding on the effectiveness of each stakeholder and how the diverse linkages between stakeholders impact scientific-knowledge commercialisation was required. Why and how networks of these linkages are established, developed and managed also needed to be examined. It was proposed to look at the wider environment of the stakeholders in order to understand multi-level interaction and the barriers and factors to scientific-knowledge commercialisation.

The study presented qualitative case research to answer the following three research questions: (1) how collaborative stakeholder networks develop to facilitate scientific-knowledge commercialisation; (2) why collaborative stakeholder networks are established for scientific-knowledge commercialisation; and (3) by whom are collaborative stakeholder networks for scientific-knowledge commercialisation established and managed?

In doing this, certain research issues were identified and the context was researched. The functions of this chapter are to summarise and synthesise the work of this study. It is important to understand this context before answering the above research questions. For this reason, the context is discussed at the start of this chapter. The chapter then outlines the proposed theory by discussing and summarising the answers to the research questions in light of this contextual background.

7.2 The contextual background

The issue of multilevel interaction had not been studied in the required depth. Prior research focused on single or dyadic analysis. Researchers often studied only single context variables, thereby neglecting the importance of different contexts such as institutional, social and spatial contexts (Welter 2011). Contextual factors are believed to set the boundaries for theoretical generalisation (Whetten 1989). A better understanding of the commercialisation context and the factors and barriers that influence the interplay between the different stakeholders was required. Welter (2011) suggests a multi-layered embeddedness perspective to contextualise theory.

It is suggested that such an approach should be able to combine the top-down effects of context on entrepreneurial endeavours and the bottom-up processes which influence that context. The approach should also include individual perspectives. The ecosystem of scientific-knowledge commercialisation shows that the process of scientific-knowledge commercialisation and the establishment and development of stakeholder networks are set in different societal, economic, environmental and technological contexts with different formal and informal institutional frameworks. The ecosystem of scientific-knowledge commercialisation can, thus, offer an overarching approach when considering the context. Employing such an approach enabled the identification of several macro (economic, social, technological and ecological), meso (stakeholder specific) and micro (individual) barriers and factors to contextualise theory on S-2-B collaborative networks.

The study employs a comparative approach. By looking at Germany and Ireland and applying the observations to the various ‘contextual spheres’, important differences are seen between the two countries. Just as importantly, some factors and barriers that are common to both countries are evident. By observing these various spheres and how they interact with each other, a more complete understanding of scientific-knowledge commercialisation is enabled.

In terms of commonalities, the findings highlight that the German and Irish scientific-knowledge-commercialisation systems are structurally quite comparable. Firstly, and most importantly, the findings show the importance of relationships. The need to build interdisciplinary and interorganisational networks is cited as the most important drivers for innovation and scientific-knowledge commercialisation.

Secondly, the commercialisation of scientific knowledge is enabled by the same types of stakeholders. In both countries it is the PIs that are viewed as being fundamental to the commercialisation process. The TTOs, which were established in both countries to facilitate the technology transfer process, are not therefore viewed as the central stakeholders.

Thirdly, stakeholders in both countries criticise the inadequate implementation of the third mission in universities. The criticism is directed towards the alignment of universities’ incentive structures with the universities objectives. Further connected criticism arises from the failure to rebalance the workloads of university employees to take account of the third mission.

Fourthly, the interviewees criticise the generalised method of applying the American model of commercialisation to European systems. The failure to properly account for cultural differences both within Europe and between Europeans and Americans (e.g. the risk appetite of both individuals and companies, attitudes towards failure and social prestige) were the main focus of this criticism.

Fifthly, criticism of TTOs is frequent to both countries. There is a reasonably widely-held belief that TTOs are one of the most considerable barriers at the moment as they represent a significant misallocation of resources. In addition, the introduction of TTOs in Germany and Ireland does not appear to have relieved the strain on PIs.

Sixthly, the current legal frameworks to the commercialisation process in Ireland and Germany are viewed as barriers. Significant delays in agreeing contractual terms, in protecting IP and a failure to enforce IPRs all serve to undermine the commercialisation process.

Seventhly, the excessive workload is perceived as a barrier by PIs and TTOs. PIs pointed to excessive administration and a failure by the university to accommodate the third mission within the PIs' workload. TTOs, on the other hand, feel that their time is consumed by protecting IP. This prevents them from commercialising and enforcing IPRs.

In terms of differences, the findings show that there are economic barriers, in terms of funding, in Ireland but not in Germany. In an Irish context, this lack of funding has caused conflicts between stakeholders. This is not to say that funding deficiencies are the only source of conflict; they are not. Pressure to show results from the investment in developing a knowledge economy is evident and some stakeholders view this pressure as unreasonable. Irish academics and government agents have different views on returns on investment and the timelines that are necessary to achieving commercial success.

In Germany, however, these demands are not as evident and the relationship between German academics and government agents is informative. In fact, the reasonably ready availability of funding in Germany appears to manifest in the continuance of the "ivory tower" approach. The satisfactory funding structure allows academics to apply for basic science funding and remove themselves from industry collaborations. Taken in isolation, it would be simple to misunderstand some of the differences. In relation to the "ivory tower" issue in Germany, it would be easy to conclude that German academics are more arrogant and unapproachable than Irish academics. The comparative study reveals, however, that Irish academics would also rather do basic research. This would, in turn, be likely to reduce their interaction with industry. Considering the context reveals that there is increased pressure on Irish academics to engage in applied science with industry partners. While Irish academics may prefer to do basic research, they are prevented from doing so by the current state of the ecosystem that they work within. The need for Irish academics to interact with industry stakeholders is therefore increased. It can, therefore, be seen that understanding the wider contextual environment and the interaction of the various spheres is important before drawing conclusions. Consequently, it is important to understand that the various spheres can impact on the research questions. In other words, the contextual findings will set boundaries for generalisation (Whetten 1989), whilst the existence of similar research results enables theory building (Eisenhardt 1989).

7.3 How do collaborative stakeholder networks develop to facilitate scientific-knowledge commercialisation?

The establishment of networks for innovation and scientific-knowledge commercialisation is seen as a requirement for economic growth and development. Consequently, current policy debates centre on the longstanding idea of creating local networks and clusters (von Hippel 1988, Etzkowitz et al. 2000, Porter and Van Opstal 2001). Despite enormous financial aid from governments, however, artificially supporting the development of such networks has proved difficult. Current research on innovation networks has identified informal or formal collaborations and facility or knowledge sharing as ways to form these networks (Zucker and Darby 2001, Zucker, Darbey and Armstrong 2002, Pérez Pérez and Sánchez 2003, Murray 2004, Löfsten and Lindelöf 2005). Unlike previous studies, where research is considering mostly the firm's perspective (Pittaway et al. 2004), this study analyses network formation from a multiple stakeholder perspective; that is, industry partners, TTO managers, PIs, government agents and commercialisation or centre managers. The qualitative findings of this study confirm that informal and formal collaborations, facility and knowledge sharing are means of establishing these networks. The process, however, on how these innovation and scientific-knowledge-commercialisation networks are established has been neglected and is the subject of this study.

The findings illustrate how stakeholder relationship networks are established. While the findings are presented in a linear approach, it should be noted that the contextual factors and barriers of the ecosystem have an influence and can impact upon the network formation. The linear approach may not, therefore, be reflective of all scenarios.

The initial use of the commercialisation service is either initiated by the PIs or the industry partner. The TTO is hardly ever the initiator or the primary point of contact for industry partners. The industry partner normally initiates contact through the PI. This is done for two reasons: (a) a special interest in the research area in order to solve a problem; or (b) the reputation of the PI. This finding implies that it is important for the PI to attract industry partners' interests by publishing in high-ranking journals. Previous links (e.g. personal relationships, prior experience with somebody or alumni) also play an important role for the initiation of collaborative activities for both industry partners and PIs.

Stakeholders will evaluate the collaboration and the business relationship based on the relationship quality, knowledge base and commercialisation service. The success of a project is not necessarily a working product. Rather, it is the ability to work through ups and downs within a collaborative project which is the stronger contributing factor to stakeholder satisfaction. In particular, industry partners assess the collaboration based on: (a) professionalism; (b) time management of stakeholders; (c) industry and market awareness of the centre and PIs; and (d) realistic evaluation of IP and feasibility by PIs and TTOs. Other factors that are generally shared by stakeholders and which influence the perception of a successful and satisfactory collaboration are: (a) frequent, open and honest communication; (b) research output and quality; and (c) relationship quality. In evaluating these factors or expectations of the business relationship, the participating stakeholders will have an emotional reaction which translates to either a positive or negative outcome.

The study proposes that trust, commitment and a favourable attitude of all stakeholders contribute to the creation of loyalty. Trust is seen as going beyond honesty and particularly included realistic evaluations of the scientific-knowledge-commercialisation process. The findings on trust show that while it is an important aspect for industry partners and academics alike, the view of the role of trust was not shared by all TTO managers or government agents. The TTO mangers believe that IP agreements are the most significant factor for binding industry partners to an arrangement, thereby conflicting with the view that industry partners and academics have. The TTO managers admit, however, that trust in PIs influences their attitude. Government agents, on the other hand, while acknowledging their neutrality point out that distrust and a bad attitude might have a bearing on further funding opportunities.

A realistic evaluation of IP was important for all other stakeholders. A realistic evaluation of the feasibility of commercialising IP was similarly important. This study shows that different expectations may result in dissatisfaction which, in turn, has a negative effect on the relationship of the participating actors and on future collaborations (Fulop and Couchman 2006, Decter, Bennett and Leseure 2007, Wright et al. 2008). Which factors impact on the successful perception of collaborations is, however, open for discussion. Mora-Valentin, Montoro-Sanchez and Guerras-Martin (2004) find in quantitative dyadic analysis between firms and research organisations that commitment, previous links, definition of objectives and conflict are relevant for the success of collaborative arrangements. Factors which are important to the research organisation are previous links, communication, commitment, trust and the partner's reputation (Mora-Valentin, Montoro-Sanchez and Guerras-Martin 2004). While this study confirms that previous links and commitment are important factors for both partners, it extends the literature by finding that commitment is also important to TTO managers, government agents and centre or commercialisation managers. In addition, it finds that communication, trust and reputation of the centre, university or PI are also very important to industry partners. Industry partners also make judgment based on the market awareness and professionalism of the centre or PI. In terms of definition of objectives (i.e. requisites, knowledge and acceptation of objective), this study extends the research by providing clarity on what these objectives are; namely, the realistic evaluation of IP and feasibility. The study shows that definition of objectives is not just an important issue for industry partners, but is also important to all other stakeholders.

Overall, the findings show that trust and commitment contribute to stakeholder loyalty. Stakeholders are loyal if they start to show a reduced willingness to stop the collaboration or change the university they are collaborating with. If such loyalty exists then industry partners are more likely to recommend or reuse the service of a particular PI or university. Similarly, TTO mangers will want to collaborate with a certain PI. Likewise, PIs that are loyal will be more committed and have an enduring desire to maintain the valued relationship. The findings, thus, show that stakeholder loyalty manifests in stakeholder retention if stakeholders repeat, or plan to repeat, collaborative projects. Stakeholder loyalty can also manifest in retention through recommendations for collaborating. Stakeholder retention therefore influences the establishment of a stakeholder relationship network through repeated collaborations.

