RESOURCE ACCUMULATION FOR OPPORTUNITY IDENTIFICATION AND EXPLOITATION BY LEAD ACADEMIC AND NON-ACADEMIC ENTREPRENEURS

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Thesis submitted to the University of Nottingham
for the degree of Doctor of Philosophy

January 2009

Abstract

Understanding the opportunity identification process represents a core entrepreneurship domain research focus. Many studies focusing on traditional firm performance outcomes neglect the entrepreneurial human and social capital drivers that are linked to opportunity identification. Research on Higher Education Institutes (HEIs) has explored different dynamics associated with the formation of firms emanating from HEIs (e.g. from the perspective of the individual firm; by exploring support and influence offered by the parent organisation; and through analysis of the spinout process). The contribution from the individual entrepreneur in identifying an opportunity for commercialisation has not been fully explored.

This study looks at how academic entrepreneurs from HEIs and non-academic entrepreneurs, from the same industrial sector, identify opportunities and accumulate resources for commercialisation during the formation of life-science firms in a geographical life-science cluster in Scotland. Entrepreneurship, studied from a human and social capital perspective, identifies how lead entrepreneurs and other team members use their individual and accumulated experiences to leverage resources. The Resource-Based View (RBV), traditionally used to examine the link between firms' internal characteristics and competitive advantage, is extended to explore entrepreneurial behaviour during opportunity identification. Emerging themes from extant literature identify entrepreneurial team formation and the external environment as potential resource pools which aid the formation of firms.

Using a process-based, case-study research approach, entrepreneurs and team members were interviewed to gather information about the identification of life-science opportunities. A lead entrepreneur's general human capital, in the form of educational achievement, was found to be a key factor shaping the opportunity identification process. Further, a specific entrepreneurial and scientific human capital was leveraged to circumvent resource barriers. Social capital also facilitated the identification and leverage of scarce resources. Lead entrepreneurs with narrower resource profiles selected a resource munificent sponsored environment to gain access to additional resources. However, a dynamic, yet unreported in empirical research, was revealed from the data. Over time, lead academic entrepreneurs were encouraged to exit sponsored environments to enhance their independence whilst industry entrepreneurs generally sought sponsored environments for physical resources. Theory building ensued during the process of gathering data and analysing the data through comparison and iterating between existing theories.

Acknowledgements

My thanks is extended to family and friends, to the entrepreneurs and their teams who welcomed me into their firms and to my supervisors Professor Paul Westhead and Professor Mike Wright who have been invaluable throughout this process and without whose support I could not have journeyed.

List of Contents

Chapter 4: Research Methodology

Chapter 5: Case Analysis: The Entrepreneur and Team Membership

List of Figures

List of Tables

Chapter 7

Chapter 8

Chapter 1: The Entrepreneur, Entrepreneurship and the External Environment

1.1 Introduction

The structure of this chapter is as follows. Section 1.2 offers a general background to why the commercialisation of HEI life-science generated knowledge is important. Past emphasis on the firm as the unit of analysis is questioned by a call from literature to appreciate the resource requirements and actions of the individual lead entrepreneur (Scott and Rosa, 1996; Westhead and Wright, 1998). This longitudinal study will explore the relationship between the entrepreneurs' actions and behaviours at several points in 'real' time (Fletcher, 2006). To assist, the following four themes will be explored: the individual human and social capital resource profiles brought by the lead entrepreneur(s) and team members; the entrepreneurial process pursued for firm formation; the context in which commercialisation takes place; and the interactive play between these themes over time.

The individual lead entrepreneur and the benefits of studying the entrepreneur as the unit of analysis are presented in Section 1.3. Entrepreneurial ownership team development is discussed in section 1.4. Section 1.5 outlines the entrepreneurial process in general, and scrutinises definitions of what opportunity identification entails and what resources are needed for this particular phase. The importance of linkage to the external environment for resource accumulation is raised in section 1.6. Section 1.7 deals with the development of the research questions motivating this study. Reasons for focusing on the life-science-based sector in Scotland are discussed in section 1.8. Questions explore aspects of opportunity identification, the individual lead entrepreneur, team formation and the external environment. An outline of the thesis is presented in section 1.9.

1.2 Commercialisation of HEI Knowledge

Over the last decade, studies have concluded that new high-technology and life-science firms within the European Union have been founded by relatively senior, highly qualified personnel coming from existing firms who have a familiarity with the industrial context in which they have been working (Storey and Tether, 1998). A

relatively smaller proportion of these firms have emanated from universities and other research institutes founded by academics whose skill sets are fostered in a traditionally non-commercial environment and geared towards the needs of the educational or research institute (Nicolaou and Birley, 2003a). In a non-commercial environment such as the Higher Educational Institute (HEI), one questions 'how' academic entrepreneurs accumulate resources and experience to create new ventures relative to their industrial counterparts (Kirkby, 2006). The general research problem associated with 'how' individual entrepreneurs access resources to exploit their ideas by forming a firm (Ardichvili et al., 2003), and 'how' they identify their opportunities in the first place (Baron and Ensley, 2006) has not been fully explored. Comparisons between entrepreneurs identifying commercial opportunities from existing firms and entrepreneurs identifying commercial opportunities from the HEI sector are also limited (Davidsson and Wiklund, 2000).

There has been increased interest in the role that HEIs play in the commercialisation process of academics' research, especially within the life-science sector, in North America (DiGregorio and Shane, 2003; Shane 2004), Europe (Chiesa and Piccaluga, 2000; Franklin et al., 2001; Wright et al., 2004 a, b), Australia (Phillimore, 1999; Upstill and Symington, 2002; Galbreath, 2005) and the Nordic countries (Klöfsten and Jones-Evans, 2000; Löfsten and Lindelop, 2002; Rasmussen, 2007). The increasing interest in firm formation from academic research emanating from HEIs has been sparked for a number of reasons. First, historically it has been viewed as a specific type of entrepreneurial activity (Samson and Gurdon, 1993; Jones-Evans et al., 1999). Second, firm formation is recognised as a special case of technology transfer for the commercialisation of HEI research (Radosevich, 1995; Wright et al., 2004a). Third, the presumed linearity of the commercialisation process has come under scrutiny (Tait and Williams, 1999; Bower, 2002; Forbes and Low, 2004). Fourth, the perceived important future role of HEIs in innovation and wealth creation is dictating more attention (Bray and Lee, 2000; Lambert, 2003) encouraged by policy-makers who have made the commercialisation of HEI knowledge an important governmental objective (Lockett et al., 2003a). The specific institutional HEI context influencing the firm formation process has merited the greatest attention (Roberts and Malone, 1996; Etzkowitz et al., 2000; Lockett et al., 2003a, b). Despite growing research interest (Zucker et al., 2002; Wright et al., 2002, 2003; Lockett and

Wright, 2005; Mosey and Wright, 2007), there is limited information surrounding 'how' commercial opportunities are identified in a traditional non-commercial environment compared to the volume of research covering commercial sectors.

The entrepreneurial process encapsulates components associated with identification, evaluation and exploitation of opportunities (Shane and Venkataraman, 2000). Entrepreneurship, from a scholarly perspective, "seeks to understand how opportunities to bring into existence "future" goods and services are discovered, created, and exploited, by whom, and with what consequences" (Venkataraman, 1997 p120). The discovery of a life science entrepreneurial opportunity may be dependent on the entrepreneurs' prior knowledge, since it is likely to involve specialist information (e.g. 'scientific') and some kind of stimuli to identify the value of it (Shane, 2000). This study explores whether lead academic and non-academic entrepreneurs possess the human and social capital to fulfil both these criteria (e.g. the specialist information required to identify the opportunity and the specialist information required to value their entrepreneurial opportunity). In addition, the nature of the opportunity, the human capital characteristics and social capital bonding of the individuals involved in the entrepreneurial opportunity may also influence the future exploitation of the opportunity (Venkataraman, 1997). The thesis uses an opportunity-based conceptualisation of entrepreneurship (Shane, 2000; Chandler et al., 2000). It centres on the development process of entrepreneurship for opportunity identification leading to firm formation, identifying the individuals involved and exploring the external environmental context in which it happens. Comparing lead academic and non-academic entrepreneurs in the life-science sector allows for behavioural patterns to emerge concerning 'why' and 'how' they identify opportunities.

Entrepreneurs are being encouraged to accumulate and leverage skills and knowledge (DTI, 2004) to identify and exploit innovative opportunities which may be associated with wider societal contributions (Verhaeghe and Kfir, 2002). Governments are prompting academics to commercialize knowledge generated within Higher Education Institutions (HEIs) (Scottish Enterprise, 1996; Lambert, 2003). The importance of the transfer of knowledge from the HEI to the commercial sector is measured by increasing official attention (*Delivering the Commercialisation of Public*

Sector Science, HC 580) both from the perspective of government (Department of Trade and Industry (DTI), 2000; Department for Employment and Learning (DEL), 2004; Scottish Executive, 2004) and HEIs (HECE, 2002b; Lambert, 2003). The relationship is two way. From one perspective, the commercial sector looks to academia as a source of scientific novelty, and for solutions to emerging technological challenges. An alternative perspective views the academic institution as the source of potential economic activity fuelled by research efforts. Recent industry / academic linkage has been concentrated in the fields of biotechnology and biomedicine (Faulkner et al., 1995; DTI, 2000; Wright et al., 2002, 2003). The study of life-science is of particular interest because it is expected to provide future industrial growth and make university/ industry linkage more visible (Forbes and Low, 2004) and, ultimately, improve life styles (Tait and Williams, 1999).

Interaction between the HEI and the life-science based industrial sector is also valuable for economic development and wealth creation (Gibbons et al., 1999; Lambert, 2003). HEIs are forging stronger links with industry and initiating spinout firm formations not only to foster the transfer of technology between HEI and industry (Martin et al., 1996; Salzar and Georghiou, 2002) but also to generate income for the HEI (Franklin et al., 2001; DiGregorio and Shane, 2003). HEIs, prompted by government, are encouraging academic entrepreneurs to commercialise their university created knowledge (Breton and Lambert, 2003). If policy-makers wish to continue to support the commercialisation of knowledge from HEIs, through the formation of firms, a comparison between the resource profiles of the entrepreneurs (Brush et al., 2001) may help answer research concerns questioning 'how' and 'why' lead entrepreneurs identify opportunities for commercialisation, and 'how', 'why', 'when' and 'where' they conduct the entrepreneurial process. Emphasis is placed on recommendations for HEI policies and strategies that might enhance or inhibit technology transfer to spinout firms (DiGregorio and Shane, 2003; Locket et al., 2003; Clarysse and Moray, 2004).

Previous empirical studies of the science-based sector have included large proportions of firms from the HEI sector (Radosevich, 1995; Carayannis et al., 1998; Heirman and Clarysse, 2004) many of which were shown to have better survival rates

than their industrial counterparts (Mustar, 1997; Shane, 2004). The formation of HEI spinout firms, involving the direct commercialisation of HEI created knowledge (Nicolaou and Birley, 2003a), is, however, only one possible process fostering the transfer of technology between the HEI and industry (Etzkowitz, 2000; Salazar and Georghiou, 2002). Other recognised routes to commercialisation include contract research, collaborative research, industrial consultation and licensing (Scottish Enterprise, 1996; Shane, 2002).

In both consultancy (Siegel et al., 2001) and contract research the co-operation is between industry and the HEI as an institution. For income generation, the dominant modes of commercial transfer are HEI independent spinout firms and licensing (Bray and Lee, 2000; Siegel et al., 2001; Lockett et al., 2003a). If the HEI, or indeed the individual entrepreneur, is unable to appreciate the full value of technology transfer through a licensing agreement then the formation of a HEI spinout firm may be sought (Powers and McDougall, 2005). On one hand, licensing is seen as less resource-intensive than spinning out new firms, both in terms of funding and people. The advantage with licensing is that it uses existing business expertise to quickly get the knowledge to market (Oakey, et al., 1990; Lambert Review, 2003). On the other hand, spinouts are a potential source of economic growth that can return significantly higher revenues to HEIs than licensing (Bray and Lee, 2000). Whilst speculative financial and reputation returns are the outcome of spinout firms, the chances of failure are also increased, particularly with technologies in the life-science sector which have long incubation times and require large investment in R&D (Powers and McDougall, 2005). Licensing, however, like consulting, reflects a relationship between the HEI and industry and does not necessarily involve a lead entrepreneur in a process of opportunity identification leading to firm formation.

Extant research covering the HEI spinout firm formation process has explored the dynamics associated with firm formation according to particular ‘phases’ in the identification and development of commercial opportunities (Druilhe and Garnsey, 2001; Vohora et al., 2004). The latter studies have generally emphasised a stage-bound approach. Gaps within the knowledge base relate to ‘how’ and ‘why’ the identification and development of opportunities for commercialisation occur (Mustar

et al., 2006). For opportunity identification, the influence of resource profiles held or built by lead entrepreneurs (Brush et al., 2001) and the impact of their profiles on the entrepreneurial process over time have also not been given due consideration (Jones and Coviello, 2005; Fletcher, 2006). Understanding opportunity identification represents a central and vital research focus in entrepreneurship (Shane and Venkataraman, 2000; Gaglio and Katz, 2001). The resource base required for firm formation from the perspective of the individual entrepreneur, specifically at the opportunity identification phase of the entrepreneurial process has not been fully explored (Venkataraman, 1997). Any future enterprise development may also be determined by how effectively the entrepreneur deals with opportunity identification and evaluation choices made at the start of the entrepreneurial process (Ardichvili et al., 2003).

Studies focusing upon the firm (Druilhe and Garnsey, 2001) and those focusing upon the contribution made by their parent organisation (Franklin et al., 2001) have neglected the key potential roles played by lead entrepreneurs. Many studies have neglected the role of the entrepreneurial human capital drivers linked to opportunity identification (Heirman and Clarysse, 2004). Typologies for identifying and describing HEI spinouts are static and have solely focused on one specific moment in time. They generally fail to consider the changing composition of actors involved in the entrepreneurial process and 'how' and 'where' these actors were sought over time (Radosevich, 1995; Nicolaou and Birley, 2003a; Pirnay et al., 2003). This study will compare the human and social capital resource profiles of academic and non-academic entrepreneurs and their team members operating in the life-science sector. Insights will be sought from the lead entrepreneurs with regard to 'how' they identify opportunities and accumulate resources for commercialisation. Ideally the entrepreneurs heading firms will be involved in the direct commercialisation of HEI created knowledge (DeGroof, 2002; Nicolaou and Birley, 2003a) and show evidence of being members of staff (or part of a team) who are or were employees of the parent HEI organisation. Non-academic entrepreneurs, on the other hand, are individuals associated with the life-science-based sector but who have no direct relationship with an HEI as an employee.