According to social-exchange theory, mutual investments are made as a result of satisfactory relationships. These investments in relationships will create social bonds and structural bonds. Trust and commitment are social bonds that, when developed, lead to the creation of a further social bond in the form of loyalty. Structural bonds that are created include information and resource sharing, pooled scientific knowledge, contractual arrangements, joint investments and pooled academic, industry and technology transfer competencies. These relationships are strategic and organisations form relationships in order to achieve goals (Wilson 1995). Similarly, the empirical evidence shows that investments are made as a result of the satisfactory relationships. These investments also create both social bonds and structural bonds which, in turn, strengthen the relationship and the formation of networks further. It is through these social and structural bonds that the formed network of multiple stakeholders produces satisfactory personal, non-economic and economic outcomes.

Researching the ecosystem shows several aspects that impact upon the creation of scientific-knowledge-commercialisation networks. Firstly, it is important to understand each stakeholder's role in order to establish a stakeholder network. The TTOs do not play the role that is currently expected of them. As it stands, TTOs are mainly perceived as dealing with the protection of the IP and are either unable, or have insufficient time and resources, to effectively commercialise IP. The overestimation of the role of the TTOs leads to a disconnect in networks. This disconnect can hinder a network's development and impacts upon a TTO's place in a network. In addition, TTOs' overvaluation of IP alienates industry partners, thereby preventing collaborative projects from being repeated and, thus, hindering retention and network building.

While universities are conscious of the need to embed the third mission in their culture, the interviews suggest that this is not being done. Against the context of the failure to embed this culture, it becomes obvious that the failure to properly understand how to embed the third mission acts as a barrier to network creation. This failure is evident in a number of ways. A good example is the oft-cited failure of universities to align incentives with their third mission. This misalignment creates an internal conflict between the PIs and the universities insofar as the PIs' motives and the universities' motives are different. The net result of this is that the PIs are considered as being a stakeholder in their own right rather than merely acting as an agent of the university. Creating a successful network is difficult enough without adding the additional variables that are brought about by having to consider an extra stakeholder in the network.

A further barrier identified is the failure of stakeholders to understand each other's points of view. The Irish Government and the HEA were criticised for not appreciating the timescales involved in scientific research. The academics view their research in terms of generating long-term benefits whilst Governments value short or medium-term commercial benefits. The issues raised here are fundamental. The Irish Government expects investment in scientific knowledge creation will generate commercial results in the short-term. Irish academics believe that it will take time for the investment in the science base to generate commercial returns. Some Irish academics cite timeframes of up to 50 years. These academics point out that the countries with the most commercial success from scientific knowledge are the countries that have been investing for 50 years and more. As a result of these diverging views on a reasonable timescale for investment to lead to commercial success, academics in Ireland worry that investment may not be maintained in the long-term. This, in turn, could cause a crisis of confidence which would undermine the academics ability to "sell" their networks. One must query, therefore, whether such discrepancies enable the formation of productive networks.

In addition, the study reveals that German stakeholders are generally content with the involvement of government agents and the execution of the funding procedures. In contrast, the Irish results show high levels of dissatisfaction and disappointment among academics with the Irish government agents. Criticism of the SFI and HEA were common, whereas EI evoked mixed feedback. Academics perceive government agents as being ill-equipped to understand the science that they are trying to commercialise. Beyond this, the SFI does not seem to have convinced the academics interviewed that they added any value to commercialisation efforts. In fact, there is a common perception that the bureaucracy involved in the process means that the commercialisation process is being hampered. This view is less evident vis-à-vis EI. While it is, therefore, easy to say that the failure to understand each other's points of views can be made accountable for creating a barrier to network formation, it is important to acknowledge that more fundamental problems are evident which lead to these failures. Such barriers relate to the general understanding of what scientific-knowledge commercialisation is, what is commercialisable and how involved each stakeholder needs to be.

The conflicting views on timelines mentioned above coincide with funding issues. The fact that these two barriers are occurring simultaneously in Ireland serves to exacerbate doubts among the Irish stakeholders as to long-term plans of the Government to build networks for the creation of a knowledge economy. This doubt undermines the motivation to cultivate networks and as a consequence has the propensity to contribute to the destruction of otherwise viable networks. Current economic constraints impact research and research collaborations in Ireland. The concern of the other stakeholders, however, appears to go beyond a lack of funding due to the recession. Government agents, as the Irish Government's representatives, need to be conscious of the potential impact of their demands for immediate commercial returns. Making these demands at a time when funding levels are weak appears to be having a particularly destructive influence on academics' confidence in Government commitment. As noted above, confidence in the commitment of other stakeholders is vital to the creation of trust and loyalty. By acting in a manner that draws this commitment into question, government agents may contribute to the destruction or failure to build sustainable networks.While prior research has shown that the presence of government support programmes is the sine qua non of commercialisation (Rasmussen, Moen and Gulbrandsen 2006, Rasmussen 2008), it appears that government support programmes, such as government agencies, can also impede commercialisation. In addition, prior research showed that the short-term oriented mission of industry partners (i.e. the aim of making money) conflicted with the long-term research oriented goals of academia (Cyert and Goodman 1997, Polt et al. 2001, Jones 2006, Lockett, Kerr and Robinson 2008). In Ireland academics are under pressure to meet short timescales from industry and government agents.

Despite the 'ivory tower view' that was expressed about German academics, Germany continues to outrank Ireland in relation to university-industry collaborations as measured by the global innovation index (INSEAD 2011) and global competitiveness report (World Economic Forum 2011). The findings show that, while Germany has a long tradition of industry engagements with existing national companies such as Siemens, BMW or Bayer, the lack of new engagements between academics and industry prevents personal relationships and poses a barrier to network creation.

This could have long-term implications for the German economy. The study shows that previous relationships, when properly managed, are of utmost importance to the sustainability of networks. As a result Germany has a significant advantage at present and commitment to Ireland's knowledge economy will need to be long-term in nature.

The findings show that there are several barriers to the implementation of IPRs which hinder network formation. The length of negotiations at the start of the process, the method of protection and a failure to enforce IPRs, are issues mentioned by the interviewees. These findings are interesting as some scholars still question the impact and effects of previous legislative initiatives. Some authors argue that the American Bayh-Dole Act, for example, has had little (Mowery et al. 2001) or no effect (Coupé 2003) on patenting output. It is also worth noting that industry partners are more likely to enforce IPRs and this needs to be taken into account when considering the benefits of collaborations. The lack of trust in TTOs in relation to the handing of the IP also hinders the initiation and retention of collaborations. This is consistent with previous research which shows that universities hamper IP exploitation by unsatisfactory allocation of resources to TTOs (Siegel et al. 2004) or by allocating staff with unsuitable skill sets (Forfas 2010).

An issue specific to Ireland is the high degree of dependency on FDI. This means that Irish policies need to meet the needs of foreign companies in order to sustain existing networks. Furthermore, indigenous companies tend to have poor absorptive capacity, no R&D culture and little or no experience of collaborating with universities. As a result, they tend to make weaker industry partners than multinational companies.

More generally it can be seen that cultural factors impact on network formation. Risk aversion, stigma against failure and social prestige influence the establishment of networks in terms of the type of network. Both Ireland and Germany are more risk averse and society has stigmas against failure. Interviewees frequently pointed to the differences between Europe and the US. Irish and German stakeholders in the scientific-knowledge-commercialisation process believe that it is better to establish networks for collaborative research than following the American spin-off route and putting emphasis on networks for spin-off activity. Some researchers have already suggested the reconsideration of government policies and pointed towards licensing (Lambert 2003) or soft activities such as consulting and contract research (Klofsten and Jones-Evans 2000). Siegel et al. (2004) also find in their analysis that all stakeholders involved in university technology transfer do not consider start-ups as a critical output. A more open discussion on the outcomes from investment in the scientific-knowledge base is required.

The establishment of certain networks depends on who is interested in a particular sector. Long-term investment in basic research provides assistance to the development of a specific network. Industry may not be willing to do this in some sectors, especially if they do not see a strategic benefit of being a partner in such a network, and the void will have to be addressed by the Government. While the question was beyond the scope of this study, an area for future research might, thus, be in which sectors industry is willing to invest and whether certain sectors can attract long-term investments in infrastructure from prospective industry partners.

7.4 Why are collaborative stakeholder networks established for scientific-knowledge commercialisation?

The creation of a 'standort', an entrepreneurial society (Audretsch 2006a) or networks (von Hippel 1988, Etzkowitz et al. 2000, Porter and Van Opstal 2001) is considered to be a new public policy approach to generating economic growth. The provision of such loci "can influence the propensity for scientists to engage in commercialization activities by providing access to spatially bounded knowledge spillovers and by shaping the institutional setting and behavioural norms and attitudes towards commercialization" (Audretsch, Aldridge and Oettl 2006 p29). Research on why such innovation networks are established is mostly limited to the benefits for firms in terms R&D outputs, productivity, R&D capabilities and survival (Adams, Chiang and Starkey 2001, Zucker and Darby 2001, Zucker, Darby and Armstrong 2002, Murray 2004, Löfsten and Lindelöf 2005). Other research has shown how networks affect the ability of entrepreneurs to start companies (Shane 2003, Shane and Eckhardt 2003, Johansson, Jacob and Hellstrom 2005). Unlike previous studies, where motives to partner with universities has mainly been researched solely from an industry partner's perspective (Pittaway et al. 2004) or, at most, a dyadic perspective, this study looks at motives to establish collaborative networks from the perspective of all participating stakeholders.

As outlined in the literature review, this study postulates that entrepreneurship is not just venture creation but rather comprises the processes of recognition, evaluation and exploitation of opportunities. Entrepreneurship involves a combination of individuals who identify, evaluate and exploit these opportunities. This is achieved by devoting: (a) the necessary time and effort; and (b) assuming the associated financial, psychological and social risks. The individuals engaged in the entrepreneurship process then, if the process is successful, receive the consequential rewards of monetary and personal satisfaction. The aim of this study is not, however, to show how networks affect venture formation or to look at how spin-offs are formed. Instead, the study's aim is to show how participating in a network that retains its stakeholders give rise to cumulative innovative effects with greater potential for scientific-knowledge commercialisation.

The findings are consistent with the resource-based view of entrepreneurship (Alvarez and Busenitz 2001). There are differences between entrepreneurs and knowledge experts. On the one hand, the knowledge expert is not fully aware of the value of the technical knowledge and how to exploit it. On the other hand, the entrepreneur who is proficient in recognising value and entrepreneurial opportunities may not have the specialised technical knowledge to generate exploitable opportunities. It is only by combining both types of knowledge that opportunities can be fully commercialised. Thus, in the context of scientific-knowledge commercialisation, knowledge experts can be regarded as academics that make the scientific discoveries. The findings contribute to the theory by showing that entrepreneurial accomplishments in a university-industry setting are more likely to succeed if scientists are integrated into networks of interactive relationships and partnerships. Knowledge experts (i.e. scientists) can gain entrepreneurial knowledge (possessed by industry partners, TTO managers or commercialisation managers) by being part of collaborative stakeholder networks.