1.3 The Individual Lead Entrepreneur

A growing body of literature supports a team approach rather than an individual approach to the entrepreneurship (Ensley et al., 2000; Üçbaşaran, 2003a). However, although the entrepreneurial process may culminate in a team effort, there is room to consider the existence of a lead entrepreneur to "clarify the firm's vision and craft the dream and strategy for the rest of the team to follow" (Ensley et al., 2000, p.60). At its simplest, the lead entrepreneur may be the individual who heads a group or team of people who may be fellow entrepreneurs, equity holders or outside investors or business advisers. Whether these people differ from the ones they lead in terms of entrepreneurial characteristics, drive, propensity to risk taking and visionary traits is open to debate (Ensley et al., 2000), but the fact remains that leadership is shown by a member of each team. In this study the lead entrepreneur will be defined as the individual who was responsible for the identification of the commercial opportunity (this may include invention or discovery through research); who was involved in the identification of the market potential for the opportunity; who was involved in the evaluation and eventual exploitation of the opportunity through the formation and ownership of a firm; and who knew or recruited the other team members, whether equity holders or not. The definition holds for both academic and non-academic lead entrepreneurs.

The contributions from lead entrepreneurs, specifically in the opportunity identification phase of the entrepreneurial process, has also not been fully explored (Venkataraman, 1997). During opportunity identification the lead entrepreneur must access resources to process the registration and identification of a potential commercial opportunity. Further, the entrepreneur may have to rely on past experience (e.g. human capital) and call on a network of personnel (e.g. social capital) for technical and commercial assistance accessed from their immediate environment (Mosey and Wright, 2007). Considering that the academic entrepreneur may enter the commercial arena with a set of human and social capital prerequisites better suited to academia than commerce, an investigation into what mechanisms they adopt to circumvent these limitations is pertinent.

The working definition of the lead academic entrepreneur will be an academic or researcher whose occupation, prior to playing a lead role in an enterprise start-up, and possibly concurrent with that process, was that of an academic, clinician or researcher, affiliated with an HEI (Samson and Gurdon, 1993). Their proposed firm will be centred on a codified product, technology or service which originated at the parent organisation and was then transferred to the new (Rogers 1986; Carayannis et al., 1998; Smilor et al., 1990). The non-academic entrepreneur is defined as a person who has previously been employed in the same industry sector and who uses their knowledge of that sector to identify opportunities. If the lead entrepreneur of a new firm has worked in the same industry sector then the entrepreneur will have a current familiarity with the sector (Oakey, 1995; Aldrich, 1999). The academic entrepreneur, on the other hand, may enter the business environment with a set of skills fostered from and for the requirements of an HEI. The barriers they face are created because they are disadvantaged by not having the appropriate commercial human and social capital to leverage resources associated with business acumen. Lead non-academic entrepreneurs, on the other hand, may have had previous opportunities to build up knowledge, networks and skills culminating in potentially more diverse human and social capital than lead academic entrepreneurs. However, limited research has been conducted looking at the relationship between human and social capital and the behaviour of entrepreneurs at the initial phase of the entrepreneurial process (i.e. at opportunity identification). Human and social capital may, therefore, be viewed as an 'input' influencing the desired behavioural 'output' of opportunity identification. The entrepreneur in this study is viewed in terms of their human capital profile (Brush et al., 2001), where the entrepreneur may be the key resource (or key restraint) to an emerging organisation (Castanias and Helfat, 1991). Firm development and survival, for example, has been attributed to the human capital of entrepreneurs (Brüderl et al., 1992; Bates, 1990; Gimeno et al., 1997). Social capital may be reflected in ties to actors who are potential resource providers and these ties may be different for academic and non-academic entrepreneurs (Granovetter, 1973). Lead entrepreneurs may not work in isolation.

1.4 The Entrepreneurial Ownership Team

Research to date has been involved in exploring the potential effect of a team of people on new ventures (Ensley et al., 1999); the composition of team members (Roure and Madique, 1986; Lechler, 2001) and team formation, member entry and exit (Kamm et al., 1990; Kamm and Nurick, 1993; Üçbaşaran et al., 2003a; Vanealst et al., 2006). Üçbaşaran et al., (2003a) highlighted a gap in the literature with regard to the entry and exit of members to new venture teams. In the context of life-sciences, the firm formation process may involve individuals who appreciate the technical significance of the technology, individuals who appreciate the commercial value of the technology, individuals involved in raising capital, individuals searching for potential markets, individuals identifying and recruiting future team members to further skills levels within the team and individuals involved in administration as well as potential customers and suppliers etc. The list is not definitive but offers an insight into probable tasks and needed resources. The entrepreneur who wishes to form a firm will also need to deal with tasks such as identifying business opportunities as well as accessing human, physical, financial and organisational resources (Druilhe and Garnsey, 2001). If the individual lead entrepreneur does not possess all these resources then the lead entrepreneur may choose a team start. By choosing a team start the entrepreneur may increase access to resources (Forbes et al., 2006).

Existing research implies that new member entry to an entrepreneurial team should increase team capacity. Empirical research about entrepreneurial teams (Üçbaşaran et al., 2003a; Clarysse and Moray, 2004), however, fails to sheds light on the process and development of entrepreneurial team formation. The identification of entrepreneurial team members is not readily discernable. Generally, in past research, entrepreneurial teams have been recognised once they have been passed through formative stages (Gartner, 1985; Katz and Gartner, 1988) but this makes the identification of members difficult and a retrospective procedure. This study follows nine lead entrepreneurs and maps the formation of their teams in real time from the identification a potential idea for commercialisation through to firm formation. The focus on entrepreneurial team members will also fulfil a call from the literature to further investigate the building of entrepreneurial teams for the formation of firms with restricted knowledge, resources and skills (Ensley et al., 1999; Brush et al., 2001;

Shane and Stuart, 2002; Chandler et al., 2005). Lead academic entrepreneurs may have superior access to technical resources but understand less about the resources connected with the commercialisation of the technology. The choice to add or subtract a new member may be important because it alters the human capital status held by the original team and may open the door to new, required resources. 'Why' and 'how' and from 'where' the addition is made and whether the original team instigated the recruitment is of importance because new membership may represent an identifiable event in team formation as could dismal and / or replacement (e.g. entry and exit of members) (Üçbaşaran et al., 2003). The composition of an entrepreneurial team is unlikely to remain static. In certain circumstances, where human capital is lacking, the contact and knowledge brought by other entrepreneurial team members may be of particular importance given the reported lack of business acumen amongst high-technology founders (Roberts, 1991; Vanaelst et al., 2006).

Within the entrepreneurial team literature the definition of team membership has been inconclusively debated (Cooper and Daily, 1997; Ensley, et al., 1999; Üçbaşaran et al., 2004). Studies focusing on entrepreneurial teams generally define team members in terms of status at start-up, ownership and control (Eisenhardt and Schoonhoven, 1990; Watson et al., 1995; Cooper and Daily, 1997). Others have defined entrepreneurial ownership team members as those with an equity stake in the venture and who also have a key role in the strategic decision making of the venture at the time of founding (Üçbaşaran, et al., 2003a; Cooney, 2005). Kamm et al., (1990) defined an entrepreneurial team according to the people who had responsibility for forming the firm and who also had a financial interest in the firm. Gartner et al., (1994) broadened this definition to include members who had strategic influence in firm formation. Ensley et al., (1990) added to this definition by including three other prerequisites. In order to be a fully fledged entrepreneurial team member each member had to have jointly established the firm; have a financial interest and have a direct influence on strategic choice in the firm. These definitions were considered too limiting for the research at hand because they did not take account of important non-equity,' outside' or network players.

Ensley et al., (1999) reviewed the role 'outsiders' performed and the profound influence they had on the development of firms. These "outsiders" or "privileged witnesses" (Franklin et al., 2001; Vanaelst et al., 2006) included paid professionals, consultants, outside directors, surrogate entrepreneurs and business advisors who offered support systems and brought needed information and skills to the venture (e.g. they provided skills not available to the individual entrepreneur). The human and social capital they brought to the firm included a network of contacts offering specialised support (e.g. advisors for giving business advice, funding financial expertise, and marketing connections). This suggests that the team should form connections with those most able to reduce resource acquisition uncertainties but that these members need not necessarily be recruited as new equity holding members. The definition adopted for this research acknowledges the importance and significance of equity holding and strategic decision making as prerequisites for membership but also explores the value of network members during the dynamic entrepreneurial process.

Forbes et al., (2006) offered two explanations in the entrepreneurial team literature explaining the recruitment of team members. One views recruitment as a rational process where consideration is given to economic benefits. The other sees addition as being driven by interpersonal attraction intertwined in social networks. In the rational process, the new members are recruited in response to a particular resource need. Kamm and Nurick (1993) speculated that, through a decision-making process, existing team members sought new members on the basis of the perceived needs of the team (Table 1.1). The decision-making model assumes that the team performs on assessment on 'possessed' and 'required' resources matching them against a kind of ideal inventory of resources. The identification of needed resources is then followed by a process of deciding 'where' to find, 'how' to choose and 'how' to convince new members to participate. However, the literature on HEI spinout firms indicates that the logic of this approach is not adhered to. Often recruited team members displayed a similar human capital resource profile to that of the recruiting members (Clarysse and Moray, 2004).

Clarysse and Moray (2004) noted homogeneity of technical resource profiles amongst engineering team members to guard against potential interpersonal conflict. The interaction between members with the right 'chemistry' played a part in new

Table 1.1 Explanation for new member entry	
General explanation for new member addition	**Resource seeking** New member is added to enhance the team's present or future inventory of resources
Implied sequence of team actions	**Problematic search** Team identifies a resource problem and then undertakes a search for a new member intended to solve problem
Representative theoretical literature linked to new member addition entrepreneurial teams	Kamm and Nurick (1993); Larson and Starr (1993)
Representative empirical studies literature linked to new member addition entrepreneurial teams	Üçbaşaran, Lockett, Wright and Westhead (2003)

Adapted from Forbes et al., (2006, p232)

member identification and entry. Having the right 'chemistry' did not necessarily mean having the right access to required resources. Human capital resources were often duplicated. Despite rational decisions to add members with human capital defined as necessary for venture success, searches were found to be affected by relationships, social networks and human capital profiles of individuals that made them similar to the existing members. The initial indication is that their social capital access to alternative networks was limited (Anderson et al., 2007). The nature and composition of the 'entrepreneurial team' did not always alter in response to the changing needs of the new firm (Clarysse and Moray, 2004; Üçbaşaran, et al., 2003a). The literature does not indicate 'why', 'how' and at what phase of development in firm formation lead entrepreneurs recruit entrepreneurial ownership team members to access, compensate and complement their own human capital endowment to assemble resources. 'Why' members exit, if their skills become redundant or inappropriate for a particular phase in the entrepreneurial process, has also not been given due attention. Exit from teams has been well documented from large established firms where under performing members have been replaced due to conflict (Ensley, et al., 2002) but not well documented for smaller firms or for firms in development. This study will therefore explore the entry and exit of entrepreneurial ownership team members from a human capital perspective during the entrepreneurial process.

1.5 The Entrepreneurial Process

In this study, entrepreneurship will be defined as the "scholarly examination of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited" (Shane and Venkataraman, 2000, p.218).

The entrepreneurial process is one which involves all functions, activities and action associated with the identification of an opportunity and the creation of organisations thereafter to pursue it (Bruyat and Julien, 2001). This study focuses on the internal human capital drivers influencing social capital leading to the accumulation of resources to make that process happen. Links are explored between a lead entrepreneur's human capital profile and the accumulation of resource 'inputs' by investigating 'where' and from 'whom' these 'inputs' are sought with regard to the opportunity identification 'output'. Entrepreneurship is viewed as a dynamic process enacted by people and influenced to different degrees by their prior knowledge and experience within the context in which entrepreneurship is carried out (Gartner, 1989). The main body of the study is concerned with actions of lead academic and non-academic entrepreneurs who respond to stimuli exposed during information search, or by alertness, imagination and innovation whilst they accumulate resources to commercialise an identified opportunity through the formation of a firm.

Entrepreneurs have to combine different resources for opportunity identification either by exploiting their resource profiles and / or from their external environment in order to organise these resources into a firm (Alvarez and Busenitz, 2001). The process involves the entrepreneur, as an individual or as part of a team, prior to and during firm formation. It could be argued that the role of the lead entrepreneur is that of an architect (Makadok, 2001). Schumpeter (1936) postulated that entrepreneurial ability may be defined as the entrepreneur's function of combining productive factors or resources. As such, entrepreneurial 'output' may be seen as the result of combining existing assets and skills to become new resources. Examples of relationships between specific types of resources on entrepreneurial behaviour such as human capital (Bates, 1995; Cooper et al., 1994; Davidsson and Honig, 2003, Mosey and Wright, 2007), financial capital (Cooper et al., 1994) and social capital (Anderson and Jack, 2002; Davidsson and Honig, 2003; Mosey and Wright, 2007) have indicated that the lead entrepreneur's human capital profile can shape the entrepreneurial process. Penrose (1972) clearly demarcated entrepreneurial ability, which links to human capital, from other physical and organisational resources of the firm. Penrose (1972) defined entrepreneurial ability as the capacity to identify and bring to fruition new combinations of existing resource bundles or to develop new resource

configurations. The starting block in this essential Resource Based View (RBV) of a firm is opportunity identification.

1.5.1 Opportunity Identification

Bruyat and Julien (2001) consider that the opportunity identification process should be thought of as a process which occurs over time, rather than a single moment of inspiration. Opportunity identification is the result of a mixture of personal, social, cultural and technological forces which merge together and lead to the perception of a possible market opportunity. The idea is then evaluated and refined. This process of elaboration is considered to be central to the process which involves searching and previewing mechanisms prior to and during translating the idea into a reality within a contextual setting (Bruyat and Julien, 2001). If the idea is viable it is then launched. There is an acknowledged process of iteration during opportunity identification. In the early phase especially, there is a reliance on the human capital resources available to the individual through experience, knowledge and training (Galglio, 1997). The opportunities are identified through a creative process by combining individual experience, networking for further experience, subjective understanding and current information. Human capital and social capital, reflected in these traits, can facilitate access to information, or people who hold that information. However, access to information by itself does not guarantee utilisation of information towards the development of an opportunity.