The findings also accord with the knowledge-spillover theory of entrepreneurship (O'Gorman et al. 2008). The results, and particularly those in Section 6.2.5, show that interactions between network stakeholders that have market and/or technical knowledge, respectively, serves to advance entrepreneurial-value evaluation. By advancing the evaluation of entrepreneurial value, the knowledge gap is narrowed and the performance of the knowledge filter is therefore improved. Thus, stakeholder networks foster the ability to evaluate the value of opportunities in a manifold way.

Stakeholder networks offer a diverse set of opinions for value generation, thereby minimising the risk of opportunities leaking through the knowledge filter and spilling over to third parties that are not embedded within the stakeholder network. In sum, the findings complement the view that relationships and interactions between persons with market and/or technical knowledge within social networks advance identification and evaluation of entrepreneurial opportunities. In this way, stakeholder networks advance scientific-knowledge commercialisation. The knowledge-spillover theory of entrepreneurship is therefore useful in explaining how networks of stakeholders facilitate the commercialisation of scientific knowledge.

The findings connected to Table 41 and Table 42 also illustrate the relevance of the discovery approach, insofar as they show that entrepreneurs identify opportunities and make entrepreneurial decisions that other people do not perceive. This is especially the case where they have better access to information about the existence and source of the opportunity due to previous life experience, social networks and information search (Shane 2003). The decision to exploit is further influenced by individual, industrial and environmental factors (Shane 2003, Shane and Eckhardt 2003). Social ties, embedding within networks and status enhance the tendency to become an entrepreneur and help to gather valuable information and mobilise resources.

On their own, none of the three entrepreneurship theories (i.e. the resource-based view, the knowledge-spillover theory or the discovery approach) can fully explain the complexity of the context in which scientific-knowledge collaborations take place. In order to commercialise scientific knowledge, the stakeholders have to be able to: (a) recognise and identify the commercial value of opportunities where an investment in new knowledge leads to the creation of an opportunity; or (b) discover existing opportunities. As indicated in the literature review, the recognition and identification of commercial value is most effectively achieved if the necessary knowledge about the market is embedded within the research of scientists and/or when scientists get access to external contacts. The findings show that these external contacts are found within scientific networks where one or more of the stakeholders possess the required commercial knowledge. In addition, the scientists interviewed view the presence of entrepreneurial stakeholders in their network as giving rise to a personal benefit as the scientists’ ability to evaluate the entrepreneurial value of their scientific knowledge is improved by interacting with these entrepreneurs. Simultaneously, industry partners see access to the scientists' technical knowledge as being an important factor for successful commercialisation and for innovation generally. Relationships and interactions between persons with market and technical knowledge are therefore viewed as positively influencing entrepreneurship. Indeed, networks are crucial to innovation and scientific-knowledge commercialisation.

There are several reasons why stakeholders get involved in collaborative research activities for scientific-knowledge commercialisation. Network capabilities are, however, the most important reason for stakeholders establishing and developing networks. These network capabilities facilitate innovation and scientific-knowledge commercialisation.

Building on entrepreneurship and capabilities theories, it is proposed that industry partners need to have "a set of abilities and resources that go into solving problems and achieving an outcome" (Zahra et al. 2006 p921). This study's findings indicate that other stakeholders also have abilities and resources at their disposal to generate ideas and identify opportunities for scientific-knowledge commercialisation. As indicated in Section 6.2.5, the existence of a stakeholder network is significant as it acts as a conduit for (a) entrepreneurial idea generation; (b) identification of opportunities; and (c) access to resources. Consequently, these networks act as a base for repeated success and innovation. The networks' benefits are the different skill sets, ideas and resources. Resources and network capabilities are the raison d'être of establishing collaborative networks. It is not just industry partners that want to interact with others to develop relationships in order to exploit and develop their resources (Turnbull and Wilson 1989); other stakeholders of the scientific-knowledge-commercialisation network have the same motivation.

The findings show that all stakeholders in networks acknowledge the substantive capabilities (Zahra et al. 2006) that other stakeholders bring to the network. The substantive capabilities that each stakeholder possesses are, thus, combined to create substantive stakeholder network capabilities. Having considered both the findings of this study and the existing literature, it is proposed that these substantive stakeholder network capabilities enable the recognition and exploitation opportunities.

As an example, increased access to financial resources, resulting from satisfactory relationships, may create opportunities within the network. This is the case as endogenous opportunities arise through the purposeful commitment of investment. These endogenous opportunities can then subsequently be exploited by the network through that network's substantive stakeholder network capabilities (e.g. necessary knowledge about the market). These substantive stakeholder network capabilities allow that exploitation of the knowledge to occur and prevent the scientific knowledge from spilling over to third parties (i.e. parties outside of the network). As noted above, therefore, this accords with knowledge-spillover theory.

Exogenous opportunities can be discovered through the provision of social capital, as well as access to more information and human capital (Shane 2003). One substantive stakeholder network capability is the provision of access to entrepreneurial knowledge (e.g. social capital, information and human capital) to stakeholders within that network. Another substantive stakeholder network capability is that access to financial resources is improved. As recognised by Shane and Eckhardt (2003), this access to financial resources enables the exploitation of the discovered opportunities. It can therefore be seen that substantive stakeholder network capabilities in a collaborative network aid the discovery of exogenous opportunities. Expedient exploitation of these exogenous opportunities is also enabled by, for example, industry partners being embedded in a network where specialist technical knowledge exists. Such embeddedness mitigates the time and cost of seeking out that specialist technical knowledge. In this way, collaborative stakeholder networks facilitate the commercialisation of scientific knowledge due to the existence of substantive stakeholder network capabilities within those networks. This position correlates with the views expressed by the interviewees, as outlined in Section 6.2.5.

While it is possible to say that substantive stakeholder network capabilities provide the network's ability to produce desired effect (Winter 2003), dynamic capabilities are believed to have a direct (Teece et al.1997, Zollo and Winter 2002) or indirect effect on performance and competitive advantages (Eisenhardt and Martin 2000, Zahra et al. 2006). Dynamic capabilities are abilities to change or reconfigure substantive (Winter 2003, Zahra et al. 2006) stakeholder network capabilities.

The configuration of capabilities is not simply a conglomeration of resources but requires the coordination of people and the coordination of people and other resources (Grant 1991). Capabilities, in this sense, should be thought of as routines with high amounts of tacit knowledge (ibid.). Similarly, most scientific discoveries in academia involve a high proportion of tacit knowledge (Thursby, Jensen and Thursby 2001, Yusuf 2008). Grant (1991) states that the perfection of such routines requires learning through repetition. When considering the difficulty of perfecting such routines in the context of commercialising scientific knowledge, it should be remembered that major innovations are infrequent, require routines and depend "on people over processes" (O'Connor and McDermott 2004 p27). Additionally, continuous activity and experimentation are necessary for firms to renew and reconfigure their capabilities (Ahuja and Lampert 2001). In the context of this study, and consistent with Zahra et al. (2006), dynamic stakeholder network capabilities are abilities to reconfigure the substantive stakeholder network capabilities in order to adapt to changes in a network's ecosystem. The findings outlined in Section 6.2.5, whereby the interviewees expressed the view that "success builds on success", provide evidence that a repetition effect improves the substantive stakeholder network capabilities. This study proposes, therefore, that stakeholder retention enables dynamic stakeholder network abilities. These dynamic capabilities are necessary to renew and reconfigure the substantive stakeholder network capabilities (i.e. resources and routines). It is suggested that the required competencies for innovation and scientific-knowledge commercialisation are more likely to be inherent in a stakeholder network. Furthermore, it is suggested that these competencies are likely to be more pronounced where that stakeholder network is used repeatedly.

The retention of stakeholders also enables a network's dynamic capabilities as it results in the retention of tacit knowledge. Tacit knowledge (i.e. knowledge that is embodied and embedded in individuals and social networks) is needed to transfer the explicit knowledge (Polanyi 1967, Nonaka and Takeuchi 1995) in technology transfer and to use a network's capabilities (Grant 1991). This is most likely to be achieved where all stakeholders communicate and interact effectively. In this way, stakeholder retention is central to enabling a network's dynamic capabilities. It is further proposed that by retaining stakeholders in a network, the amount of tacit knowledge that is lost is reduced. Given the difficulty of replacing tacit knowledge, the retention of tacit knowledge is central to the continuous process of perfecting routines for innovation and scientific-knowledge commercialisation. This view is evident in this study's findings as a number of interviewees observed that industry partners will follow a PI where that PI changes university. This willingness to follow PIs is a good illustration of the importance that industry partners attach to both the tacit knowledge of PIs and the benefits accruing from repeated interactions with the same stakeholders. It further illustrates that stakeholder retention an issue for all stakeholders and not solely a concern of universities. This study suggests that the importance of stakeholder retention in forming and developing networks with dynamic network capabilities is, thus, evidenced by stakeholder behaviour.

Eisenhardt and Martin (2000) propose that dynamic capabilities are important to address rapidly changing environments. This proposition seems applicable to the ecosystem that scientific-knowledge commercialisation operates within as the interviewees indicated that changes in the ecosystem of projects (e.g. a change in an industry partner's strategy or introduction of a radical new technology) can represent a significant, and potentially fatal, threat to those projects. When considering the value of dynamic capabilities to a particular network, it should be remembered that highly volatile environments will increase the value of dynamic capabilities (Zahra et al. 2006). It may be the case, therefore, that networks in rapidly changing sectors (e.g. ICT) attribute more value to dynamic capabilities than networks in more stable sectors (e.g. life sciences).

Based on the view of Zahra et al. (2006), these dynamic capabilities, where they have been enabled, must be well deployed and managed by the stakeholder network's decision makers if they are to achieve desired outcomes in circumstances where substantial changes occur in the network's ecosystem. There is, therefore, a need for the decision makers in a network to manage these dynamic capabilities.

In sum, this study shows that stakeholder retention enables dynamic stakeholder network capabilities and the retention of tacit knowledge. Dynamic stakeholder network capabilities are the network abilities necessary to improve and reconfigure substantive stakeholder network capabilities. Such dynamic capabilities are necessary to facilitate innovation and scientific knowledge commercialisation where the network's ecosystem changes substantially. It is suggested that the required competencies for innovation and scientific-knowledge commercialisation are more likely to be inherent in a stakeholder network that is used repeatedly. Where dynamic capabilities have been enabled, there is a need for the network's decision makers to manage the capabilities effectively.