Shane and Venkataraman (2000) stated that the connection between information and the exploitation of information must be accompanied by an understanding of a new means-ends relationship. Prior business experience may, for example, allow for an increased state of alertness to opportunities. The facilitation of ideas may be prompted by prior experience based insights which may direct the individual entrepreneurs' expectations and interpretations of market stimuli (Gaglio, 1997). Sarasvathy et al., (2003) offer a market outlook on opportunities by defining them according to uncertainties. They are labelled as opportunity recognition, opportunity discovery and opportunity creation in which the market status of supply and demand play a part of the identification process (Table 1.2). In the life science sector it is anticipated that the former two interpretations of opportunity are more relevant. The entrepreneurs in this study were either dealing with potential products

for which there was a known market (e.g. opportunity recognition) or were feeding a demand for which there was no present supply (e.g. opportunity discovery). In addition, because there is time and resource costs involved with search and identification processes, entrepreneurs with more resources are presumed to be involved in more detailed search processes. Accordingly, opportunities may be seen as solutions to specific problems expressed in terms of dissatisfaction with the performance of present activities (e.g. a reactive search) which might reflect a situation when resources are not abundant, whilst other opportunities are recognised when there are sufficient resources around for the search and discovery to be made (e.g. proactive search) (Chandler et al., 2002). Access to resources and networks for opportunity identification is not only restricted to people but may be influenced by the external environmental context.

Table 1.2 Typology of entrepreneurial opportunities
1. *Opportunity Recognition* If both sources of supply and demand exist rather obviously, the opportunity for bringing them together has to be "recognised" and then the match-up between supply and demand has to be implemented either through an existing firm or new firm. This notion of opportunity has to do with the exploitation of existing markets e.g. arbitrage and franchises.
2. *Opportunity Discovery* If only one side exists – i.e., demand exists, but supply does not, and vice versa then, the non-existent side has to be "discovered" before the match-up can be implemented. This notion of opportunity has to do with the exploration of existing and latent markets e.g. cures for diseases (Demand exists; supply has yet to be discovered); and applications for new technologies such as the personal computer (Supply exists, demand has to be discovered).
3. *Opportunity Creation* If neither supply nor demand exist in an obvious manner, one or both have to be "created", and several economic inventions in marketing, financing, etc. have to be made, for the opportunity to come into existence. This notion of opportunity has to do with the creation of new markets e.g. Federal Express, Face-book.

Adapted from Sarasvathy et al., 2003, p 145.

1.6 Location and the External Environment

Resource leverage may be internally constructed, from the human capital reserves of the lead entrepreneurs and entrepreneurial ownership team, and influenced as a result of adaptation to the external environment. A recent body of research has focused upon firm formation and the relationship between environmental conditions and the nature of entrepreneurial activity (Üçbaşaran et al., 2003). Using the RBV as a theoretical framework, several investigations of the creation of HEI spin-off firms have given credence to the relationship between exogenous conditions and endogenous, or internal, features as being important for firm formation (Druilhe and

Garnsey, 2001; Heirman and Clarysse, 2004; Vohora et al., 2004; Lockett and Wright, 2005; Powers and McDougall, 2005). However, what these studies have failed to explore are the benefits entrepreneurs gain from different types of external environment or if, indeed, the lead entrepreneur changes location to access resources during the entrepreneurial process. This study addresses this gap by exploring the differences in access to resources in two types of external environment (e.g. sponsored and non-sponsored environments) and maps changes of environment.

A sponsored environment may provide the entrepreneur access to tangible resources such as laboratory facilities and equipment (Steffenson et al., 2000) as well as intangible resources such as access to human capital pertaining to scientific and business knowledge (Rappert and Webster, 1997; 1998) and social networks pertaining to actors and organisations providing resources (Hoang and Antoncic, 2003). An example of external actors with relevant human capital may comprise of Technology Transfer Officers (TTOs) (Jones-Evans, et al., 1999; Carlsson, 2002) employed by HEIs to promote the commercialisation process or the potential exploitation of 'surrogate entrepreneurs' (Franklin et al., 2001) who can provide lead academic entrepreneurs, deficient in experience and knowledge, with information about commercialisation relating to their past entrepreneurial experiences. The environment is seen as a pool of resources in which the firm enters a transactional relationship.

Policy-makers and practitioners are aware that some entrepreneurs need to deal with resource barriers and certain types of entrepreneurs may find difficulties gaining access to sufficient resources to pursue a business opportunity. The British government (and Scottish Executive) directly (and indirectly) seeks to provide resources (i.e., information, advice, training, finance, premises, etc.) to increase the flow of entrepreneurs, particularly knowledge and technology-based entrepreneurs (Westhead and Batstone, 1999; Anon, 2004). For example, property-based Science Park initiatives adjacent to HEIs and HEI incubator units (Lockett et al., 2003a; Clarysse et al., 2005) are forms of sponsored environment (Flynn, 1993) which can be selected by entrepreneurs to reduce risk, uncertainty and resource issues faced by inexperienced entrepreneurs with limited specific human capital. Sponsored environments can provide inexperienced and experienced entrepreneurs with broader

pools of technical, managerial, financial and network resources and they increase the legitimacy of the lead entrepreneur and the entrepreneurial team (Mustar, 1997). The latter resources, however, may not be required by entrepreneurs who can lever resources and knowledge from an industry rather than a HEI context. In this study, a sponsored environment is specifically defined as one which will foster the creation and growth of life-science firms and promote formal and operational links between firms and HEIs (Siegel et al., 2003).

1.7 Development of Research Questions

Building on the previous sections reviewing the lead entrepreneur, team members, the entrepreneurial process and the external environment, the following section develops research questions associated with each theme (e.g. the individuals involved and the influence of human capital on opportunity identification; team membership and the role of social capital; and access to resources through location choices in the external environment).

The initial human capital resource pool embedded in the lead entrepreneur(s) (Miller and Shamsie, 1996) may shape the opportunity identified. Resources such as education, reputation, experience, knowledge of industry and network contacts exist within the entrepreneur prior to the creation of a new venture (Brush et al., 2001). Entrepreneurs with greater human capital exposure may identify more opportunities whilst the 'innovativeness' may suggest a 'quality' opportunity (Shane, 2000). What is unclear from the literature is what type of human capital influences 'quality' and does it reflect in the technical or the commercial opportunity? Some lead academic entrepreneurs may face barriers at the opportunity identification phase because they have insufficient specific commercial human capital resources to leverage. Lead industry entrepreneurs, on the other hand, may have had previous opportunities to build up knowledge, networks and skills culminating in potentially more diverse human capital than lead academic entrepreneurs. The former may start the opportunity identification process with smaller and narrower initial resource bases (Brush et al., 2001). As previously stated, the inability to acquire appropriate resources may shape choices made relating to later evaluation and exploitation of opportunities (Vohora et al., 2004). Djokovic and Souitaris (2006) proposed that there

is scope for focusing on the entrepreneur as the unit of analysis because it allows for a linkage between the firm formation phenomenon with entrepreneurship theory on opportunity identification (Shane and Venkataraman, 2000; Ardichvili et al., 2003). These observations lead to the following research question:

Research Question 1: 'How' different are lead academic and lead non-academic entrepreneurs' initial resource profiles?

Failing to access the required resources, lead entrepreneurs may turn to others who possess experience and skills better suited to commercialisation. Entrepreneurs that perceive resource gaps may recruit team members to compensate for their own human capital deficiencies. However, little research has centred on the entrepreneur as the unit of analysis, and 'why' and 'how' they recruit an entrepreneurial team with reference to opportunity identification (Westhead et al., 2005). Evidence suggests that HEI spinout firms are much more likely to be team based (Birley, 2002; Vanealst et al., 2006). Further, teams are significantly more likely to achieve success than individual entrepreneurs (Üçbaşaran et al., 2003a). The network contacts and complementary skill sets brought by team members, students, academics and surrogate entrepreneurs to develop technologies may be particularly important in the technological sector given the lack of business acumen of certain entrepreneurs. To address resource deficiencies, lead academic entrepreneurs may recruit additional entrepreneurial ownership team members who have the requisite human capital profiles with regard to technical, managerial and entrepreneurial capabilities, business ownership experience, product / process and market knowledge, legitimacy and contacts (Üçbaşaran et al., 2003a). Motivationally, having an equity stake in the new venture may incentivise members to identify, pursue and exploit opportunities. The human capital of each entrepreneurial ownership team member may, therefore, be leveraged to address issues relating to the opportunity identification process. These observations and insights lead to the following research questions:

Research Question 2: 'Why' do lead academic and lead non-academic entrepreneurs form entrepreneurial ownership teams?

Research Question 3: 'How' do lead academic and lead non-academic entrepreneurs form entrepreneurial ownership teams?

Research Question 4: 'Where' do lead academic and lead non-academic entrepreneurs form entrepreneurial ownership teams?

An opportunity involves the identification of a new idea, which others have failed to recognize, or have chosen not to pursue for the creation of economic value (Sarasvathy et al., 2004). The entrepreneurial opportunity "consists of a set of ideas, beliefs and action that *enable* the creation of future goods and services in *(the presence of or)* the absence of current markets for them" (Sarasvathy et al., 2003, p142). In this study, the opportunity identification process relates to the identification of the product and the identification of the potential market. This leads to the following research questions:

Research Question 5: 'How' do lead academic and lead non-academic entrepreneurs identify and exploit opportunities for creating a firm?

Research Question 6: 'What' types of opportunities do lead academic and non-academic entrepreneurs identify?

Past studies, and those focusing on traditional firm performance outcomes, neglect the entrepreneurial human capital drivers that are linked to the opportunity identification that creates venture wealth (Busenitz et al., 2003). To help answer 'how' different entrepreneurs identify opportunities, human capital theory, traditionally associated with productivity, is extended to explore tacit resources held by the individual entrepreneur (Becker, 1993a, b). The opportunity identification phase of the entrepreneurial process has been under researched from an empirical perspective even though it is recognised as one of the principal questions in the domain of entrepreneurship (Gaglio and Katz, 2001). The ability of the entrepreneur to identify opportunities, seek resources and combine resources may be embedded in human capital, accumulated over a period of time through general and specific experiences (Brush et al., 2001). Recent studies have enhanced our understanding of the links between aspects of human capital and opportunity identification (Davidsson and Honig, 2003; Shepherd and DeTienne, 2005), but they have generally focused on a narrow array of human capital variables (e.g. upon the responses from students or nascent entrepreneurs rather than practicing entrepreneurs). Many of the latter studies have failed to explore the 'why' and 'how' questions relating to opportunity identification. Some studies simply ask respondents if they think they will recognize opportunities in the future (Davidsson and Honig, 2003). Consequently, there is a

dearth of empirical evidence relating to the links between practicing entrepreneurs' human capital profiles and the actual opportunity identification process. In this study, existing literature is extended by suggesting that the way in which human capital is acquired may be linked to the context in which and where an opportunity is identified.

Human capital, as an intangible resource giving rise to the ability to lever resources in the process of opportunity identification, has been given insufficient attention relative to tangible resources. The developing literature using the RBV of the firm indicates that there is a link between intangible resources and sustained competitive advantage (Hall, 1993). However, people centred, competence based, intangible resources are difficult to observe and describe. They may be differentiated from firm assets because they are not necessarily owned by the firm and they are not easily transferred (Chandler et al., 2005). This is particularly important in the case of a life-science firm. Human capital related to a specialised education about a certain technology may generate a tacit resource profile which is not possible to express explicitly. A distinction is, therefore, made between an entrepreneur's general and entrepreneurship-specific human capital profile in regard to its influence on opportunity identification and exploitation (Becker, 1993a, b). If there exists an opportunity for productive economic activity, then individuals with quality human capital should be better at perceiving and organising the opportunity. It is thus the human capital embedded in the individual entrepreneur which is the important resource (Hall, 1993). The challenge, at first, is how entrepreneurs, not the firm, construct a resource base. It is the quality and diversity of human capital in terms of experience and know-how which may influence the identification of a commercial opportunity. This discussion leads to the following research question:

Research Question 7: To what extent are opportunity identification and exploitation activities related to the actual and perceived human capital characteristics of the lead entrepreneur / entrepreneurial team?

Social capital, as another intangible resource, which may be influenced by human capital (or vice-versa) has also been identified as a component which gives rise to the leverage of other resources (Bozeman and Mangematin, 2004). Social networks lead entrepreneurs, lacking in resources, to recruit other entrepreneurial ownership team members, source potential investors culminating in the establishment of a firm and the

creation of a reputation. How social networks are established and developed by lead entrepreneurs is less understood within the HEI context than the commercial context (Mosey and Wright, 2007). Past literature indicates that the establishment and development of social capital is challenging within the HEI environment, especially if the entrepreneurs stay within the HEI environment (Mustar et al., 2006; Nicolaou and Birley, 2003). Vohora et al., (2004) recognise that academic entrepreneurs are confronted by barriers to transition from scientific to commercial networks because they need to seek and develop a broader legitimacy within commercial networks through accessing social capital (Delmar and Shane, 2004). As already stated, academics tend to have weak ties with actors located outside of their immediate department (Granovetter, 1973). These initial observations lead to the following research question:

Research Question 8: To what extent are opportunity identification and exploitation activities related to the actual and perceived social capital characteristics of the lead entrepreneur / entrepreneurial team?

A factor which may influence both human and social capital and access to both is the external environment. External environmental conditions can shape the creation and discovery of opportunities, as well as access to resources required to pursue and exploit opportunities. Two external environmental alternatives are explored e.g. the sponsored and the non-sponsored external environment. To circumvent attitudinal, resource and operational obstacles to the creation of new life-science-based ventures, stakeholders in the wealth creation process may provide sponsored environments (Westhead and Batstone, 1999). Sponsored environments can provide an institutional context that increases the legitimacy of inexperienced entrepreneurs who are seeking to reduce the liabilities of newness and smallness (Delmar and Shane, 2004). Sponsorship, by definition, involves planned environmental control by different government bodies and agencies to assist the creation and survival of new firms. In this study, sponsored environments are specifically identified as providing access to critical human, social and physical capital (Siegel et al., 2003a, b). Resource deficient entrepreneurs may choose more resource munificent external environments to benefit from resources offered in that environment (Mustar, 1997; Pfeffer and Salanick, 1978). Sponsored environments can reduce uncertainty for inexperienced entrepreneurs, support flows of resources to entrepreneurs, and encourage entrepreneurs to make

network bridges with a broad spectrum of actors (Mosey et al., 2006) who can provide skills, capabilities and knowledge required to address barriers and critical incidents (Vohora et al., 2004) relating to the opportunity identification process. A novel contribution of this study is an analysis of the human capital profiles and behaviour of lead entrepreneurs who have selected sponsored and / or non-sponsored environments. Relating to the external environment as a pool of influence and tangible and intangible resources, the final research question is:

Research Question 9: 'How' does the external environment impact on the entrepreneur's / entrepreneurial ownership team's access to resources?