Aside from the network capabilities, a cost saving benefit exists in networks. Relationship marketing theory argues that long-term stakeholder orientation is more cost efficient because retaining and maintaining stakeholders costs less than acquiring new ones. Switching costs refer to direct costs, sunk costs and opportunity costs. Direct costs refer to costs associated with the search, initiation and arrangement of new business relationships, as well as potential investments in those relationships. Sunk costs are previous irreversible costs or investments that were made and which benefit the relationship. As these costs are specific to the particular business relationship they cannot be transferred to another and are therefore lost. Opportunity costs relate to the lost net benefit of a deserted relationship. The higher each of these cost is, the more likely it is a tendency to persist will accrue. In other words, by being part of a permanent collaborative network future switching costs can be avoided.

Researching the context revealed that the life-science sector is a particular good example of why networks should be created to enable long-term results for innovation and scientific-knowledge commercialisation. The timelines for creating something that is worth commercialising in that sector tends to be very long. The findings showed that certain industry partners welcome the concept of strategic relationships and are willing to invest in these networks by providing machinery or additional research staff. In turn, they want to be kept informed on progress in the research area.

These findings also complement the study's findings on conflicts of interest. While academics are more concerned about basic science, industry partners are more in favour of applied science. This creates problems in relation to identifying the appropriate start for collaborative research projects. A premature start can lead to disappointment in terms of feasibility of a project and unrealistic expectations. Stakeholder networks could bridge the gap between basic and applied research conflicts due to inherent network capabilities. University PIs can gain access to knowledge about applicability and industry partners have access to innovative knowledge. This, in turn, enables the identification of the appropriate start time for the commercialisation of a particular technology or compound. When deciding to support R&D, governments will need to be aware that certain sectors are more willing than others to invest in R&D with a long-term view. Policy decisions in this regard will dictate the success, or otherwise, of bridging the gap between basic and applied research.

7.5 Who establishes and manages collaborative stakeholder networks for scientific-knowledge commercialisation?

The commercialisation of scientific knowledge has become a primary objective for universities worldwide. While the management and establishment of networks have mainly been researched from a firm perspective, it is suggested that third parties are important for the development of relationships and networks (Pittaway et al. 2004). The question of who guides this process had not been adequately addressed and required further examination. Current policy is based on the belief that the establishment of TTOs enables successful transfer of technologies and creates the “formal gateway between university and industry” (Rothaermel, Agung and Jiang 2007 p740). In many cases governments provide direct and indirect support funds for TTOs (OECD 2002, Forfas 2010) to enable successful knowledge transfer and commercialisation. The role of the TTOs is often referred to as bridging the gap between the university and industry (Siegel et al. 2004, Wright et al. 2008). The views on the role of the TTOs are, however, rather inconsistent. Some authors argue that the TTOs are responsible for establishing links between university and industry (Jones-Evans and Klofsten 1999, Siegel et al. 2004, Debackere and Veugelers 2005) while others argue that a TTO’s marketing activities are only needed where existing links are weak and all participants are not already rooted in personal or broader scientific networks (Colyvas et al. 2002).

A lack of management skills in TTOs (Spilling 2004, Wright et al. 2008), insufficient IP, market and entrepreneurial experiences in TTOs (Lambert 2003, Hall 2004, Zhao 2004) and bad staffing practices (O'Shea et al. 2004, O’Shea, Chugh and Allen 2008) were found to be operational barriers to scientific-knowledge commercialisation and reflect quality issues within the TTO.

As outlined in the literature review, the efficiency and acceptance of TTOs vary from country to country. The TTO’s role as boundary spanner has been researched with conflicting findings. The role of the academic as the bridge between industry and academia is, however, not clearly set out. Given the importance of networks in the theoretical frameworks, there was a need for a better understanding of (a) who enables effective interaction and (b) how stakeholder relationships are managed in scientific knowledge collaboration networks.

The findings show that the PI acts as a boundary spanner in both Germany and Ireland and has the key role at various different stages in the establishment of networks. The results show that it is the PI that is responsible for establishing and managing collaborative networks. These results show that this view of the PIs is often shared by the TTOs themselves. The results of the interviews leave little doubt that this is by far the most commonly held view among stakeholders. The PI is directly responsible for developing collaborative networks either through direct contact initiated by the PI or where it is her or his reputation catches the potential industry partner’s eye. Academic research collaborations are increasingly seen as a source of bringing ideas to the market (Porter and Ketel 2003, Pittaway et al. 2004). PIs must, however, show a willingness to engage with industry. The findings show that the interest and motivation in participating in collaborative research and commercialisation is not just a requirement of industry partners but also of government agents, TTO managers and centre managers. These results cast a series of implications which are discussed in Section 8.2 and 8.3.

The process of initiating contact will also differ depending on whether the research is faculty-based or conducted within an excellence centre. In terms of excellence centres, the findings indicate that, while it is still the PI who is in charge of initiating contacts, the responsibility can be spread among a group of PIs. Faculty-based research centres are usually “one-man shows” and PIs, thus, have to take care of contact initiation themselves. This finding is general in nature, however, and a single PI can be the critical determinant in an industry partner’s decision to commence a project. Caution against generic assumptions is, therefore, important. Excellence centres have an advantage over faculties as an aggregation effect is created by virtue of the concentration of a number of PIs in one location, but this is not to say that faculties cannot compete.

The quality of the PI’s work remains important after the establishment stage. Partners evaluate the knowledge base and the PI’s ability to manage and negotiate. The PI’s involvement determines the development, success and sustainability of the network. In

the literature there is strong consensus that collaboration of the original researcher and 'customer' are of great importance in both the development phase and afterwards (Jolly 1997, Roberts 2000, Thorburn 2000, Jensen and Thursby 2001, Zucker, Darby and Armstrong 2002, Knockaert et al. 2009). This study shows the importance of the PI in the initiation phase and the continued significance of the PI's input at later stages.
The study finds, however, that industry partners can become loyal to PIs and that this loyalty can last much longer than any individual project. The findings show that industry partners even change to another university in order to go with the PIs and continue the working relationship. The pivotal role played by the PI is therefore plainly evident.

In terms of management of relationships, the findings showed that it is the PI who is responsible for coordinating these relationships and acting as a guardian for evaluating and reconciling mutual interests. Again, the TTO's role was perceived as being less important. Instead, the PI has to be 'a jack of all trades', taking on the roles of project manager, relationship manager and negotiator. This is in addition to the PI's traditional academic roles of teaching, researching, acquiring funding and Ph.D. supervision and mentoring (Sabatier, Carrere and Mangematin 2006). The universities' failure to rebalance the PI's activities and incentives is putting a strain on networks. Despite these issues being raised in various previous studies (Friedman and Silberman 2003, Lockett et al. 2005), the findings show that the issue clearly persists in both Ireland and Germany.

The study finds that PIs are also very important for sustaining and maintaining the network with other stakeholders. Government agents and industry partners require high-quality research from the PIs as continuous funding is dependent on the quality of the PI's work. This is therefore another requirement from the centre managers. In addition to sustaining and maintaining existing networks, the quality of research determines the centre's reputation and thus determines the likelihood that the centre will attract new industry partners.

In addition, the abovementioned excessive workload of the PIs can be seen as a barrier to scientific knowledge being commercialised. These excessive workloads cause difficulties in managing various stages of the commercialisation process. The large number of tasks that PIs have to carry out means that PIs have to choose between those tasks. As noted above, the incentive structures are such that commercialisation tasks are more likely to be given a lower priority. In this way the management of the commercialisation process can be inhibited.

These findings on the PI's role raise questions about the role of the TTO in establishing links and bridging the gap between academia and industry (Wright et al. 2008, Yusuf 2008). The findings show that TTOs are generally negatively perceived. About 50 % of the interviewees (excluding TTOs) stated that they did not trust the TTOs' ability to commercialise knowledge and act as boundary spanners. This percentage needs to be viewed in light of the fact that interviewees were not directly asked about their trust in TTOs and that the other 50 % of interviewees did not express confidence in TTOs. The TTOs are viewed as overarching support structures which fulfil an informational and educational role. Even this role is, unfortunately, not used regularly due to the PIs' lack of time and industry partners' views on TTOs. A view expressed by the TTOs themselves is that PIs do not fully appreciate the ways in which the TTOs can assist the PIs. It can be surmised that the definition of the TTO's role is currently unclear and acts as a barrier to the commercialisation process. The prevailing misconception of the role played by TTOs needs to be addressed through a realistic rebalancing of responsibilities within networks. Currently, it is likely that this misconception is partly responsible for the excessive workload of PIs.

The empirical results illustrate that the TTOs do not play the role that is currently expected of them. TTOs are perceived as mainly dealing with the protection of IP and are either unable or have insufficient time and resources to either execute the commercialisation of scientific knowledge or to patent IP. While this might not be a problem for excellence centres, as they employ their own commercialisation specialists and IP managers, faculties will either have to do the commercialisation themselves or, more likely, the commercialisation will not happen at all. This raises the question of whether alternatives should be explored, such as centralising the TTO service or allowing research centres to employ their own technology transfer personnel. The introduction of similar organisational technology transfer structures by most of the excellence centres suggests that TTOs are either understaffed, insufficient and/or that networks are better managed locally.

At a minimum, the findings suggest that the role of the TTO needs to be re-evaluated and clarified so that TTOs can better support the PIs in their role of establishing and managing collaborative networks. The study suggests that the PIs are better placed than TTOs to act as boundary spanners between science and business. As noted above, the findings suggest that the PI is viewed as a stakeholder in their own right rather than as a representative of the university. As a result of this, there is an additional stakeholder in the network and therefore an additional set of interests that need to be considered (i.e. a significant additional variable). The significance of this is increased by the central role that PIs play in establishing and managing stakeholder networks.

7.6 Conclusion

By placing stakeholders at the centre of the scientific-knowledge-commercialisation ecosystem, whereby they are integrated into a network of different relationships, it is easier to show why, how and by whom these S-2-B collaborative networks are established, developed and managed. The ecosystem of scientific-knowledge commercialisation can be used as an analytical guideline for researching entrepreneurial contexts.

The context revealed two major concerns for scientific-knowledge commercialisation in Ireland and Germany. Despite the continued prevalence of the ‘ivory tower’ perception of certain sectors of German academia, Germany continues to outrank Ireland in relation to university-industry collaborations. The findings show that that Germany has a long tradition of industry engagements with existing indigenous companies, especially in the engineering sector. As outlined by the Commission of Experts for Research and Innovation (2009), however, Germany lacks new strategic engagement. This is particularly the case in newer industry sectors (e.g. life science). Such lack of engagement between academics and industry prevents the development of relationships and poses a barrier to future network creation. The findings imply that the cause of this might be that the German funding system allows academics to apply for basic science funding and remove themselves from industry collaborations. This could have long-term implications for the German tradition of university-industry collaboration and the German economy.

The study shows that the recent approach taken by the Irish Government, through government agents, in its interactions with Irish academics is leading to a concern that the Irish Government may be guilty of short-termism. Current economic constraints in Ireland exacerbate doubts among the stakeholders about the Government's long-term commitment to building networks. Ireland needs to develop a realistic and long-term approach to the development of its knowledge economy.

When forming such a long-term view, it is important to recognise that Ireland is a late developing economy and its industrial base is highly dependent on multinational subsidiaries. As a result, one challenge for the Irish Government is to encourage multinationals to undertake more research in Ireland as the R&D capabilities of indigenous firms is limited. This challenge is made somewhat more difficult as multinationals are generally less embedded in the local economy than their indigenous counterparts.

The Irish Government has taken some steps towards addressing these challenges. While Irish academics may prefer to do basic research, they are prevented from doing so by the current ecosystem. The need for Irish academics to interact with industry stakeholders is therefore increased. Additionally, government agents in Ireland are more focussed on foreign direct investment than their German counterparts, as can be seen by the important role the IDA plays in Ireland's economy. While Germany clearly seeks out foreign direct investment as well, Germany is less reliant on these investments due to the presence of more indigenous partners.

In an Irish context, it is often the IDA that makes the initial contact with multinational industry partners. Incorporating the IDA as a more direct stakeholder in collaborative networks would therefore seem to have a heightened importance in Ireland. The perception among industry partners appears to be that the IDA is more influential in initiating contact between stakeholders than university-funding organisations (e.g SFI). The comments from industry partners may, therefore, indicate that government agents' networks of academic contacts are currently being underutilised.

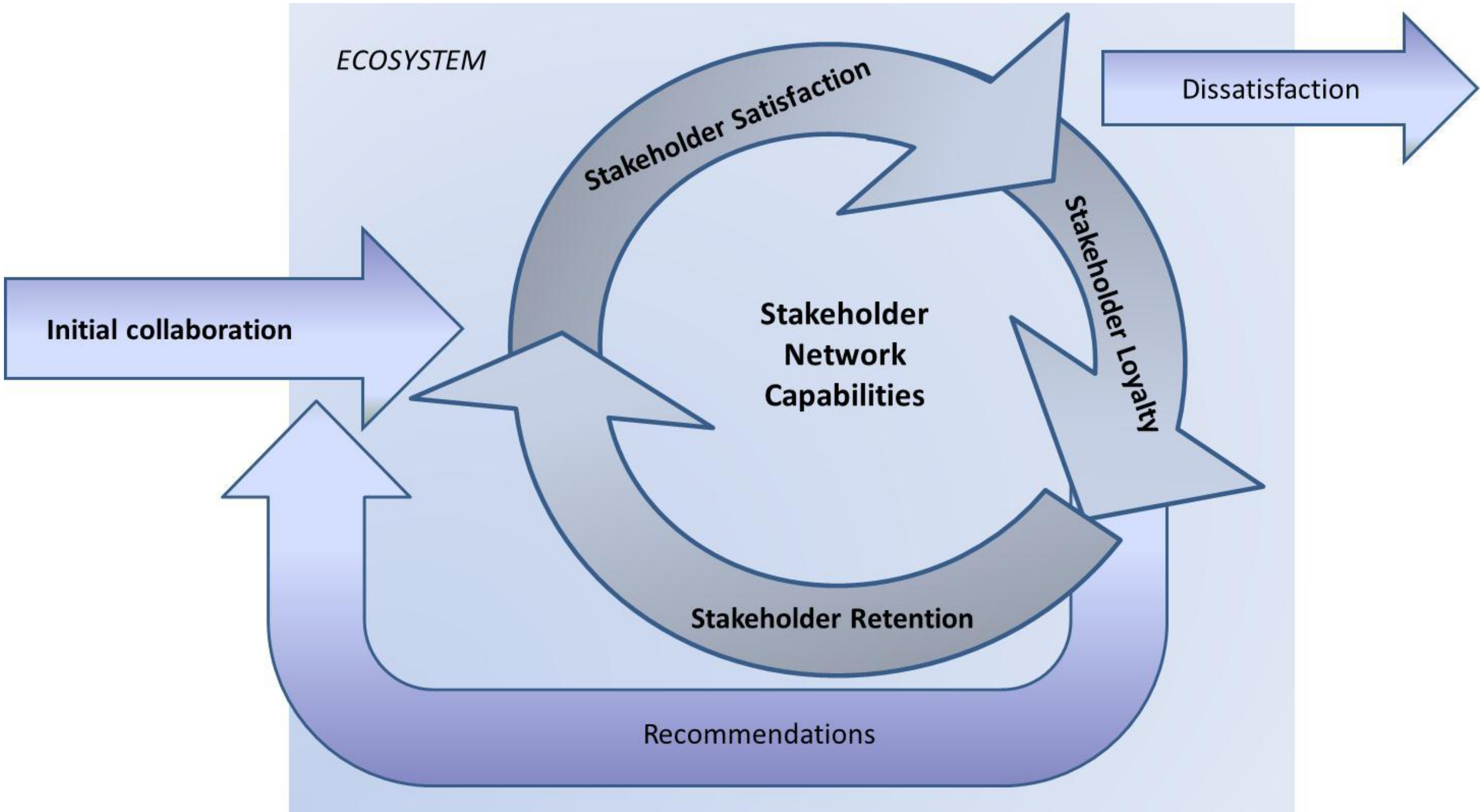
Overall, the study shows that it is the PI, rather than the TTO, who plays the key role in establishing and managing the relationship in order to retain stakeholders and create collaborative networks. In the same vein, industry partners turn to the PI when trying to initiate and create a collaborative network. The establishment of stakeholder networks is enabled by retaining stakeholders. The study shows that stakeholder satisfaction and stakeholder loyalty contribute to stakeholder retention. The findings show that the government agents play an allocative role in both countries. While loyalty may not be an issue for government agents as they need to remain unbiased, trust in relation to further funding seems to be an important determinant in the government agents' decision making.

The formation of collaborative stakeholder networks depends on internal and external contextual barriers and factors. The development of an improved collaborative stakeholder network is one of the desired outcomes of retaining stakeholders. The improved network capabilities that result from this network development are the reason that networks facilitate scientific-knowledge commercialisation. In other words, stakeholder retention influences the development of advanced collaborative stakeholder networks due to repeated collaborations. Innovation is facilitated by routines and people and it is through these routines, in the form of repeated collaborations, that the success of innovations and commercial results are enhanced. Overall, the findings show that the network is the conduit for idea generation, identification and resource allocations due to stakeholder network capabilities. Theory on entrepreneurship, dynamic capabilities and relationship marketing theory perspectives show that the benefits and outcomes of collaborative stakeholder relationship networks are manifold. Being part of such a network enables the commercialisation of complex scientific knowledge through the existence of: (1) entrepreneurial knowledge to commercialise specialised knowledge and gain a SCA; (2) a diverse set of opinions (through knowledge sharing) for the value generation, minimising the risk of opportunities leaking through the knowledge filter and spilling over to third parties not embedded within the stakeholder network; (3) different sets of competencies; (4) internal and external financial resources; (5) the possibility to disperse risks; (6) synergy effects of networks e.g. bargaining power or lower R&D costs; (8) an increase in the propensity to become an entrepreneur and start a company; and (9) savings due to the avoidance of switching costs.

As major innovations are infrequent, require routines and depend on people over processes, the importance of stakeholder networks where repeat collaborations take place is evident. While there is no consensus on the optimal networking configuration for innovation (Pittaway et al. 2004), this study contributes to the discussion by suggesting that the most important aspect is that stakeholders repeatedly collaborate and communicate and, thus, use the inherent network capabilities of their networks.

Incorporating the findings of this study, Figure 16 outlines the development of collaborative networks to facilitate innovation and scientific-knowledge commercialisation.

Figure 14: Collaborative networks – A science-to-business marketing approach to scientific-knowledge commercialisation



Source: Own conception

8 Conclusions

8.1 Introduction

The study shows that collaborative networks are important for scientific-knowledge commercialisation. University entrepreneurship and the process of scientific-knowledge commercialisation can be improved by applying a S-2-B marketing approach. Relationship-marketing theory can help to understand the scientific-knowledge commercialisation process in academia. This chapter outlines managerial and policy implications, the strengths and weaknesses of the study and concludes on the study's contributions to the knowledge base.

8.2 Managerial implications

Encouraging people to engage in innovation is a serious issue for industry (O'Connor and McDermott, 2004). This study indicates that managerial challenges also exist for scientific-knowledge research and innovations coming from universities. "People make decisions to exploit an entrepreneurial opportunity,…because they believe that the expected value of exploitation (both monetary and psychic) exceeds the opportunity cost for alternative use of their time plus the premiums that they would like for bearing uncertainty and illiquidity" (Shane 2003 p62). Contextual findings on the context suggest that PIs are already burdened with research, teaching and administration activities. In addition, engaging in collaborative activities is not valued highly by PIs and that, where they do engage, their engagement is not significantly rewarded. The findings on the role of PIs, however, suggest that the PIs also need to show a willingness to engage in collaborations. The need to encourage PIs to do collaborative research is therefore a managerial implication. Several scholars (Australian Research Council 2000, Goldfarb and Henrekson 2003, Siegel et al. 2004, Lockett, Kerr and Robinson 2008) have already debated the impact of: (a) insufficient incentive structures; (b) the university reward system; (c) the preconceived notion of incentives in favour of teaching and publishing; and (d) the lack of recognition of research commercialisation.

It is important to take into account that most scientists take part in commercialisation to further their research. A choice exists to either take the entrepreneurial route or to commercialise research through collaborative projects. What choice will be made depends on commercial motives (entrepreneurial route) or research-related motives (collaborative projects and TTO route) (D'Este and Perkmann 2010). The findings show that you cannot simply force PIs to collaborate and PIs must be adequately incentivised. Incentives should not be simply thought of in terms of financial incentives. For example, the attraction of freedom to academics should not be underestimated. Rather than dismissing the desire of academics to work in an autonomous way, this could be a strong incentive in rewarding entrepreneurial behaviour. Those PIs that show a willingness to engage in the commercialisation process should be given this freedom through the relief of other tasks that restrict their academic freedom. Were the role of TTOs to be redefined to focus on, for example, reducing the PI's administrative burden then this would allow the PI to work on matters that they want, as opposed to have, to do. Monetary rewards and opportunities for promotion need to be more clearly aligned with the universities third mission. The failure to do this has led to PIs being perceived as a stakeholder in their own right, thereby complicating the process of network creation and development. This issue has been highlighted in numerous previous studies but has not been addressed. Until this is addressed then networks will be prevented from maximising commercial returns from scientific knowledge, and in some cases, the commercialisation process will not commence at all.

Realistic evaluation of IP and feasibility, as well as the realistic evaluation of the process, is important. As an example, the Irish Government is perceived by the Irish interviewees as not having realistically evaluated the time horizon for university-research commercialisation to generate positive commercial returns for the Irish economy. This misevaluation, in turn, contributes to the Irish Government agents being dissatisfied with the commercialisation endeavours. This dissatisfaction has a negative impact upon the development of collaborative networks. While trusting the Government is not a direct aspect of loyalty within networks, as the stakeholders depend on the funding anyway, it contributes to satisfaction with, and development of, the relationship as it has a bearing on stakeholder confidence in the network's sustainability in the long-term. Consequently, managers of collaborative projects have to be aware that expectations need to be set appropriately from the start. This will help to establish a good relationship and aid stakeholder satisfaction.