1.8 The Life-Science Sector in Scotland

The definition of life-sciences in this study encompasses all researchers and / or firms in the field of biotechnology, pharmaceuticals, biomedical technologies, medical devices, food processing, environmental and biomedical devices (Smith, 2004). Life-science firms are attracting attention because they are becoming increasingly important for industrial employment in many countries (Storey and Tether, 1998). New technology-based firms (NTBFs), which include the life-sciences, in Europe have been found to constitute only a small proportion of new firms, but have displayed a significantly higher survival rate and show a capacity to grow faster than the average firm (Storey and Tether, 1998). As stated already, founders are typically highly educated and have long work experience within the life-science sector. Recent studies have also shown that a proportion of these firms are created from the HEI sector. Two out of five high technology firms started in France were set up by HEI researchers (Mustar, 1997) whilst four percent of high technology and medium technology firms in Flanders were also research based start-ups (Heirman and Clarysse, 2004). In the context of this study, entrepreneurs leading life-science firms within one European country, Scotland, and governed by a one policy initiative are interviewed to explore 'how' and 'why' they identify opportunities to exploit within the life-science sector. Justification for the choice of the life-science sector and country follows outlining forces shaping the sector at the time of the fieldwork.

The life-science-based sector in Scotland was given official attention after the publication of the "Network Strategy" (Scottish Enterprise, 1994; 1996) when high technology, and in particular biotechnology, was earmarked for potential economic

growth based on a substantial reputation for existing quality scientific, technological and medical research and education within the HEI sector. Promoting innovation with entrepreneurship is a recognised benefit to the economy and employment policy (OECD, 2001; 2002). The supply of the technology, technological skills and knowledge is affirmed by the proven quality of Scotland's basic research base. This is a recognised critical factor in the commercialisation of basic research (Audrecht, 2001; OECD, 2002; Zucker et al., 2002; Scottish Executive 2002b). Historically, Scotland has experienced several prominent, potentially successful large scale projects which have ended in commercial failure. These included the cloning technology made famous by Dolly the sheep and the development of pharmaceutical agents for treating cystic fibrosis. Although Scotland is renowned internationally for the quality of scientific education and research and has dedicated centres of research excellence, as well as a number of growing life-science companies, there is not, as yet, a sufficient range of investors and supporting services and networking between companies and researchers for it to be considered a fully functioning cluster (DTI, 1999a). There are, for example, fewer larger companies, restricting access to expertise. Whilst recognising a proven research base, specific barriers, market and systemic failures have been identified which impede the commercialisation of basic research. Scottish political and economic development policy recognises that the rate of exploitation of research in the market place is not being fully utilized. Reducing barriers to entrepreneurship and enabling the creation and growth of life-science firms is under scrutiny.

1.8.1 Barriers to Entrepreneurship in the Life-Science Sector

The degree of entrepreneurial culture is expressed as being less in Scotland compared to the UK. GEM (2005) and MORI / Scottish Enterprise (1999) survey findings suggest that Scotland lags behind the UK in terms of positive attitudes to entrepreneurship. Historically, the gap in appreciation for entrepreneurial activity has been dominant and may, therefore, have an influence on the uptake of entrepreneurial activities in general. In addition to cultural differences, specific identified market and systemic failures to entrepreneurship within the life-science sector in Scotland are framed around ongoing concerns. A lack of access to technological / market opportunities relevant to the exploitation of basic research for economic productivity gains is exaggerated because of the immaturity of the support structure. There is

uncertainty and risk-averse behaviour leading to sub-optimal activity in corporate venturing, entrepreneurship and investment (Graham, 2002). A recognised deficiency in managerial and commercial expertise and a lack of combined forces involving both managers and technologists with a mixture of science and business knowledge also acts as a barrier (Forbes and Low, 2004). This translates as a lack of a specific type of human capital to secure patent rights (Bower, 2002) or to oversee regulatory procedures and develop social networks with partners to obtain the financial resources to support technology development (Baum, 2004). The incentive structure of the HEI system does not reward firm formation and the lack of knowledge transfer success has lead to a negative perception of entrepreneurs from the investment sector (Higher Education Review, 2004). The life-science sector has also been hindered by a lack of concerted and consistent co-operation and collaboration between industry and academia (and vice-versa).

Additional barriers may prove to have a negative impact for both lead academic and non-academic entrepreneurs due to the uncertainties about future prospects within the life-science market (Aldrich and Fiol, 1994). The conceptualisation of a technological discovery and how it can be applied to the market place may prove problematic. In the life-science market place there are some inventions and basic technologies developed for which no market has been defined (or indeed some markets for which no technology has been developed) (Ardichvili et al., 2003). New technology and new markets are unpredictable. Emerging markets may change, incompatible technological products compete for market acceptance and technical hurdles routinely derail projects (Tushman and Rosenkopf, 1992). Entrepreneurs' inexperience in managing long exploratory development phases also increases risks. Kakati (2003), on interviewing venture capitalists financing high-tech firms, found that the development of a new technology was not in itself a guarantee for commercial success. Investors have been traditionally very sceptical about new start-ups led by academic entrepreneurs and only participate when they feel there is a fully functioning balanced (business/technical) professional team in situ (Roure and Keeley, 1990; Cyr et al., 2000). Lead entrepreneurs with academic or research backgrounds have also found it difficult persuading financiers that they possess managerial competencies to run a business (Storey and Tether, 1998). Mason and Harrison (2002), however, offered an opposing view of available finance for start-up

and argued that the problem is not a supply side issue (i.e. from business angels) but one based on poor quality in the form of proposals, business plans and negotiating skills on the part of the academic entrepreneurs. On this specific point, it has also been recognised that the evaluation of life-science firms by investors is inherently difficult and so it has been suggested that investors cannot evaluate such firms in traditional ways (Audretsch, 2001). The alternative offered is to evaluate the human capital embedded in the entrepreneurial ownership team which are overviewed in the next section. This is justification for studying human capital as a resource and team membership as a possible access to needed resources. From a social capital perspective, Shane and Stuart (2002) speculated that new ventures with founding teams that had pre-established network relationships with venture investors would be more likely to acquire external funding because their relationship was based on trust, prior knowledge of each other and feelings of obligation.

1.8.2 Life-Science Provisions

Notwithstanding, commercialisation activities in the UK HEI sector have increased over the last five years (Carlsen, 2000; Lambert Review, 2003; Scottish Executive, 2004). This can be measured by the growth in the number of Technology Transfer Offices opening in UK universities, including HEIs in Scotland, especially during the late 1990s (UNICO, 2002; 2003). The need for better technology transfer has been recognised by a number of industry sectors. A report on the UK biotechnology sector concluded that UK universities need to do more to promote best practice in technology transfer (Biotechnology and Biological Sciences Research Council (BBSRC), 2004/2005). There is, for instance, a strong reliance on academia for the promotion and stimulation of new knowledge for the life-science sector.

In Scotland, however, there exists an imbalance between the strength in the size and performance of Scotland's public research base and relative weakness in terms of the number and size of companies with significant technological capability. Public sector interventions aim to increase the probability of promising companies being created. A deliberate targeted investment programme was launched in 1999 to expand and strengthen the life-science-based sector in Scotland to encourage the development of a life-science community with greater competitive advantage both nationally and internationally (Forbes and Low, 2004). The sector also benefited from

the support of the governmental business development body, Scottish Enterprise and especially a group, Biotech Scotland, supported by its regional partners (Scottish Enterprise, 2003). Promotion of businesses has been significantly enhanced in recent years, and a wide range of support measures are now in place in terms of accommodation for firms, training, business advice and investment opportunities. Policies include the Scottish Co-investment Fund, a programme of co-investment in a range of new and existing private sector led equity funds; and the Business Growth Fund, a debt and equity vehicle for investment in new and early stage growth businesses. Grants are being provided through the SMART and SPUR programmes supporting small to medium sized firms (SMEs) to develop new, highly innovative and commercially viable products or processes. The Proof of Concept Fund aims to address a gap in the commercialisation market between scientific discovery and prototype or proof of concept stage and is targeted at HEIs.

The Royal Society of Edinburgh fellowship scheme offers training for post-doctoral students to give them an opportunity to decide whether to continue in academia or to pursue a commercialisation route. Co-operation between Scottish firms and the science base is also promoted through the Scottish Executive, Expertise, Knowledge and Innovation Transfer Programme (SEEKIT) and SCORE programmes, which encourages knowledge transfer between the Scottish public sector science base and Scottish SMEs. The Scottish Funding Council's Knowledge Transfer Grant (KTG) was introduced in 2002. KTG funds a wide variety of knowledge transfer activity. Three market-based Intermediary Technology Institutes, one specifically for life-sciences, were set up in Scotland in 2004 with the aim of identifying future emerging markets and developing the technology required to exploit these commercially. Overall, public sector funding for R&D and product/process development increased from £5.3m in 2000-2001 to £11.8m in 2004-2005.

Selecting lead entrepreneurs from a one country perspective, all governed by the same policy initiative, highlights the forces shaping the sector at the time of the fieldwork and lends itself to potential theoretical development. The proportion of lead academic to non-academic entrepreneurs within the sector, in Scotland, at the time of the study, was unknown but an email survey identified differences between lead entrepreneurs in the life-science sector.

Accommodation for firms in the form of supported environments (e.g. HEI incubator units and science parks / technology parks) has drawn attention due, in part, to the growth in the numbers of high technology firms around Stanford University and MIT in Boston which provided the model for science parks in the UK (Saxenian, 1985). Importing and establishing a similar philosophy to the development of life-science cluster formation in the UK has resulted in the establishment of Oxford and Cambridge as centres of excellence and fully functioning clusters encapsulating the critical factors leading to recognition (e.g. an exploitation of an established research base; the prospect and infrastructure to support company development; access to large mature companies and a skilled work force) (DTI 1999a,b,c; Cooke, 2001; Ernst and Young, 2004). Advancement of similar clusters in Scotland has been slower to materialise despite governmental initiatives. Cluster development in Scotland, between Edinburgh, Glasgow and Dundee, the latter being cited as the most active centre of its kind outside Oxford and Cambridge, is still considered to be at earlier stages than Cambridge (UK).

Mature life-science companies are mainly located in clusters around Cambridge and Oxford, London and the South East. The bulk of UK business expenditure in Research and Development (R&D) is also undertaken in those areas of England's South East (20%) and East (24%). In those two parts of the country R&D expenditure per employee in 2000 was over £1,000 whereas in Scotland it was £246 for the same period and £592 for the UK (Scottish Executive, 2000a). United Kingdom R&D expenditure in pharmaceuticals, for example, is £2.7 billion whereas Scottish R&D spending is £114 million, 4.3% of the UK total. The sector employs 5,000 people in Scotland and spends £22,500 per employee on R&D whilst in the UK £43,500 is spent per employee. These figures indicate the life-science sector in the institutional context of Scotland as being associated with not only low expenditure on R&D but also a sector in a state of transition. Reasons for late adoption in Scotland may be attributed to factors specific to the life-science sector and to wider external environmental factors.

1.9 Outline of the Thesis

Chapter Two begins with a review of the theoretical perspectives guiding this study. A literature review follows examining the entrepreneur, entrepreneurial

ownership team formation (the individuals), the context in which they behave entrepreneurially (the external environment) and their affect on opportunity identification (the dynamic entrepreneurial process). The themes explored in the conceptual framework touch on the individuals involved (i.e. the lead entrepreneurs and their team members). As they amass resources, the RBV of the firm helps to understand and explore the resource requirements for firm formation and a critical junctures model (Vohora et al., 2001) exploited to identify phases in the entrepreneurial process. Finally, drivers influencing firm formation in the external environment are explored. Drivers may originate from the resources held within the external environment. The literature review provides the basis from which the research questions are developed.

In Chapter Three a theoretical route map is introduced. Human capital theory and the Resource-Based View (RBV) of the firm are expanded to include entrepreneurship prior to and during the process of firm formation. Whilst the RBV of the firm helps identify resources internal to the organisation resources are also sourced from the eternal environment. Social capital theory is explored for its role in resources accumulation. A conceptual framework is created and major themes identified.

Methodological issues are discussed in Chapter Four. The phenomenological paradigm is justified and qualitative (or interpretive) methodology guided data collection and analysis. Underpinning methodological choices were the nature of 'why' and 'how' research questions (Gephart, 2004). Initially an exploratory survey was conducted to identify life-science firms and to distinguish the difference between academic and non-academic entrepreneurs. A novel typology was created distinguishing lead academic to non-academic entrepreneurs on sponsored and non-sponsored environments. Information was collected thereafter from a theoretical sample of entrepreneurs within the typology over a period of time. Novel themes arising from the data were associated with changes in team membership, changes in location and changes in access to resource requirement and leverage over time. Team membership was monitored over the research period and the entry and exit of members mapped. The movement of firms between sponsored and non-sponsored environments was also monitored over the same time. Explanation is offered for the choice of a multiple case-study approach. Data was collected from in-depth follow up

interviews with multiple respondents relating to each lead entrepreneur and their influence on access to accumulation and leverage of resources recorded. The transcription process and the subsequent coding of data to search for additional themes, patterns, similarities and differences, was aided by a computer software package (i.e. NVivo) which stored the data and allowed for cross referencing.

In Chapter Five, entrepreneurs (Theme 1), and team members (Theme 2), on sponsored and non-sponsored environments are compared. Triangulated respondent data highlighted human capital characteristics which influenced opportunity identification. Social networks were exposed giving access to governance and relationships (Hoang and Antoncic, 2003). Chapter Six explores the opportunity identification process (Theme 3) during Information Search leading to Opportunity Identification (e.g. discovery); Resource Accumulation, Leverage and Management (e.g. evaluation) and Firm Creation (e.g. exploitation) (Alvarez and Busenitz, 2001). In Chapter Seven the choice and influence of the external environment (Theme 4) on entrepreneurs' ability to lever resources is subject to scrutiny. There was a consistent movement between different sponsored environments by academic entrepreneurs and a move from non-sponsored environments to sponsored environments by non-academic entrepreneurs. In each chapter propositions are derived from the data and material extracted to build on theory.