It has been proposed that capabilities such as market learning, market creation or market testing are necessary at the incubation stage and not at the early stage (O'Connor, 1998, 2006). In contrast, the findings suggest that managers of collaborative projects must recognise that it is important to industry that university partners can judge the market feasibility or potential of their ideas from the start. While it is true, therefore, to say that industry partners should have a high degree of market awareness (Story, Hart and O'Malley 2009), it is also necessary that these capabilities are possessed by PIs. Without these skills PIs will not be able to realistically evaluate a project at the early stage. An unrealistic evaluation will increase the risk that the project will have an unsatisfactory conclusion, as expectations may be set too high. The existence of these competencies is one of the key factors in an industry partner's decision to repeat projects with a particular network. Conversely, where these capabilities are not possessed by the PI then the satisfaction derived from collaboration can be undermined by the setting of unrealistic expectations at the discovery stage in the project. The development of managerial capabilities of PIs is equally important. The industry partners' satisfaction, as well as the quality of the service provided to industry partners depends on the PIs professionalism. The management time and the drive the PIs put into maintaining the relationships.

While research value is always important to a network, relationship value is a SCA. In order to obtain this competitive advantage, universities need to recognise the managerial implications. Fostering awareness among university staff of the value of networks is critical, as is resourcing in such a way as to allow PIs sufficient time to cultivate key relationships.

As it currently stands, TTOs are expected to work on the protection of IP and the exploitation of that IP. The TTOs themselves feel that they are not sufficiently resourced to conduct both functions. It should be considered whether it would be more effective to outsource the protection of IP to other service providers, thereby allowing TTOs to: (a) concentrate on commercialisation of the IP that is generated by universities; and (b) provide focused support to PIs. There is currently a disconnect within networks that is caused by a lack of clarity as to what activities TTOs should focus on. The TTOs role within networks needs to be reconsidered and more clearly and realistically defined.

The study highlighted that there are numerous conflicts of interest within existing networks. While academics are more motivated by basic science research, industry partners are more in favour of applied science projects. This creates problems with identifying the right time to start collaborative research projects. A premature start can lead to disappointment in terms of feasibility of a project and unrealistic expectations. Stakeholder networks could bridge the gap between basic and applied research conflicts due to network capabilities. University PIs can gain access to knowledge about commercial applicability of their research and industry partners would gain access to innovative knowledge. Stakeholder network managers (mostly PIs) should therefore enable regular information and knowledge exchange.

'After sale' activities should be put in place to contribute to the sustainability of both the product and the relationships with the stakeholders. These "after sale" activities will help to sustain commercialisation activities. Some of these activities could be in the nature of support or mobilising researchers as proposed by Mangematin and Robin (2003). They emphasise the role of Ph.D. students in the circulation of tacit knowledge. The German engineering sector provides a good example of this point. In that sector, engineering research is viewed as having moved away from the "ivory tower" approach. This view is not surprising given that German Ph.D. students traditionally work in sectors such as the automotive industry and are therefore integrated into the engineering sector from an early stage. The existence of collaborative networks thus enables both the continuous transfer of knowledge between research organisation and industry. There is also the possibility that Ph.D. students could spin off companies due to the experience they will have gained in industry.

Given the central role of the PI in collaborative networks, it would appear important that the PIs are commercially aware. Some of the industry partners mentioned that some PIs lack industry experience and lack training or education in commercialisation activities. While training PIs could address this issue to a certain extent, thought must be given to hiring PIs that have industry experience. Bringing PIs with increased levels of commercial awareness into stakeholder networks is likely to enhance the capabilities of those networks and would serve to minimise disconnects between the university and their industry partner. Collaborations between Ph.D. students and industry can increase interaction between firms and academia (Mangematin 2000). The promotion of industry

Ph.D. programmes, such as the German engineering model, might thus help to reduce the disconnect between industry and academia. In addition, it is confirmed that serial inventors are role models and crucial to creating an entrepreneurial milieu (Goktepe-Hultèn 2008). The hiring of PIs with industry experience, thus, enhances the propensity to create a culture of interest in collaborations for scientific-knowledge commercialisation. PIs with industry experience will also have a broader set of contacts in industry which helps them initiating collaborative projects.

The findings showed the importance of relationships. It is the PI who is responsible for establishing, managing and maintaining the stakeholder network. As every relationship is different, a consequence for universities is that they should be supportive of relationship management. Offering management training to PIs may help them to improve their management of these relationships.

In terms of trust, the study showed that stakeholders should encourage the development of trust. Trust can be established by first starting small, low-risk projects. This will enable showcasing the abilities of the stakeholders. Encouraging open and honest communications by talking about each stakeholder's expectations throughout, but also after, the collaboration is an important way of developing trust.

8.3 Implications for policy

Morlacchi and Martin (2009) outline in their recent reflexive overview on science, technology and innovation policy research that past policies play an important role in establishing the present and the future. They note that the environment and the society in which policies are implemented are changing. In order to bridge the divide of research, practice and policy-making, it is necessary to take the changing environment and society into account when shaping newly adjusted science, technology and innovation policies. Science, technology and innovation policy "exhibits a preference for firm, industrial and national level analysis, viewing the Market and State (in the shape of Government or policymakers, with their role in regulating or facilitating market interactions and collective processes among business firms and other organisations) as the main interlocutors" (Morlacchi and Martin, 2009 p.572). Furthermore, policy-making is seen "as an exercise of planning, and the function of the social sciences is to provide the theoretical foundation that makes this planning possible" (ibid. p.573). In this context, a thorough examination is required in assessing and assisting the potential for scientific-knowledge commercialisation facilitated by an ecosystem approach.

The findings of this study entail policy implications for the individual institutions at a micro level as well as at the macro level. While the 'triple helix' shows that internal and external partners are integrated and are able to network within the knowledge infrastructure, it does not provide for a better understanding of the complex system of knowledge commercialisation and the commercialisation process. The S-2-B approach, however, constitutes the process of commercialisation and thus enables policy makers to take the process into account. Furthermore, policy makers should recognise the differences between types of innovation and should not solely rely on hard, generic metrics such as patents and invention disclosures. For innovation to happen, it is important to supply an environment where people can work long-term and repeat collaborative projects. These collaborative projects will enhance capabilities within networks, thereby making those networks more likely to be productive.

Research on the context also revealed that perceptions of PIs vary by country. Although, German industry partners still view the many university PIs as sitting in their 'ivory towers', they start collaborative projects with them due to their reputation and knowledge base. In Ireland, on the other hand, industry participation is almost always a requirement for funding and PIs therefore seek out collaborations. The Irish Government seeks direct commercial returns from investment in third-level research by prioritising licensing agreements and the establishment of university spin-off companies. Industry and academics, however, see collaborative research and other forms of industry engagement as more essential than the transfer of IP through licensing or academic spin outs (Faulkner and Senker 1994, Cohen, Nelson and Walsh 2002, D'Este and Patel 2007, Perkmann and Walsh 2009). Policymakers should not neglect the need for basic science funding as basic research enhances both the knowledge base and reputation of universities. This, in turn, can attract industry collaborations naturally instead of forcing collaborations through such funding structures alone. This is a good example of where hard metrics will fail to show significant development in the short-to-medium term.

While basic research may not produce a patent or invention disclosure that is immediately commercialisable, it will aid the development of networks and make future success more likely.

The conflicting views in terms of time horizons are particularly complex due to the multiple conflicts that exist. Arguably the most serious of these conflicts is that the Irish Government appears out of step with both industry and academics. The expectation from the government agents appears to be that basic research will generate returns within 10 years (that 10-year period currently expiring). Unlike many European countries which have been investing in the university sector for over 50 years, Ireland has only begun a deliberate investment policy in the last decade. Whether or not this position is reasonable is probably a secondary concern; what is more worrying is that the funding of research appears to be weakening at the same time that government agents are expressing frustration with commercial returns. While the reduction in funding levels has been caused by the recession, the danger is that this reduced funding may create the perception that the Irish Government's long-term commitment to creating a knowledge economy is waning. There appears to be concern among the academics that there is a misapprehension at policymaker level as to the time horizons that are necessary for basic research to generate results. Conversely, the academics do not seem to have understood the expectations that the funding would generate commercial benefits within the first decade. While it is unlikely to be possible to change the preference of industry partners for returns in shorter timescales, their willingness to invest in basic research or to form long-term collaborative networks will be impacted if there is any doubt that funding from the Government will not be available for a sustained period. This will clearly impact on the likelihood that long-term collaborative networks will develop. Based on the views of academics, the Irish Government needs to be prepared to invest for a sustained period, potentially of up to 50 years, before the true benefits of the investment will be seen. If academics perceive this weakening of the Governments position then the consequences of this would be likely to include considerable uncertainty, followed by a loss of talented researchers to competing jurisdictions and an undermining of existing networks. The risk of losing talented researchers is exacerbated by the fact that researchers tend to experience few professional barriers to moving jurisdiction and are therefore generally highly mobile.

The aligning of qualifications through the Pisa process is likely to further increase this mobility. A clear statement of Government commitment is therefore required to avoid networks being undermined or destroyed.

As noted in Section 5.2.1, the possibility that an industry partner may abandon a project due to strategic changes is something that must be borne in mind when contracts are being drawn up at the initial funding stage. It is only at this stage that meaningful disincentives can be put in place that might discourage this behaviour. Examples of disincentives include: (a) that the industry partner relinquishes all proprietary rights flowing from the project if they withdraw from the project before a given date; (b) a penalty clause for early withdrawal; and/or (c) liability for the costs of the university incurred up to the date of withdrawal (and potentially costs arising due to the withdrawal). The extent to which these solutions would be acceptable would depend on the level of funding being provided and the significance of other factors attracting the industry partner to engage in the project. Making provisions such as these conditions of entering into projects with industry partners amounts to a policy decision, but the need to have regard for the appropriateness of these conditions in a particular case mean that certain managerial implications also arise.

The abovementioned excessive workload of both the PIs and, to a lesser extent, TTOs needs to be looked at. Resolving this problem is likely to involve spending funds on either training (if the issue is time management) or additional staff (if the issue is under-resourcing).

In relation to the time issue, certain aspects of the TTO’s role could be outsourced. For example, if the protection of IP was outsourced then the TTOs could focus their energy on commercialisation activities. While it may be that the legal framework is currently overly cumbersome, an analysis of that legal framework was outside of the scope of this study. For the purposes of this study it is sufficient to note that numerous stakeholders viewed the legal process as being so lengthy as to undermine the commercial value of their projects. Doubts about the efficacy of the IPRs were also raised as a concern.