Chapter Eight offers a summary of the key findings and an assessment of the research data whilst suggestions and recommendations are made for future academic research and implications for policy-makers. The movement of firms between different environments revealed itself to be the most novel contribution as was the simultaneous exploitation of two environments by academic entrepreneurs. A revision of the provisional theoretical framework is discussed and findings used to build theory.

Chapter 2: Theoretical Insights

2.1 Introduction

This chapter will review the literature which influenced the formation of the research questions set out in Chapter One. Themes explored in past literature with regard to the identification, creation, evaluation and exploitation of ideas from HEIs are identified. Existing empirical literature related to resource accumulation for firm formation relying on human capital, social capital, team formation and external environmental influences is presented. Theories guiding previous studies are outlined. Gaps in the knowledge base are identified and used to justify the multilevel theoretical approach of this study.

The structure of the following sections includes a justification of a multilevel theoretical approach in Section 2.2 which will enable the exploration of themes in the conceptual model set out in Chapter 3. A resume of the theoretical perspectives guiding this study are outlined in Section 2.3. A review of human capital theory is presented in Section 2.4 as is prior research relating to the influence of human capital. This includes a separation of both general and specific human capital as presented in Sections 2.4.1 and 2.4.2. Social capital is explored in Section 2.5. A summary of the Resource Based View (RBV) of the firm is offered in Section 2.6. The importance of the external environment and access to resources in different locations is discussed in Section 2.7. A general critique of the theoretical approaches is presented in Section 2.8. Finally, a summary is offered in Section 2.9.

2.2 The Multilevel Theoretical Approach: A Justification

A failure of past research has been characterised by a static and cross sectional approach to the study of opportunity identification, evaluation and exploitation relying on stage models of growth and development (Churchill and Lewis, 1983; Scott and Bruce, 1987). The phase or stage approach has been extended to include firm formation from HEIs (Shane, 2004). Within the HEI spinout firm sector stage studies have been criticised for being too rigid, prescriptive, predictive and formulaic (Mustar et al., 2006). Stage models take a positivist position assuming that the external environment is a constant pre-given. At their simplest, they describe a predictable

process moving from one pre-given state to the next. Such processes are seen as manageable and the next step predetermined because the steps of the process are known. Because of this high level of prediction, stage models seem better suited to the study of incremental change, such as growth (Galbraith, 1982) rather than the unpredictable study of newly forming entities. The strength of the stage approach is that it provides a clear view of the start and finish of the entrepreneurial process, albeit pre-determined. Stage studies compartmentalise and separate different aspects of the commercialisation process and are complicated by and adjusted through feedback loops and overlaps and do not necessarily take into account the heterogeneity of skills and past experiences and networks brought to firm formation by the individual(s) involved (Ndonzuau et al., 2002; DeGroof and Roberts, 2003; Clarysse and Moray, 2004; Druilhe and Garnsey, 2004; Heirman and Clarysse, 2004; Vohora et al., 2004). There is a start and finish point and it is believed that all firms start from the same stage. The existence of a firm is assumed as the starting point of the process. Explanations about moving from one stage to another are not always well explained.

In contrast, this study offers a dynamic opportunity-based approach exploring several layers of the process, the individuals involved, the context in which they operate and their interaction with each other to capture how opportunity identification leading to exploitation unfolds. Exploring the interaction between these elements has been a failure of past research. Levels of exploration will involve the relationship between human capital and the opportunity identification behaviour of lead academic and non-academic entrepreneurs; the relationship between the external environment and access to resources at different phases and at different locations during the opportunity identification process; the relationship between the dynamic entrepreneurial process and changing resource requirements following a resource based view perspective; and the relationship between lead entrepreneurs and recruited team members following a human capital and social capital perspective. The theoretical stance of this study is multilevel. To explore and capture influences of resources, the effect human and social capital and the ‘pulls’ and ‘pushes’ of location ‘in real time’, a qualitative methodology was chosen. From a qualitative methodological research standpoint the chosen theoretical perspectives complement the interpretivist paradigm where the interest is in understanding phenomenon from within (e.g. from the perspective of the involved social actors) (Gephart, 2004).

A qualitative methodology, using a multiple case study method for data gathering and analysis, outlined in Chapter 4, allows for an inductive process of discovery rather than testing for justification (Guba and Lincoln, 2000). A multiple theoretical stance enables exploration of the internal construction of resources (Zahra, 2007). Such an approach prompts theory building and the formulation of propositions for future verification. The use of a longitudinal study is spurred by the traditional static nature of previous studies and answers a call from literature for a process and multilevel approach to studying entrepreneurship (Low and MacMillan, 1988; Shane and Venkataraman, 2000; Davidsson and Wiklund, 2000; Mustar, et al., 2006). A longitudinal study allowed a focus on events that described how processes and subsequent events changed over time. Instead of seeking causal explanations for events, the progression of processes leading to events became the focus which allowed an exploration of how the opportunity identification process evolved over time. This approach explored 'why' and 'how' resources were configured by the individuals involved, 'why' and 'how' and from 'where' these individuals knew each other, 'why' and 'how' the opportunity developed and 'why' and 'how' the external environment influenced access to resources.

The application of a multiple theoretical position was influenced by two distinctive types of theory aimed at social research which Aldrich (2001) distinguishes as two forms of 'process research'. There is *outcome driven* explanations that start with an observed out-come and move backwards to search for events that explain the outcome. The other is *events-driven* explanations that start with observed events and move onto outcomes or changes in processes. The former is backwards looking whilst the events driven explanations are built forward from events towards outcomes. The first definition features a category of concepts or variables that pertain to actions and activities which are associated with "variance theory" (Mohr, 1982) of change where *outcome driven* explanations examine the degrees to which a set of independent variables statistically explain variations in outcome criteria (e.g. the dependent variables). The causal process that generates the outcome is presumed to operate continuously over time and the variables are assumed to remain constant over time (Van de Ven and Engleman, 2004). The *event driven* approach is more often associated with a process theory where explanation for change is embedded in temporal order and subsequent changes in events occurs based on a story of historical

narrative (Langley, 1999). Change, therefore, unfolds and cannot be untangled unless a narrative is elicited from participants (extracted in this study from case studies) about their perceptions of events leading to the outcome. The process events driven approach employs narrative explanation to give insight into the contribution actions and events make to a particular out-come. Where variance theory draws on variables and causality, process theory encompasses the discrete states and events where time ordering is critical to the outcome. According to Van de Ven and Engleman (2004), the process approach is necessary to address questions about how the entrepreneurial process unfolds and evolves over time. Pettigrew recommended that research investigating change, or an unfolding process, should encapsulate the context, the content and the process of change longitudinally (Pettigrew, 1990). In this study the opportunity-based conceptualisation of entrepreneurship, emphasising the opportunity, the individuals and the context are used to capture different components of the process in real time (Bruyat and Julien, 2001).

An unfolding process of opportunity identification requires theories which 'fit' with the evolution of the phenomenon and with the research paradigm. The perspective of this study is that the process is emergent, rather than prescriptive asserting that processes leading to firm formation are not fully predictive and are open to influence. To capture the unpredictability this study draws on several theoretical perspectives. First, from a human capital perspective a link is drawn between the past relevant experiences of lead entrepreneurs, such as prior business ownership, and their opportunity identification behaviour (i.e. a process). Second, lead entrepreneurs' social capital, related to who they know rather than what they know, might be enhanced by past network experiences associated to past relevant practices associated to commercialisation (i.e. a network). Third, the RBV perspective is related to the entrepreneurs' ability to draw on new resources leading to firm formation (i.e. an event). Fourth, the external environmental context is seen as an influencing factor giving access to network resources, specialist personnel and physical resources (i.e. a milieu) (Jack and Anderson, 2002; Etzkowitz, 2002). The aim is to generate and build on theoretical insights emerging from the data gathered from lead entrepreneurs and team members and to analyse that data through comparison. This approach will also address observations made about entrepreneurship literature in general that there is a lack of theorising on process (Davidsson and Wiklund, 2001; Üçbaşaran et al., 2001).

Some conceptions of organisational development emphasise internally constructed processes which are not only the result of adaptation to the external environment (i.e., they offer an inside-out view). Brush et al., (2001) and Bergmann Lichenstein and Brush (2001) have addressed the entrepreneurial challenge of setting up a resource base, studying the human capital components of what individual entrepreneurs bring to the entrepreneurial process (e.g. the resource base). These individuals may need to accumulate broader legitimacy through accessing social capital (Delmar and Shane, 2004; Mosey and Wright, 2007) which in turn may be influenced by their human capital (or vive versa). The resource based view (RBV) of the firm (Barney, 1986) also assumes that change is not necessarily dependent on the external predictable environment, but based in organisational and human resources that are built over time and are adaptable to the changing environment. The RBV assumes that the process leading to firm formation cannot be influenced by exogenous conditions alone and that endogenous factors are important for the out-come. Since the process starts with an individual, then human and social capital become the first and most important resources.

2.3 The Multilevel Theoretical Approach: A Guide to this Study

The opportunity identification process leading to potential firm formation starts with the individual entrepreneur. Results of empirical investigation suggest that not all identified opportunities are pursued (Shane and Venkataraman, 2000). The extent to which an entrepreneur identifies an opportunity and in turn evaluates the opportunity for potential pursuit may be a function of their human capital influenced in turn by their social capital. In this study it is suggested that the resource profile brought the individual may be associated with their opportunity identification behaviour. Human capital theory relates to Themes 1 and 2 in the conceptual model in Chapter 3 (i.e. people). However, although the individual entrepreneur may provide the impetus for the opportunity which, in the case of life sciences may be activity based on leading edge technology, the creation of a resource base for potential firm formation may be out-with the capability of that individual. Academic entrepreneurs, for example, may lack business exposure and lack access to investment capital to bring their potential products closer to market. The entrepreneur must, therefore, match up the technological opportunity with other resources encompassing

commercial dimensions such as access to financial, physical, social and human capital. Some of those resources may be mobilised outside the realm of the entrepreneur's experience and others may be sourced relying on the entrepreneur's access to networks of social contacts. The human capital of lead entrepreneurs and how they accumulated this experience may have a direct bearing on how they developed their social capital (Delmar and Shane, 2004). However, academic entrepreneurs may face constraints compared to their non-academic counterparts because the non-commercial environment of an HEI may restrain their development of social capital (Mustar et al, 2006; Nicolaou and Birley, 2003). Social capital, therefore, also relates to Themes 1 and 2 in the conceptual model in Chapter 3.

To circumvent resource barriers entrepreneurs may recruit team members from their immediate external environment. Earlier team formation research focused on top management teams (Eisenhardt et al., 1990) whilst only a cursory amount of recent empirical research has dedicated itself to the study of entrepreneurial team formation emanating from HEIs and industry (Bergmann Lichenstien and Brush, 2001; Clarysse and Moray, 2004). The heterogeneity of human capital, encapsulated within a team, may be important for a new firm because as it evolves, certain human capital attributes may become more essential than others (Üçbaşaran et al., 2004). Human capital and social capital theory, in relation to team membership, is extended in Theme 2 to the entrepreneurial ownership team members and important non-equity holding members, who have been often ignored in past research. The RBV perspective will relate to Theme 3 which explores resource accumulation during the process of information search and opportunity identification leading to firm formation. Entrepreneurs may chose to bridge resource gaps by seeking resources in different external environments, some of which are richer in resources than others. This encapsulates Theme 4 in the conceptual model. A dynamic rather than a static view of opportunity creation and exploitation will be presented. The theoretical frameworks guiding this research are now presented.

2.4 Human Capital Theory

Change in the development of a firm is a highly complex and iterative process involving resource inputs from other sources, not always including the lead academic entrepreneur (Bower, 2003). By concentrating only on the entrepreneurial process there has been a tendency to overlook the diversity of the individual entrepreneur and their input to the process (Üçbaşaran et al., 2001). Prior to the initiation of an organisation, there has to be an individual or group of individuals who have responsibility for the identification of the opportunity leading to the creation of the venture (Davidsson and Wiklund, 2000). The entrepreneurial process is seen as the result of actions of key individuals, the entrepreneurs or surrogate entrepreneurs (Franklin et al., 2001), the entrepreneurial team (Clarysse and Moray, 2004; Üçbaşaran et al., 2003a) or 'privileged witnesses' (Vanealst et al., 2006). Each may bring different experiences, legitimising their human capital, to the process.

The rudiments of human capital theory have been attributed to the economist Gary S. Becker (1993a) who calculated that human activities have an effect on productivity and consumption. According to human capital theory, individuals increase their productivity as a result of formal and informal education, work experience as well as exploiting network relations (e.g. social capital). A distinction is made between general human capital (i.e., education and work experience) and specific human capital (i.e., managerial capabilities, entrepreneurial capabilities, technical capabilities and business ownership experience) (Becker, 1993a, b). The outcome of productivity is calculated as the result of investment in 'input' activities like education and training. The sum of the inputs governs human capital. Human capital may be seen as the combined intelligence, skills and expertise (i.e. intangible resources) that are embedded in individuals or the members of the organisation or seen as a type of capital which is people dependent (Fernandez et al., 2000).

Human capital has been viewed as consisting of a hierarchy of skills and knowledge with varying degrees of transferability across firms (Castanias and Helfat, 1992). Some skills are specific to a firm and some are transferable because they are generic. General human capital is applicable to many economic activities and includes aspects such as education, age, gender and managerial understanding (Table 2.1). Specific human capital is more limited in its application (Gimeno et al., 1997) and can

relate to prior business ownership, attitudes towards entrepreneurship, parental business ownership and entrepreneurial capabilities (Gimeno et al., 1997; Üçbaşaran, 2004) (Table 2.1).

Table 2.1 Types and Components of Human Capital	
Type of Human Capital	**Components**
General Human Capital	Education Gender and age Managerial human capital Managerial and technical capabilities
Specific Human Capital	Business ownership experience Parental business ownership Entrepreneurial capability

Adapted from Üçbaşaran (2004) p 44.

The entrepreneur's human capital, evident from her past experiences, skills and competencies, is generally viewed as influencing business development (Storey, 1997). More specific to this study is the investigation of the entrepreneur's human capital influence on opportunity identification and exploitation thereafter rather than on business development. Past literature has inferred the importance of cognitive processes (Alvarez and Busenitz, 2001), the role of social networks (Hills et al., 1997), and the effect of prior knowledge and experience (Shane, 1999) on an individual's ability to identify, evaluate and exploit opportunities for commercialisation. In this study it is speculated that the ability to do so may be a joint function of the nature of the opportunity, the human capital characteristics of the entrepreneur(s) and their social capital networks. The ability to make the connection between the specific knowledge and the commercial opportunity requires special skills, insights and circumstances (Venkataraman, 1997), which may be enhanced though social networks (Mosey et al., 2006).