Government funded university research centres which rely on researchers from diverse faculties, multiple departments and disciplines are not guaranteed to improve university–industry interactions due to difficulties in aligning individual and centre objectives (Boardman 2009). Given the central role that PIs play in the initiation and management of collaborative networks, caution against generic policy prescriptions for the creation of excellence centres is important. Excellence centres have an advantage over faculties as an aggregation effect is created by virtue of the concentration of a number of PIs in one location. Faculties, however, can compete as a single PI can be more important than the size of a centre. It is therefore crucial to consider the centrality of the PI when formulating future recommendations for such policy initiatives. Hiring scientists for the sole purpose of working in an excellence centre, as opposed to drawing on existing researchers who work partly in a faculty and partly in an excellence centre, is of such a recommendation.

Overall, the study proposes that both Germany and Ireland should focus on collaborations and partnerships instead of spinning out companies. Government agents in Ireland need to understand that short-termism can be detrimental to establishing long-term partnerships. As Ireland is dependent on foreign direct investment, the IDA plays an important role. Incorporating the IDA into collaborative networks would therefore seem to have a heightened importance in an Irish context, as the IDA makes initial contact with multinational industry partners. However, industry partners viewed government agents from the funders of scientific research in Ireland, such as SFI, were less likely to be involved in initiating contact. A consideration would, thus, be to either integrate SFI into the IDA or, at least, improve the disjointedness place that SFI currently occupies within collaborative networks. In addition, the promotion of industry Ph.D. programmes, such as the German engineering model, and/or hiring of PIs with industry experience enhances the prospects that a culture of interest in collaborations for scientific-knowledge commercialisation in Ireland will develop. The scientists who are employed by excellence centres are not hampered by the day to day administration demands of faculty life.

Germany, on the other hand, needs to be aware that while their good funding structure enables scientific excellence, it can also contribute to academics removing themselves from industry collaborations. This is particularly relevant where strategic partnerships are required (e.g, in life sciences). Whilst, established firms such as BMW, Siemens etc. have strong links with universities, Germany needs to invest in networks in emerging industries. Introducing Ph.D. programmes in the life science sector might be the first step to achieving more university-industry collaborations in that sector.

8.4 Strengths and weaknesses of the study

The study has a number of key strengths. Perhaps the most obvious strength is the multi-stakeholder approach. Multi-level interaction had not been studied in the required depth. Most prior empirical studies only looked at single or dyadic perspectives of university-industry interaction. Simply relying on one or two participants in the scientific-knowledge-commercialisation process may lead to incorrect conclusions. The willingness of various stakeholders to participate in the study is particularly impressive given the sensitive nature of some of the IP.

A second key strength of this study results from the use of literal and theoretical replication to pick the cases. The multi-stakeholder analysis can, thus, inform a general understanding. This is especially the case if the stakeholders agree on certain topics irrespective of size, type or location of the centres. The design of the study enabled analytical generalisation by expanding theories. Quality criteria for case study research within the critical realism paradigm have been addressed by (a) employing a multi-stakeholder cross-case analysis (based on theoretical and literal replication), (b) use of and comparison with prior theory, as well as (c) achieving source, theory and analysis triangulation. Adopting a critical realist approach was justified as the research phenomena were complex interorganisational relationships where causal explanations are too complex for survey or experimental methods.

A third key strength is the use of an interdisciplinary approach to the study of collaborative-stakeholder networks for scientific-knowledge commercialisation. Relationship marketing theory and entrepreneurship theory facilitated a richer investigation of the issue of collaboration in the S-2-B markets. In particular the choice of relationship marketing theory is appropriate as it was developed specifically for practitioners to understand the impact of relationships on business performance. Whilst, recent research on entrepreneurship focuses on entrepreneurs as agents of economic growth. In addition, the St. Gallen ecosystem provides an overarching framework for a comprehensive contextual analysis.

Given the nature of case study design, however, it is not possible to broadly generalise the findings or produce final theory. The developed theory should therefore be subject to further theory testing.

A further limitation is the cross-sectional research design. Although, the interviewees were asked to reflect upon the entire project and the resulting relationship, ideally one would hope to track the relationship over a period of time.

Acknowledging the context limitations of Ireland and Germany, future research should look at the benefits to PIs of undertaking research with industries, including how universities acknowledge these commercialisation endeavours in terms of promotions.

The analysis is limited by the fact that individual interviewees cannot be named due to confidentiality conditions in the interview process. This prevents a comparison between the individual collaborations. In addition, incomplete information on the research outputs from the centres and faculties also prevents comparisons based on performance measures.

Additional research is also required on organisational structures of universities in terms of management and formalisation. Management and behavioural theory might, thus, grant an insight into the behaviour of academic institutions and stakeholders in scientific-knowledge-commercialisation process.

8.5 Contribution to knowledge base

Placing the stakeholders at the centre of a relationship marketing and entrepreneurship framework, whereby they are integrated into a network of different relationships, helps to show why, how and by whom collaborative networks for S-2-B commercialisation are established and develop. It also helps to show how these networks' capabilities aid the process of commercialising scientific knowledge.

The study showed that relationship marketing as a theory can contribute to university entrepreneurship literature and broaden the applicability of the approach in its own field. In B-2-B markets, satisfaction is defined as a positive affective condition which does not emerge by virtue of single transactions but rather through business relationships. Both the affective and cognitive approach is based on the evaluation of all aspects of a business relationship. The findings show that the rationale behind this can also be applied to a S-2-B context. During the collaboration, the involved stakeholders evaluate that collaboration and the connected business relationships based on the relationship quality, knowledge base and commercialisation service. The success of a project is not necessarily a working product. Rather, it can be that the ability to work through ups and downs within a collaborative project is the stronger contributing factor to stakeholder satisfaction. In particular, industry partners assess the collaboration based on: (a) the professionalism; (b) time management of stakeholders; (c) the industry and market awareness of the centre and PIs; and (d) a realistic evaluation of IP value and project feasibility by PIs and TTOs. Other factors that influence the perception of a successful and satisfactory collaboration, which concerns every stakeholder, are: (a) frequent, open and honest communication; (b) research output and quality; and (c) relationship quality. After evaluating these factors or expectations of the business relationship, the stakeholders will have an emotional reaction which amounts to a positive or negative outcome. The resulting stakeholder satisfaction or dissatisfaction has an impact on whether loyalty will evolve and stakeholders will retain. It is through the retention of industry partners and other stakeholders that collaborative networks are developed which facilitate scientific knowledge commercialisation. It is therefore recommended that universities encourage their staff to understand the construct of stakeholder satisfaction so as to facilitate network development.

Literature on the interaction approach accentuates the salience of previous purchases and mutual evaluation in order to establish satisfying exchange relations. It builds upon the idea that the nature of the relationship between two entities may not merely be built up during the course of a single major transaction, but rather through an interaction process within a certain environment; the occurring transactions modify the overall atmosphere or nature of the relationship (Håkansson 1982). The literature review on the interaction approach and the resulting network perspective which contributed to relationship marketing theory argues that greater attention must be paid to the embedded network context and environment in which relationships occur (Anderson, Håkansson and Johanson 1994). No relationship can be understood without looking at the wider network and environment. The intention of a network perspective in relationship marketing is to offer a theory that imposes a realistic view so that managers are aware of the environment they are operating in. They need to be able to identify the stakeholders and 'manage' the external and internal environments. In order to understand how stakeholders in the scientific-knowledge-commercialisation process should be addressed, it is necessary to consider all stakeholder groups (necessary relationships), including the ones that are not directly linked to each other (contingent relationships) but which still influence behaviours and network exchanges. The study shows that scientific-knowledge commercialisation can be analysed by placing the stakeholders in an ecosystem. Such an approach can identify: (a) key stakeholders; (b) contextual factors and barriers; (c) the stake and importance of each stakeholder/group by describing stakeholder interests and resources; (d) the dynamic relationships among stakeholders that need to be examined; (e) how effectively the expectations and needs of each stakeholder are being met; and (f) objectives and priorities to consider stakeholder interests and bridge gaps. Such an approach can, thus, help to facilitate stakeholder-relationship management and relationship-management-strategy development.

The study also contributes to university entrepreneurship literature and the debate on university-industry collaboration processes. Collaborations are established through a relationship establishment process (i.e. a progression from initial contact and interaction to retained and long-term relationships). It also extends entrepreneurship literature by applying that literature to the area of scientific-knowledge commercialisation. The study shows that being part of a network enables the endogenous creation of opportunities (through committed investment in new knowledge) and the recognition and exploitation of these opportunities as market and technical knowledge is present in the network. Being part of such a network also enables the discovery of exogenous opportunities through access to social capital and resources. In this context, the findings show the importance of stakeholder relationships and networks in enabling scientific-knowledge commercialisation. The study proposes a relationship-marketing approach to answer the call for more multi-level analysis, a deeper understanding of linkages and how they impact scientific-knowledge commercialisation. In addition, it proposes an ecosystem approach for the analysis of entrepreneurial endeavours where spatial, societal and institutional contexts are taken into account, thus contributing to the contextualising entrepreneurship debate. The study also contributes to the debate on TTOs within university entrepreneurship theory by proposing that PIs are better placed to act as boundary spanners.

Overall, the study supports that transfer and commercialisation of scientific knowledge is regarded to be successful if participants are integrated into diverse stakeholder networks of collaborative relationships (Harmon et al. 1997, Meyer 2003, Goktepe-Hultèn 2008). The establishment of networks for innovation and scientific-knowledge commercialisation is seen as a requirement for economic growth and development. Despite enormous financial aid from governments, however, artificially supporting the development of such networks has proved difficult. Current research on innovation networks has identified informal or formal collaborations and facility or knowledge sharing as ways to form these networks (Zucker and Darby 2001, Zucker, Darbey and Armstrong 2002, Pérez Pérez and Sánchez 2003, Murray 2004, Löfsten and Lindelöf 2005). Unlike previous studies, where research primarily considered the firm's perspective (Pittaway et al. 2004), this study analyses network formation from a multiple stakeholder perspective: that is industry partners, TTO managers, PIs, government agents and commercialisation or centre managers. The qualitative findings of this study show that informal and formal collaborations, as well as facility and knowledge sharing, are means of establishing these networks. The process, however, on how and why these innovation and scientific-knowledge-commercialisation networks are established has been neglected and was subject of this study.

Research on why such innovation networks are established is mostly limited to the benefits for firms in terms R&D outputs, productivity, R&D capabilities and survival (Adams, Chiang and Starkey 2001, Zucker and Darby 2001, Zucker, Darby and Armstrong 2002, Murray 2004, Löfsten and Lindelöf 2005). Other research has shown how networks affect the ability of entrepreneurs to start companies (Shane 2003, Shane and Eckhardt 2003, Johansson, Jacob and Hellstrom 2005). Unlike previous studies, where motives to partner with universities have mainly been researched solely from an industry partner's perspective (Pittaway et al. 2004) or, at most, a dyadic perspective, this study looks at motives to establish collaborative networks from all participating stakeholders. The study finds why it is important to establish stakeholder relationships and collaborative networks for scientific-knowledge commercialisation. Substantive stakeholder network capabilities are the main reason why stakeholders want to establish collaborative networks. The findings indicate that industry, as well as other stakeholders, have abilities and resources at their disposal to generate ideas and identify opportunities for scientific-knowledge commercialisation. The combined substantive network capabilities provide the stakeholder network's abilities for scientific-knowledge commercialisation. Dynamic stakeholder network capabilities are, thus, believed to have an effect on performance and competitive advantage, especially in a volatile environment. These dynamic stakeholder network capabilities are inherent in a stakeholder network that is used repeatedly. It is proposed that stakeholder networks enable the creation of endogenous opportunities and the recognition and exploitation of these opportunities. It is similarly proposed that stakeholder networks enable the discovery and exploitation of exogenous opportunities.

The question of who establishes stakeholder relations and manages stakeholder relationships within collaborative networks had not been adequately addressed and required further examination. This study supports the existence of boundary spanners. The view that TTOs act as boundary spanners (Jones-Evans and Klofsten 1999, Siegel et al. 2004, Debackere and Veugelers 2005, Wright et al. 2008) is, however, not supported. Instead, the study proposes that the PI has the dominant role in initiating and managing stakeholder relationships.

Furthermore, the study proposes that the excellence centres are good policy initiatives as they have an advantage over faculties, in that they have higher numbers of PIs in order to establish international visible, competitive research facilities. Due to the PI's central role in the establishment and management of collaborative networks for scientific knowledge commercialisation, the structure and organisation of these centres should be carefully considered.

Leading researchers ask for more theory building research (Markman, Siegel and Wright 2008). The issue of multilevel interaction had not been studied in the required depth. Prior research focused mainly on single or dyadic analysis (Plewa and Quester 2008). Researchers often studied only single context variables, thereby neglecting the importance of different contexts such as institutional, social and spatial contexts (Welter 2011). Contextual factors are believed to set the boundaries for theoretical generalisation (Whetten 1989). A better understanding of the commercialisation context and the factors and barriers that influence the interplay between the different stakeholders was required. Welter (2011) suggests a multi-layered embeddedness perspective to contextualise theory. The study extended the literature by proposing an ecosystem approach to scientific-knowledge commercialisation, thereby showing the value of context to theory-building research.

Table 45 concludes and summarises the theoretical, empirical, methodological and practical contributions below.

Table 45: Detailing the domain and extent of contribution

Domain of contribution	Extent of contribution		
	What has been supported?	**What has been extended/ developed?**	**What has been advanced?**
Theoretical	The importance of relationships and networks for university entrepreneurship	A S-2-B marketing approach has been developed incorporating relationship marketing and entrepreneurship theory	The importance of repeat collaborations within stakeholder networks and, thus, repeated use of inherent and continuously improving network capabilities for scientific-knowledge commercialisation
Empirical	A polyadic view on university entrepreneurship is important to understand scientific-knowledge commercialisation B-2-B Relationship marketing: Retention, satisfaction and loyalty are important for relationship success Entrepreneurship theory: The importance of networks and network capabilities	Holistic understanding of key determinants and enablers of scientific knowledge commercialisation The process on how and why collaborative networks are established to facilitate scientific-knowledge commercialisation has been described	In bringing together relationship marketing, entrepreneurship and contextual perspectives broad patterns in how, why and by whom collaborative networks are established and managed were identified
Methodological	The value of context sensitive research and its theoretical and empirical focus	A multi-layered embeddedness perspective to contextualise theory A critical realist informed empirical inquiry	An ecosystems approach to research scientific-knowledge commercialisation
Practical	The existence of boundary-spanners in collaborative networks Excellence centres are established to create internationally visible, competitive research facilities	While general principles of the role of boundary-spanners hold, the dominant logic that TTOs are boundary -spanners does not Again, the general principles are right but that does not mean that faculty-based research centres fail	The PI has the dominant role in initiating and managing contacts and collaborative networks Caution against generic policy prescriptions: Excellence centres have an advantage over faculties as an aggregation effect is created by virtue of the concentration of a number of PIs in one location. This is not to say that faculties cannot compete; a single PI can be the critical determinant.

8.6 Conclusion

Universities' knowledge has garnered considerable interest. Governments, regions and industry partners are turning to universities to generate commercial returns or access to knowledge. University-industry collaborations are increasingly expected by government funding agents as a result of this. The establishment and management of collaborations for scientific-knowledge commercialisation is therefore of utmost importance.

Based on a relationship marketing and entrepreneurship framework this study has demonstrated why, how and by whom collaborative stakeholder networks are established and managed and how those networks develop. The study finds that network capabilities are the reason why collaborative networks are established. It finds that collaborative stakeholder networks act as conduits for innovation and scientific-knowledge commercialisation due to these network capabilities. The findings highlight the role of individuals, and in particular PIs, in the collaborative network. Central to the process are the PIs' expertise and their ability to build trusting relationships with industry partners. The PI has to be 'a jack of all trades', taking on the roles of project manager, relationship manager, negotiator, as well as the traditional academic role (e.g. teaching, Ph.D. supervision and mentoring). The findings suggest that PIs are better placed than TTO managers to act as boundary spanners in bridging the gap between science and industry. The study also finds that stakeholder satisfaction and loyalty contribute to the establishment of stakeholder retention. The findings suggest that it is important to retain stakeholders within networks so as to develop collaborative networks that facilitate scientific-knowledge commercialisation.

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Appendix

Appendix A: SEMI-STRUCTURED INTERVIEW PROTOCOL

Could you start by summarising your position and tasks within the company/university/TTO/government agency?

Could you please summarise your experience of collaborating with university/research centre/company on this project and potential scientific knowledge commercialisation activities?

Use of university/applied vs. basic research

How was this project initiated?

What type of project was it?

Why did you do the project with an industry partner instead of doing the research in the university?

What where the initial objectives? Did they change?

How did you hear about the company? (active search/uni initiative)

What were the reasons for choosing the company? Are they the same reasons that keep you involved today?

What are the benefits of doing research with a industrial partner from your viewpoint?

Who are the different partners that are involved in this project? Is anybody more or less important?

Satisfaction

Overall, how do you feel about the project?

What do you evaluate?
How?

What where your initial expectations?

How did your actual experiences relate to these expectations?

How do you respond if you are unhappy?

Loyalty

Do you share all information with the partners?
Why?

What sort of information?

PROPE QUESTION IN CASE THEY SAY TRUST: How is trust established?

Have you ever stood up and defend the university/research centre if others criticise it? Why? If not, would you?

Do you have or are you planning to have an ongoing relationship with the university/research centre?
Why?

Retention

Have you done or will you do another project with the university/research centre/industry partner/TTO/government agency?
Why?

Have you or will you recommend the university/research centre/industry partner/TTO/government agency to others?
Why?

Relationship Management & Establishment of network

Who establishes relationships?

Who is responsible for the management of the relationships?

How do you build a collaborative stakeholder relationship network?

Why is it important to maintain the relationship?

How do you explain the stability over time?

Have there been disputes? How were they handled?

Has it been easy/difficult to maintain the relationship?

Entrepreneurial Activity

Why are you part of such a network of links?

How do you measure the success of the project?

Factors

What are the enablers to commercialising knowledge?

Barriers

What are the barriers?

Appendix B: Correspondence

[redacted]
CTVR,
Dunlop Oriel House,
Trinity College Dublin,
Ireland

Prof. Brian MacCraith
designate President
Dublin City University
Dublin 9
Ireland

14th June 2010

Dear [redacted],

Ms Diana Nadine Boehm is a doctoral student of Dublin City University in Ireland. Her doctoral research looks at the commercialisation of scientific knowledge in high performance research centres in Bavaria and Ireland.

This study is of direct importance to the development of research centres in that it will lead to a greater understanding of the commercialisation effort. All participating centres will receive a report on their commercialisation activities, the identified barriers and enablers, and suggestions for improving their overall performance. Furthermore, a seminar on best practice in scientific knowledge commercialisation based on the general results will be provided.

Personal interviews will form the core of her research. We would be most grateful if you could take some time out of your busy schedule to assist Ms Boehm in her research. Please be rest assured that all data provided by you will be treated in the strictest of confidence, will not be divulged to third parties, and will only be published in an anonymous form.

Ms Boehm will be in Germany from the 30th of June until the 7th of July and will be able to discuss any further details of her study in person. She will be contacting you in this regard in a timely manner.

Thank you very much for your time and your valuable contribution to the study.

Yours sincerely,

Prof. Brian MacCraith

DCU President-designate

Prof. Brian MacCraith
designierter President
Dublin City University
Dublin 9
Ireland

[redacted]
Ludwig-Maximilians-Universität München
LMUexcellent
Munich Center For Integrated Protein Science (CIPSM)
Department of Chemistry and Biochemistry
Office: F1.042
Butenandtstr. 5 - 13
81377 München
Germany

Dublin , den 14. Juni 2010

Sehr geehrter Herr [redacted],

Frau Diana Nadine Böhm ist Doktorandin im Fach Betriebswirtschaftslehre an der Dublin City University in Irland. Im Rahmen ihrer Doktorarbeit beschäftigt sie sich mit einer komparativen Analyse der Kommerzialisierung von Wissen in Exzellenzzentren in Bayern und Irland. Ziel ihrer Untersuchung, deren Kern eine auf persönlichen Interviews basierende Feldstudie bildet, ist es, Erfolgsfaktoren für die Vermarktung von Know-how zu identifizieren und so einen Beitrag zur Weiterentwicklung von Forschungseinheiten zu leisten.

Alle an der Studie teilnehmenden Forschungseinheiten werden als Feedback einen detaillierten Bericht erhalten, der Vermarktungsaktivitäten, identifizierte Einflussfaktoren und Hindernisse, sowie spezifische Vorschläge zur Optimierung der entsprechenden Anstrengungen enthalten wird. Darüber hinaus steht Frau Böhm dem Munich Center For Integrated Protein Science – falls gewünscht – für ein persönliches Feedback in Form eines Vortrags, eines Workshops oder einer Diskussion zur Verfügung.

Wir wären Ihnen äußerst dankbar, wenn Sie in Ihrem engen Terminplan etwas Zeit finden und Frau Böhm bei ihrer Studie unterstützen könnten. Selbstverständlich werden alle von Ihnen zur Verfügung gestellten Informationen streng vertraulich behandelt, nicht an Dritte weiter gereicht und ausschließlich in anonymisierter Form veröffentlicht.

Frau Böhm ist in der Zeit vom 30. Juni bis 7. Juli 2010 in Deutschland und könnte gegebenenfalls alle weiteren Details zu ihrer Studie auch persönlich mit Ihnen besprechen. Sie wird sich dazu zeitnah mit Ihnen in Verbindung setzen.

Herzlichen Dank im Voraus für Ihre Unterstützung.

Mit freundlichen Grüßen,

Prof. Brian MacCraith

DCU designierter President