2.4.1 General Human Capital

Past studies representing a range of results demonstrate the relationship between education, entrepreneurship and firm success (Evans and Leighton, 1989; Robertson and Sexton, 1994; Gimeno et al., 1997; Reynolds, 1997). However, few studies have looked at the relationship between general human capital and the propensity to identify an opportunity and set up a firm. One stream of thought suggests that lead entrepreneurs with greater knowledge and skills create firms with bundles of unique and difficult to imitate competences (Grant, 1991). The competences are seen to be

closely related to the skills of the founders, attributed to what the founder has learned through formal education and prior professional experience. Colombo and Grilli (2005) used this premise to study the relationship between the growth of new technology based firms (NTBFs) and the human capital characteristics of their founders (Table 2.2). General human capital, in this case, referred to the lead entrepreneurs' (founders) years of educational and work experience. In previous empirical work general human capital has been proxied by educational attainment and by years of work experience before forming a new firm and by the owner's age. In relation to education, most work has concentrated on the positive effect of survival of new firms rather than on observations which encompass observations about human capital at the earlier phases of the entrepreneurial process (Bates 1990; Brüderl et al., 1992; Gimeno et al., 1997). Some studies have been inconclusive about the effect of education on entrepreneurship (Greene, 2000; Liao and Welsch, 2003) whilst others have found that better educated people are the most likely to become entrepreneurs (Bates, 1995). Storey (1994) indicated that less than half of the 17 studies he cited showed a positive effect of the entrepreneur's education. In contrast, Cooper et al., (1994) showed that high growth firms were more usually formed by highly educated individuals. Westhead and Cowling (1995) also found similar results for UK NTBFs. However, for more insight into the general human capital which may be more influential at the earlier and emergent stages of the entrepreneurial process, less empirical evidence is available. One exception is Davidsson and Honig (2003). Their study investigated tacit and explicit types of knowledge leveraged through education. Explicit human capital as measured by years of schooling had a small significant and positive effect of entrepreneurial discovery (Table 2.2).

Lead entrepreneurs in the life science sector may introduce products for which there is a demand but, as yet, no supply (e.g. a new medical product) or they may be introducing something revolutionary for which demand and supply is an unknown entity (Sarasvathy et al., 2004). Marvel and Lumpkin (2007) address this topic by considering 'how' human capital relates to an entrepreneur's ability to create radical innovations. They examined the effects of both general (i.e. experience depth, experience breadth, and formal education) and specific human capital (i.e. knowledge of ways to serve markets, knowledge of customer problems, knowledge of markets and knowledge of technology) on their ability to deliver radical products, processes

Table 2.2 Studies on human capital

Author(s)	Theoretical perspective(s)	Method	Sample size	Unit of analysis	Geographical scope	Main findings
Mosey and Wright (2007)	Human and Social Capital	Case-studies	24	Technology-based Academic Entrepreneurs	UK	Difference in human capital influences the entrepreneur's ability to develop social capital. Prior business ownership experience is essential to build relationships with experienced managers and potential equity investors
Marvel and Lumpkin (2007)	Human Capital	Hierarchical regression analysis	145	Lead Technological Entrepreneurs	USA	In terms of general human capital, formal education was found to be most highly related to the degree of innovativeness. For specific human capital, technology-related knowledge was found to be most highly related to innovativeness
Packalen (2007)	Organisational legitimacy; individual and organisational status; human can social capital	Theoretical paper	5	Illustrative examples from biotech sector		An organisations initial legitimacy and ability to obtain resources is derived from interaction between three main facets of its founders' backgrounds: industry status, entrepreneurially relevant past experiences and other demographic features, and social capital. The presence of one type of capital may reduce the dependence on or need for others
Allen, Link and Rosenbaum (2007)	Human Capital	Survey of patenting activity	1,335	Faculties at HEIs	USA	Older faculty and those with tenure are more likely to engage in entrepreneurial activity. The authors interpret this result as signifying that tenure and age enhance the "absorptive capacity" of faculty members, with respect to the commercialisation of innovation
Colombo and Grilli (2005)	Human Capital	Econometrics	506	High-tech industries in manufacturing and services	Italy	Examines the relationship between human capital and the growth of NTBFs. Both educational and work experiences of founders affect firm growth. Previous managerial experience influences access to external private equity funding. Technical expertise positively increases growth.

Table 2.2 Studies on human capital (cont)

Author(s)	Theoretical perspective(s)	Method	Sample size	Unit of analysis	Geographical scope	Main findings
Shepherd and De Tienne (2005)	Prior Knowledge	Experimental approach and hierarchical regression analysis	78	MBA and executive MBA students	USA	Prior knowledge of customer problems provides understanding for identification of opportunities
Davidsson and Honig (2003)	Social and Human Capital	Binomial logistic regression	Nascent entrepreneurs (n=380); control group (n=608)	Nascent entrepreneurs	Sweden	Following the developmental process of nascent entrepreneurs for 18 months individual factors leading to opportunity discovery and exploitation were identified. Higher levels of human capital sparked firm formation; tacit knowledge from prior start-up experience was influential; having parents and friend in business was influential
Üçbaşaran, Wright and Westhead (2003b)	Human Capital	Case studies	8	Habitual starter and acquirer entrepreneurs	UK	Human capital accumulated by habitual entrepreneurs influence subsequent behaviour (e.g. prior business ownership experience is discussed in relation to an entrepreneur's human capital accumulation as well as their search and business opportunities and behaviour)
Westhead, Wright, and Üçbaşaran (2001)	Resource based view	Logistic regression analysis	116	Independent firms	UK	Internationalisation of small businesses is governed by a small number of resource based variables (e.g. older age of founder, quantity of resources, denser information and contact networks, management know-how contributed be becoming and exporter)
Brush et al., 2001	Resource-based View	Case-studies	2	Lead entrepreneurs	USA	Strong reliance on human capital e.g. personal endowments (education, experience, reputation, knowledge of industry, network contacts). Network contacts bought by team members particularly important in technology business.
Fernandez, Montes, and Vazquez (2000)	Resource based view	Theoretical paper		Intangible resources	Spain	Typology of strategic analysis of intangible resources classified as human capital; organizational capital; relational capital and technological capital.

Adapted from Wright et al., 2007, p794-795.

and services. Their results indicate that both general and specific human capital is related to the delivery of radical innovations. They countenanced a priority on developing both types of human capital over time for a successful breakthrough (Table 2.2).

2.4.2 Specific Human Capital

Specific human capital results from people's exposure to education, training or experience that has a more limited scope of applicability (Gimeno et al., 1997). Specific human capital, applicable to the entrepreneurial process, may include business ownership experience, parental business ownership experiences and entrepreneurial capabilities (Gimeno et al., 1997). It may refer to entrepreneurial specific human capital or years of experience in a specific industry related to an entrepreneur's current business. Industry specific knowledge, for example, including information about customers and suppliers yields knowledge about the sector in general and markets in particular which may minimise the "liability of newness" (Stinchcombe, 1965; Gimeno et al., 1997; Fernandez et al., 2000; Brush et al., 2001). Firm founders with industrial experience have tacit knowledge of effective strategies, customer preferences and an array of contacts with customers, suppliers and other industrial players (Brüderl et al., 1992; Gimeno et al., 1997; Brush et al., 2001). Additionally, Brüderl et al. (1992) found that firms started by individuals with previous start-up experience (i.e., specific human capital) had an advantage relative to firms created by first time entrepreneurs. Davidsson and Honig (2003) stressed the importance of specific human capital for exploitation of an initial nascent opportunity but concluded that general human capital became more important as the venture matured. As the entrepreneur and the firm matured, over time, learning 'when' to rely on specific and general human capital became crucial. On the one hand, specific human capital was used for predicting entry into nascent entrepreneurship but was found to have only a weak predictive quality for carrying the start-up process towards successful completion (Davidsson and Honig, 2003). General human capital became much more important to the lead entrepreneur and his investors during exploitation of the venture (Shepherd and De Tienne, 2005).

Packlen (2007) studied three main factors of founding team member's background in the biotechnology sector (Table 2.2.). These related specifically to

industry status, entrepreneurially relevant experience and other general human capital features. Packlen suggested that there is a counterbalance between human capital features (e.g. as the status of founding members increased, the ability to leverage external resources increased). A manifestation of this result is seen in the positive effect of industrial status on the ability to network with resource providers and also a perceived increase in firm legitimacy. Self employment experience is also an indicator of entrepreneurial specific human capital on two counts. First, it generates general know-how about the act of entrepreneurship and second, generates experience about the leadership role in entrepreneurship i.e. experience in managing and directing employees. Similarly, entrepreneurs with previous venture start-up experience may be endowed with human capital useful to the new venture (Fernandez et al., 2000; Üçbaşaran et al., 2003b) (Table 2.2.). Another indicator of entrepreneurial human capital is linked with parental self employment (Evans and Leighton, 1989; Brüderl et al., 1992). Self employed parents may act as a role model. Those growing up in such environments may perceive entrepreneurship as a viable career whereas those who have not had this family experience may not.

Resource barriers encountered at opportunity identification and exploitation and how they were overcome was central to the study conducted by Mosey and Wright (2007) studying technology-based entrepreneurs from HEIs (Table 2.2). In their longitudinal study Mosey and Wright (2007) drew attention to how differences in human capital contributed to the entrepreneurs' ability to develop social capital (i.e. contact with other resource providers). It was found that those entrepreneurs with prior business ownership experience (i.e., specific human capital) had broader network ties to equity finance and managerial resource providers. The academic reputation, gained through education (i.e., general human capital), of lead academic entrepreneurs acted as compensation to counterbalance a lack of reputation within the business community (Meyer and Rowan, 1977).

Table 2.3 summarises specific human capital categorisations using empirical evidence from previously mentioned studies. Management know-how capital, reflecting management specific skills and knowledge, is gleaned from past experience or is made available through advisors, mentors or partners. Industrial specific know-how reflects specific experience in the same business sector whilst financial capital

and the ability to raise it is considered a visible resource allowing the pursuit of more capital intensive strategies (Cooper et al., 1994; Westhead et al., 2001).

Table 2.3: Specific Human Capital Categorisation

Management Experience	Management know how can be utilised to identify partners, investors, advisors to nurture the firm with necessary resources (Carter et al., 1996)
	Management know how can be accumulated from family background where parents owned a business and acted as a role model (Becker, 1993a).
	Skills and knowledge accumulated during previous business ownership is beneficial to entrepreneurs (Gimeno et al.1997; Cooper et al. 1994).
	Types of entrepreneurs show differences in their characters, motives and attitude (e.g. novice, serial and portfolio) (Westhead and Wright, 1998).
	Team starts have more human capital available to them and therefore more expertise and greater access to financial resources. External investors prefer team starts because they offer more credibility (Bruton and Rubanik, 2002; Roberts, 1991).
	External advisors/mentors can bring to the attention of the entrepreneurs a variety of opportunities (Clarysse and Moray, 2004).
Industry Experience	Pre-ownership experience in the same industry offers detailed knowledge about that sector pertaining to customers, suppliers, shareholders (Chandler and Hanks, 1991; Brush et al, 2001).
Financial Experience	Founder's ability to gather funds acts as a buffer against "newness" and acts against premature mortality (Brüderl et al. 1992).

However, a question remains over the 'value' of different types of human capital at different phases in the entrepreneurial process (e.g. for an event or a process). A further criticism of the literature is that it fails adequately to take into account the role of social structure on human capital outcomes and what kind of learning experiences could be helpful at what phases in the entrepreneurial process (Davidsson and Honig, 2003). One conclusion of the Davidsson and Honig (2003) study was that during the entrepreneurial discovery phase specific human capital, pertaining to tacit knowledge, gained from previous start-up experience, was particularly influential. However, as the entrepreneurial process unfolds, other types of general human capital appear to increase in importance. A speculative reason for this phenomenon explores the differences between discovery and exploitation. Perhaps new forms of activity for discovery are based on more tacit forms of human capital whilst the skills for exploitation are based in more explicit forms of human capital. Lacking necessary skills, the entrepreneur's options to gaining access to vital resources and additional skills may be sought from either learning (Corbett, 2007),

from the external environment through networking with known resource providers or from the direct recruitment of other people (e.g. through the exploitation of social capital). Either way, human capital profiles can also be manipulated and changed over time (Sarasvathy, 2001).

An entrepreneur with previous entrepreneurial experience (e.g. specific entrepreneurial human capital), for example, may learn to acquire unique resources more quickly than the entrepreneur with no past experience (Üçbaşaran, 2004). In other words, the entrepreneur with experience may have a better ability to combine sets of resources to create new ones (Brush et al., 2001). Experience thus provides episodic knowledge (Corbett, 2002), that is, experientially acquired knowledge developed through direct experience (Blackler, 1995). Episodic knowledge acquired through business ownership experience can be used to identify future opportunities (Shane and Khurana, 2003). Shane (2000) stated that because information and knowledge is generated thorough people's idiosyncratic life experiences, 'knowledge corridors' allow people to see and recognise opportunities differently (Venkataraman, 1997) and thus identify a utility for resources and attach different values to different resources. Opportunity identification may thus be a function of an individual's capacity to handle complex information using their prior knowledge (Venkataraman, 1997; Shane, 2000). People with higher human capital endowment may be in a stronger position to set up larger firms and attract investment because they have more access to business knowledge (Brüderl et al., 1992; Gimeno et al., 1997; Bates, 1995) or experience (Brüderl et al., 1992; Evans and Leighton, 1989). Experienced entrepreneurs may also use their entrepreneurship-specific human capital to gain access to a predictable uninterrupted supply of financial and social capital (Cooper et al., 1994).

2.5 Social Capital Theory

Anderson et al., (2007) offer a comprehensive overview of the diversity of definitions associated to the words 'social capital'. In recent studies social capital has been defined as the expectations of social interactions traded through interdependencies (Anderson et al., 2007); as resources embedded in relationships (Burt, 1992; Johannisson et al., 1994); as resources derived from networks of

relationships (Nahapiet and Gholshal, 1998); as a cumulative capacity for social groups to work together (Leana and Van Buren 1999); as the norms which govern relationships; and as a function (Anderson et al., 2007). From these recovered definitions social capital does not appear to be an outright resource in itself, like cash or information, but rather acts as a catalyst within a system of relations and social belonging in which individuals are embedded (Barbieri, 2003). It is a catalyst because it facilitates relationships in order to gain access to resources and its presence encourages social interactions. Social capital is, therefore, probably better termed as a 'social condition' (Anderson et al., 2007). To have a catalytic effect this 'social condition' cannot work in isolation but has a relationship with human capital (Lester, et al., 2008). Research has suggested an interactive relationship between human capital and social capital (Mosey and Wright, 2007). It could be the case that human capital may be enhanced by an elevated 'social condition' and that the entrepreneurs' position within a network of resource providers enhances their embedded human capital. Entrepreneurship is a process set in a milieu of past, present and future relationships. Entrepreneurs may be products of their social environments (past and present) and identify opportunities influenced by their social background. Social capital theory determines networks of relationships as a valuable resource for conducting the entrepreneurial process and for potentially sourcing other resources (Nahapiet and Ghosal, 1998).

In terms, however, of identifying and exploiting opportunities, the role of social capital is less known (Davidsson and Honig, 2003). Past research argues that high levels of social capital allow entrepreneurs to gain access to resource holders such as venture capitalists and market information providers. Social capital is seen as one of the necessary components of the entrepreneurial process in line with human and financial capital (Liao and Welsch, 2003). Davidsson and Honig (2003) suggest that social capital may assist by providing access to actors with critical information and essential resources. Mosey and Wright (2007) speculate that human capital may be influential in developing social capital.

An important source of support for the lead entrepreneur may, therefore, be the entrepreneur's network bridges (Mosey et al., 2006) or social networks (Hills et al., 1997; Lockett et al., 2003a; Grandi and Grimaldi, 2003). Academic entrepreneurs are

dependent on a wide network of actors within the HEI context (Mustar, 1997). With a shortage of resources and expertise, networking can be crucial to the ability of the entrepreneur to gather information about market conditions and the development of new techniques (Nicolaou and Birley, 2003b). Social networks encompass the people that the individual entrepreneur knows and can be a significant resource for the new firm (Johannisson et al., 1994; Hills et al., 1997; Johannisson, 1998; Mosey et al., 2006). Limitations in the lead academic entrepreneur's knowledge, for example, may be addressed using their social network to extend boundaries and levels of information. Academic entrepreneurs may lack the more refined abilities of acquiring resources and information processing functions necessary for firm development which established entrepreneurs might already have developed. If, however, the academic entrepreneur discusses the business idea with social contacts then it is more likely that access to resources such as financial backing, psychological support, physical goods, technical expertise and business information will be sought. Since no firm is self sufficient, the need to acquire resources creates dependencies between individuals (Pfeffer and Salancik, 1978).

Within the realms of this research it has been recognised that new ventures in the life science sector are rarely initiatives taken by individuals acting in isolation (Aldrich, 1999). The actualisation of an idea allows for observation of the nature and influence of networking capital. Liao and Welsch (2003) differentiated between the nature of social capital in high-technology ventures and non-high-technology ventures. They suggested that the nascent technology entrepreneur is more focused in the forms of information they exchange compared to non-technology entrepreneurs. Non-technology entrepreneurs engage in less discrete and more expensive social networking whilst technology based entrepreneurs benefit from 'relational embeddedness' (Anderson et al., 2007) because of a need to exchange non-redundant information. The exchange, however, does not always occur by formal means. Some capital (social and human) is generated from prior employment experiences and is utilised in future entrepreneurial ventures. Not only do past experiences influence human capital, the individuals' social capital impacts on their embeddedness in the wider community. Prior work related experiences play a role in developing knowledge, experience and network connections for future opportunities (Johannisson et al., 1994). If not a resource but a network, or a 'social condition', social capital

may be influential in gaining access to required resources for 'value creation' in the opportunity identification process.

2.6 The Resource-Based View of the Firm

The foundations of the RBV of the firm are attributed to Edith Penrose and her seminal work on the growth of the firm (Penrose, 1972). The traditional stance of the RBV offers a framework for understanding growth and sustainable competitive advantage within mature firms (Penrose, 1972; Wernerfelt, 1984; Barney, 1991). Competitive advantage is attributed to organisational resources and has emerged as an influential framework in the study of strategic management research (Barney, 1991). Sustainable competitive advantage, in this study, focusing on opportunity identification, refers to the implementation of '*value creation*' rather than '*value appropriation*'. None of the entrepreneurs under study generated rents. Through the lens of the RBV, the firm is considered to be a "collection of productive (heterogeneous) resources" (Penrose, 1972), tied semi-permanently to the firm's management (Wernerfelt, 1984; Barney, 1991). The firm is seen as an evolving entity balancing existing internal and external resources and developing new ones.

The RBV of the firm concentrates attention on resources held by the firm and postulates that processes and events are governed by the unique resources owned and controlled by the firm. This view lies contrary to theoretical stances which view the market or industry forces as being the controlling feature (Teece et al., 1997). The market forces view maintains that firm strategy is constrained by industry structural forces and as such, internal independent managerial action can be ignored (Porter, 1980). Focus lies with explaining and evaluating industry, not the internal working of the firm. However, in this study, prior to firm formation, lead entrepreneurs may not understand in which 'industry' their potential product belongs and emphasis is placed on internal resources rather than the opportunities or threats offered by industrial analysis. Internal resources are more valuable than externally acquired or bought resources, since such resources may be traded in the market. "Instead, critical resources are those that are built and accumulated within firm boundaries, their non-imitability and non-substitutability hinging on specific traits of their accumulation process" (Spanos and Lioukas, 2001, p911). Resource endowment becomes the key to firm heterogeneity, as a result of barriers to resource imitation. Firm development is

thus dependent on resources which are valuable, rare, inimitable and non-substitutable (Barney, 1991). Resources may be seen as input factors, controlled and used by the entrepreneur to develop their opportunities (Amit and Schoemaker, 1993). Valued resources may thus be built up through cumulative firm experiences. These new forms of resources may encompass organisational and managerial process (i.e. co-ordination / integration, learning and reconfiguration), specific asset positions (i.e. technological, financial, reputation assets) and path dependencies (i.e. the ever changing history of the firm) (Spanos and Lioukas, 2001).

However, although the RBV gives insights into the planning process of new ventures it is pre-occupied with content rather than process and does not explain how resources are developed. The strengths and weaknesses associated with using the RBV of the firm in analysis are outlined in Table 2.4.

Table 2.4 : Strengths and Weaknesses of the RBV

Strengths	Weaknesses
• Performance is a return from unique assets owned and controlled by the firm (Barney, 1986; 1991; 2001a). The emphasis is on the internal workings of the firm. In this study firm formation rather than performance will be the return from unique assets held by the founder or founding team. • RBV sees the firm as a bundle of unique resources (Barney, 1991) not as a bundle of activities (Porter, 1980). • RBV places emphasis on the impact of idiosyncratic firm attributes on firm performance/formation. • Firms are seen as heterogeneous based on the resources on which they establish their strategies. • Resources are assets that are owned or controlled by the firm and can be tangible or intangible. • Some resources are socially complex procedures which gives firms the ability to exploit and combine resources through organisational routines in order to accomplish targets (Collis, 1994). • Combined resources encompass organisational and managerial processes (i.e. co-ordination/ integration, learning and reconfiguration), specific asset positions (i.e. technological, financial, reputation etc.) and path dependencies (i.e. a firm's history) (Teece et al., 1997). • The personal qualities of the entrepreneur are an important influence on the development of the firm (Casson, 2003)	• RBV does not account for the possibility that the sustainability of rents is determined by the influence of competitive forces encountered by the firm 'outside' of the firm (Porter, 1980). In firm formation, prior knowledge of these competitive forces could affect the formation of the firm. • Does not recognise the "outside in" perspective regarding market structure (Spanos and Lioukas, 2001). • Strategy is seen as being driven from within the firm not as being driven by industry (Porter, 1980). • Managers or lead entrepreneurs could be limited in their choice of strategic alternatives by their framework of available resources. • Strong emphasis on using the firm as the unit of analysis, not the individual entrepreneur. • Open to influence from managers (or in this case entrepreneurs) with choices between market manoeuvring and resource building. (In the early phases of formation the entrepreneur may not know what market sector to enter and will therefore devote time to building resources to address the market issue).

It is the identification of resources, opportunities and networks used by entrepreneurs (Shane and Venkataraman, 2000) relying on past experience which the RBV has failed to endorse. Initially, the firm is not the instigator of resource creation. The entrepreneur and team therein mastermind the entrepreneurial act and creativity (Barney, 2001a) through a process to generate valuable resources whereby human capital resources become dynamic processes capable of combing resources to overcome barriers to commercialisation. The resource which holds value for the potential new firm may be the human capital embedded in the lead academic entrepreneur and his or her ability to manipulate, choose and administer new resources using entrepreneurial ability (Penrose, 1972). Penrose (1972) clearly demarcated entrepreneurial ability, which links to human and social capital, from other physical and organisational resources of the firm. Entrepreneurial ability is defined as the capacity to identify and bring to fruition new combinations of existing resources. However, there is a lack of standardisation across the RBV literature concerning a definition for resources. In addition, the literature implies that some resources have greater priority depending on phase of development of the firm (Brush, et al., 2001). The following section discusses resources in more depth and highlights empirical studies embedded in the RBV tradition.

2.6.1 Resources

From a RBV perspective, the firm is seen as an evolving entity balancing existing internal and external resources and developing new ones. Resources may be anything that is a strength or weakness of the firm that can be tangible or intangible such as information, skilled people, finance, knowledge etc. (Wernerfelt, 1984). Tangible resources are those factors pertaining to financial capital or physical value such as plant equipment and stocks of new material (Grant, 1991). Intangible resources are factors which are non-physical in nature. "Intangible resources range from the intellectual property rights of patents, trademarks, …..trade secrets, public knowledge such as scientific works; to the people dependent or subjective resources of know-how; networks; organisational culture and the reputation of product and company" (Hall, 1992 p.1). Adopting this classification from Hall (1992) intangible resources can be further divided into two categories: assets and capabilities (or skills). If the intangible resource is something that the firm 'has' it is seen as an asset and if

the intangible resource is something the firm 'does' it is a capability or skill (Galbreath, 2005).

Combinations of intangible resources give individuals distinctive character and abilities and includes achieved capabilities resulting in work ethics which may have both positive and negative effects on productivity (Becker, 1993a, b). Bontis, et al., (1999) summarised these intangible resources as competencies (e.g. skills and know-how; attitude, motivation and leadership qualities) and intellectual agility (e.g. ability to learn). Some authors say that intangible resources, influenced by human capital input, are inimitable because they have a strong tacit dimension and are socially complex (Alvarez and Busenitz, 2001). Examples of socially complex combinations are firm reputation, networking knowledge and human capital itself (Carpenter et al., 2001). Being in possession or having experience of such intangible resources may give the entrepreneur competitive advantage over those who do not have similar resource profiles. The possession of specific technical knowledge, for example, a key component of human capital for the lead academic and non-academic entrepreneur in the life science sector, may be unique to a situation, not easily appropriable and be useful for a certain period of time to yield competitive advantage (Dimov and Shepherd, 2005). Academic reputation may have a similar effect. Intangible resources tend to be difficult to observe and describe but have a significant impact on firm formation (Brüderl, et al., 1992; Bates, 1990; Gimeno et al., 1997). Given that opportunity identification may be tacit, highly inimitable, socially complex, embedded in process and individuals, in-depth field work using a multiple case-study approach may offer a way to untangle an, as yet, understudied phenomenon of opportunity identification behaviour (Rouse and Daellenbach, 1999).

Intangible resources may also assist the lead entrepreneur to acquire and develop additional organisational resources over time (Chandler and Hanks, 1998). Organisational, physical, financial and human capital resources may be acquired by the individual entrepreneur or accumulated by gathering other sources of resources to assist in the build up of further required resources e.g. the process of combining and organising resources as a new resource (Alvarez and Busenitz, 2001). 'How' the entrepreneur achieves this is perceived to be an important resource in itself. The original technical and managerial knowledge that makes up the tangible and intangible

resources of the potential firm are usually held by the lead entrepreneur or founding team. An expansion of this knowledge becomes the advantage to the firm. Entrepreneurs in emerging organisations must first assemble resources to build a resource base (Brush et al., 2001). Resource bases are built on the foundation of both human capital experiences and social capital connections. This observation is pertinent for a comparison of lead academic and non-academic entrepreneurs because the former may have no commercial legacy, be embedded in a traditional non-commercial environment, and have little network access to required resource strengths. The focus of this study is on the internal drivers (e.g. human capital resources and social capital connectedness) and how they lead to resource accumulation for opportunity identification leading to firm formation. This is an important point because a substantial resource based literature of the firm links the accumulation of resources with competitive advantage but often fails to mention the source of the resources and assumes that some resources are more valuable than others without adequately explaining how organisations can access or develop such resources.

According to Alvarez and Busenitz (2001) entrepreneurship related resources can be identified in their own right. They identified three specific resources concerned with human capital which the entrepreneur brings to a new firm that are critical to "the creation of heterogeneous output through the firm that are superior to the market" (Alvarez and Busenitz, 2001, p.770). They are the lead entrepreneur's unique awareness of opportunities (e.g. information search); the ability to access and acquire the resources needed to exploit an opportunity (e.g. evaluation of needed resources) and the organisational ability to recombine homogeneous inputs into heterogeneous outputs (e.g. exploitation). An expansion of these resources becomes the advantage to the firm. The expansion of resources means that they can also take on another dimension. They can be either static or dynamic (Lockett and Thompson, 2001). Static resources may be considered to be tangible resources which may be utilised as appropriate over a finite life. Dynamic resources (e.g. the intangible resources) may reside in resources such as an organisation's capacity (or individual's capacity) for learning which will generate additional opportunities over time (e.g. exploitation or expansion of human and social capital).

2.6.2 Learning: A Dynamic Resource

Individuals can develop their human capital through learning from experience (Jovanovic, 1982; Corbett, 2007; Mosey and Wright, 2007). The interaction between human capital and information acquisition is about more than just what the entrepreneur knows but involves the process they go through to identify the opportunity and internalise new information (Corbett, 2007). The entrepreneurial learning process has been described as "the outcome of a sequence of choices among competing beliefs or actions, whose relative influence over an individual's decisions increase or decrease over time as new experiences take place" (Minniti and Bygrave, 2001).

Erudition, gained from previous experience and performance, can be separated into tacit (know how) knowledge, the non-codified components of activity; explicit knowledge (know what), conveyed in procedures, written documents, educational institutions etc.; and social capital (know-who) (Anderson and Jack, 2002) extracted from the benefits from social structures, networks and membership (Portes, 1998; Liao and Welsch, 2003). Learning and the knowledge it brings is therefore a complex resource which is intangible and systemic (Miller and Shamie, 1996) as opposed to tangible, discrete and property based. The importance of intangible resources may be that they assist the lead entrepreneur to acquire and develop additional organisational resources (tangible and property based) over time (Chandler and Hanks, 1998).

Recent empirical research revealed that an individual's ability to identify an opportunity may not only be dependent on knowledge (Shane, 2000) but also "upon the *process* through which individuals acquire and transform their information and knowledge (i.e. learning)" (Corbett, 2007 p.98). Whilst we recognise that prior knowledge and human capital are important, 'how' that knowledge is gained and applied is also important (Kolb, 1984). 'Experiential learning' (Kolb, 1984) looks at three elements: existing knowledge, the process of acquiring new information and the transformation of new information into new knowledge (McGill et al., 1992). 'How' the lead entrepreneur learns is not only limited to experience. 'Acquisitive learning' processes, such as gaining information by recruiting new team members, complement 'experience-based' learning by increasing the lead entrepreneur's ability to source resources (Keil, 2004). Although recent research has indicated that learning-by-doing

(experience-based) may allow for the refining and development of individual as well as organisational capabilities, it is less suitable for building up initial knowledge and new abilities when embarking on a new enterprise or activity (e.g. it is time consuming). Experience based learning may be restrictive, centring repeatedly on only one cycle of knowledge whereas acquisitive learning allows for the recruitment of resources from outside the realm of experience of the entrepreneur. It has been shown that experience-based learning may lead to a cycle in which existing knowledge in one domain leads managers to strengthen activities in that domain alone, at the expense of other activities in which the firm has little experience (Levinthal, 1996). For example, Keil (2004) in his recent study of the information and communication technology (ICT) sector, indicated that one firm under investigation repeatedly went for the option of acquisitions because it had no experience in joint ventures. Only when managers realised that by focusing solely on acquisitions their business was missing out on opportunities did it start a programme to build up its capabilities in joint ventures. This was an example of experience-based learning being interrupted. Acquisitive learning may increase the entrepreneurs' ability to source resources through, for example, the recruitment of new team members who bring with them relevant and needed knowledge to form a spinout firm. As such, team members may help build and spread knowledge within the spinout faster than if the inexperienced entrepreneur tried to build up knowledge from experience only.

Experiential learning is seen as a cyclical concept hovering between experience and adjustment in behaviours. "Learning by doing" models rely on solutions sought to problems by learning activity (Arrow, 1962). Learning is thus seen as a cumulative and path dependent process (Costello, 1996), self reinforcing (Levinthal, 1996), based on existing expertise and knowledge. The existing expertise is embedded in human capital and the expertise may affect future learning cycles. The human capital of the academic entrepreneur championing an HEI spinout, for example, implies a higher level of education, a higher level of skills and knowledge and has been shown to imply a higher realisation for learning (Del Canto et al., 1999).

Sarasvathy (2001) suggests that there are two ways in which nascent entrepreneurs can pursue opportunities. Using 'effectual logic', entrepreneurs may define targets loosely allowing for learning through experimentation and the use of

their abilities to discover and exploit various contingencies. Here again, there is a reliance on what the entrepreneur already knows through their accumulation of human capital in the form of past education and expertise but the emphasis is on exploiting potential contingencies rather than prior knowledge (McKelvie and Wiklund, 2004). 'Causal logic', on the other hand, involves clearly defined targets and well developed plans. The logic in this case is that the future can be predicted and the focus is on exploiting prior knowledge in the discovery and exploitation of opportunities. Causation relies on the entrepreneur exploiting their existing knowledge and works best within a static, linear environment where the future is somewhat predictable. In a dynamic market such as life-sciences, effectual reasoning appears to be more functional since the entrepreneurs have to deal with an environment which is open to change and therefore difficult to predict. Learning through effectual reasoning, therefore, plays an important role in the discovery of opportunities. The tacit, non-codified and specific nature of learning may be internally generated by both a capacity to use past experiences and to experiment with possible contingencies (Nonaka, 1994).

Learning is thus a dynamic resource which resides in the entrepreneur's capabilities to process new knowledge (Lockett and Thompson, 2001). From a strategic point of view intangible resources, such as the ability to learn, are important because external competitors find such resources hard to detect and evaluate because they are invisible. Competitive advantage (or in this case value creation) comes first from the entrepreneur's expanding knowledge base and absorptive capacity (Cohen and Levinthal, 1990). In other words, it depends on what the entrepreneur, and team members, has learned in terms of entrepreneurial capabilities such as opportunity identification and continuous innovation that transforms ideas (e.g. 'inputs') into potential firms offering heterogeneous 'outputs' (Alvarez and Busenitz, 2001). Resources alone are not responsible for value creation. Learning and application are necessary and both types of learning are complementary and not competitive. In this study both the human capital profiles of the lead entrepreneur and team members will be explored to monitor how their personal resource bases were expanded through learning.

2.7 The External Environment

External environmental conditions can also shape the creation and discovery of opportunities, as well as access to resources required to pursue and exploit opportunities (Reynolds et al., 1994; Siegel et al., 2003a, b). Organisations (or individuals) are viewed as entering transactional relationships with environmental factors because they cannot generate, internally, all necessary resources such as finance, technology and access to customers (Flynn, 1993). The environment is seen as being the dominant factor in the development and survival of the firm. The entrepreneur, even during the opportunity identification phase, will need a predictable uninterrupted supply to critical resources (Westhead, 1995). Some entrepreneurs, perhaps those lacking in experience, need to adapt and / or move to more resource munificent environments to ensure business formation and development (Pfeffer and Salancik, 1978). Within a sponsored environment such as a science park, for example, lead entrepreneurs can address attitudinal, operational, resource and strategic barriers to opportunity creation, identification and pursuit by broadening their social networks.

The external environmental context shapes or influences the starting resource configurations for opportunity identification and later developments of firm formation (Shane and Stuart, 2002). Characteristics such as geographical location (DeGroof and Roberts, 2004) the characteristic of the HEI (Smilor et al., 1990; Grandi and Grimaldi, 2003), the characteristics of the sponsored environment and proximity to HEI (Westhead and Batstone, 1998) have all been found to influence the opportunity identification process. The individuals involved in the opportunity identification process are embedded in external environments which influence their access to resources and therefore influence their actions and outcomes of the processes they embark on. If there is a parent organisation (e.g. the HEI), it will have its own culture, incentive systems, rules and procedures and may influence the opportunity identification process and access to resources (Moray and Clarysse, 2005) (Table 2.5). Lead non-academic entrepreneurs may emanate from a different external environmental context which may be influenced by different rules and offer a set of different resources. Although the internal context may shape opportunity identification, creation and exploitation, the entrepreneur's social network position within the HEI or industrial context may also shape their propensity to source resources from the external environment. Resource endowments, for example,

obtained from the parent organisation for the new firm at start-up have been found to have an impact on the firm's ability to access further resources. Close involvement with the parent organisation and formal IP transfer has been perceived by other resource providers positively for the provision of future access to resources including financial capital (Carayannis, et al., 1998; Niclolaou and Birely, 2003; Hindle and Yenken, 2004).

Table 2.5: Differences between an HEI and industry settings

	HEI setting	Industry setting
Reward structure	Priority based	Property based
Motivation	Broad range of motivational factors (i.e. curiosity, esteem, financial)	Profit
Knowledge	Sharing of knowledge (Intellectual Property (IP))	Protection of knowledge (IP)
Form of cooperation	Loose relations (couplings)	Formal contracts
Time horizon	Long term	Short term
Role	Knowledge production	Knowledge exploitation
Goal	Novelty important	Market important
Management	Academic freedom	Hierarchical

Adapted from Rasmussen (2007, p.23)

The level and satisfaction of networking activity also affects the quality of experiential learning of the entrepreneur (Johannisson, 1986). The importance of effective external networks lies not just in the reduction of transaction costs and the benefit of external economies but in the strengthening of local networks such as in a supportive environment (Flynn, 1993). Local networks have been recognised as a source of entrepreneurial learning with the focus on individual entrepreneurial learning rather than collective learning (Szarka, 1990). The lead entrepreneur may thus be embedded in a social structure which may create opportunity and stimulate learning. Social embedding assists the entrepreneur to use the specifics of the environment. The literature indicates that both the identification and realisation of opportunity are conditioned by the entrepreneur's role in the social structure (Jack and Anderson, 2002). Personal social capital acts as 'glue' for networks and a 'lubricant' that facilitates networks (Anderson and Jack, 2002). Social capital, such as trust for

example, is just as important as the accumulation of resource stocks and internal capabilities (Casson, 2003).

2.8 Critique of Theoretical Perspectives

The RBV has until recently given little credence to the role of the entrepreneur in the entrepreneurial process (for an exception see Alvarez and Busenitz, 2001). This includes the individual(s) involved in creating and combining resources to create new heterogeneous resources in new combinations alien to competitors in order to create competitive advantage. Further, the RBV has not adequately explained endogenous resource acquisition and creation (Foss, 1997) (Table 2.6). The RBV has also failed to enlighten us about 'where' resources come from, 'how' these resources are selected and by 'whom' (Godfrey and Gregersen, 1997). In the new firm there is very little to build on (e.g. no reputation, no traditions etc.) (Mahoney and Pandian, 1992) apart from the individual entrepreneur's resource base influenced by past experiences and connections. In addition, there is likely to be few social contexts within which resource decisions are embedded (e.g. firm traditions, network ties, regulatory pressures etc.) (Oliver, 1997). Another criticism of the RBV has been directed at the static nature of the theory. The RBV has not given due attention to the firm's ability to respond to changes in their external environment. Due consideration to the context in which resources are sourced and exploited or whether they are more valuable in some contexts than others also needs to be given further consideration (Miller and Shamsie, 1996). Human capital theory also fails to explain if the 'value' of human capital remains the same throughout a process. The literature implies that some resources have greater priority depending on phase of development of the firm (Brush, et al., 2001). An inconsistency within the social capital literature is centred on the absence of an acceptable definition. As a social condition it is assumed that the 'value' of social capital will not remain consistent throughout the process. A summary of the strengths and weaknesses of each of the theoretical perspectives aiding this study are offered in Table 2.6.

Table 2.6 Strengths and weakness of theoretical perspectives			
Theory	**Reason for use**	**Strength**	**Weakness**
Human capital theory	Progress / Productivity seen in terms of relevant specific and general human capital of the individual	Acknowledges human capital heterogeneity	Does not explain if human capital has the same value throughout the firm formation process
Social capital theory	Progress seen in terms of relevant networks, embeddedness and proximity	Acknowledges social capital heterogeneity	Does not explain if social capital has the same value through the firm formation process
Resource-based view of the firm	Progress explained through the identification of resources which drive the process	Deals with heterogeneity	Does not explain how and where resources are developed or the importance of resources at different stages

2.9 Summary

This chapter focused on an opportunity-based conceptualisation of entrepreneurship incorporating the individuals involved, the processes they encounter and the environment in which they behave. It encapsulates a theoretical stance which is inductive to allow for the emergence of processes influenced by access to resources embedded in human capital profiles, from social conditions and from the external environment. Promoting an interpretivist perspective, change is seen as a process which is not prescriptive but emergent. The dimensions of change include the individual(s) in the form of the lead academic and non-academic entrepreneur, the entrepreneurial ownership team members and members who act as advisors but who do not hold equity in the potential firm; the processes involving information search leading to opportunity identification and the accumulation, leverage and management of resources for potential firm formation; and the influence of external environmental context in the form of sponsored and non-sponsored environments; all functioning over time.

The construction of a resource base as an entrepreneurial challenge has been addressed by Brush et al., (2001). Lead entrepreneur's profiles may reflect different relationships between prior knowledge and opportunity identification (Shane, 2000), between human capital and opportunity identification (Davidsson and Wiklund, 2000), between learning and their ability to identify opportunities and coordinate required resources over a period of time (Corbett, 2007) influenced by networks of valuable relationships for conducting the entrepreneurial process (Nahapiet and Ghosal, 1998).

A human capital perspective assumes that change may be dependent on past experiences culminating in specific and general experiences which may influence the identification, reconfiguration and access to needed resources. Social capital is another component in line with human and financial capital (Liao and Welsch, 2003). Human capital theory is the starting point to observe what individual entrepreneurs bring to the process. There is, therefore, a focus on the internal drivers leading to resource accumulation. In addition, as the entrepreneurs move towards forming a team and forming a firm the RBV of the firm assumes that change is not solely dependent on outside factors but is based in organisational and human resources that are built over time through a process of learning either from experience or through the recruitment of team members. However, it is recognised that some entrepreneurs may be unable to generate all necessary resources internally and may enter into a transactional relationship with the environment and that some external environments may be richer in resources than others. To capture any relationship the external environment is monitored to see if it remains consistent throughout the process. The static nature of past research is challenged by conducting longitudinal research where data is recorded in real time. The real time analysis allowed for monitoring team member entry and exit and for the observation of changes in external environmental contexts.

Since lead entrepreneurs must learn to seek resources, pick and combine resources to build future capabilities (Makadok, 2001), this chapter has also questioned the accumulation and leverage of resources through a learning and co-ordination process. Learning was expressed in different forms, seen as a capability expanded either through 'doing' or through the recruitment of people with the requisite skills and knowledge. Human capital is thus seen as more than a competency; it is an intellectual agility demonstrating the ability to learn (Bontis et al., 1999). This ability to learn may manifest itself through the entrepreneurial ability of combining new resource bundles or resource configurations (Penrose, 1972). In the entrepreneurial process resource productivity leads to overcoming barriers to commercialisation instigating a move between critical junctures (Vohora et al., 2004). If the individual lead entrepreneur is deficient in entrepreneurial ability or has restricted experience, then the recruitment of team members may lead to the search for alternative routines to development. These individuals may bring additional or

complementary human capital and access to external social ties (Mosey et al., 2006) allowing for quicker learning, an increase in entrepreneurial ability and the identification and acquisition of needed resources such as finance, marketing or business advice.

Chapter 3: Conceptualisation

3.1 Introduction

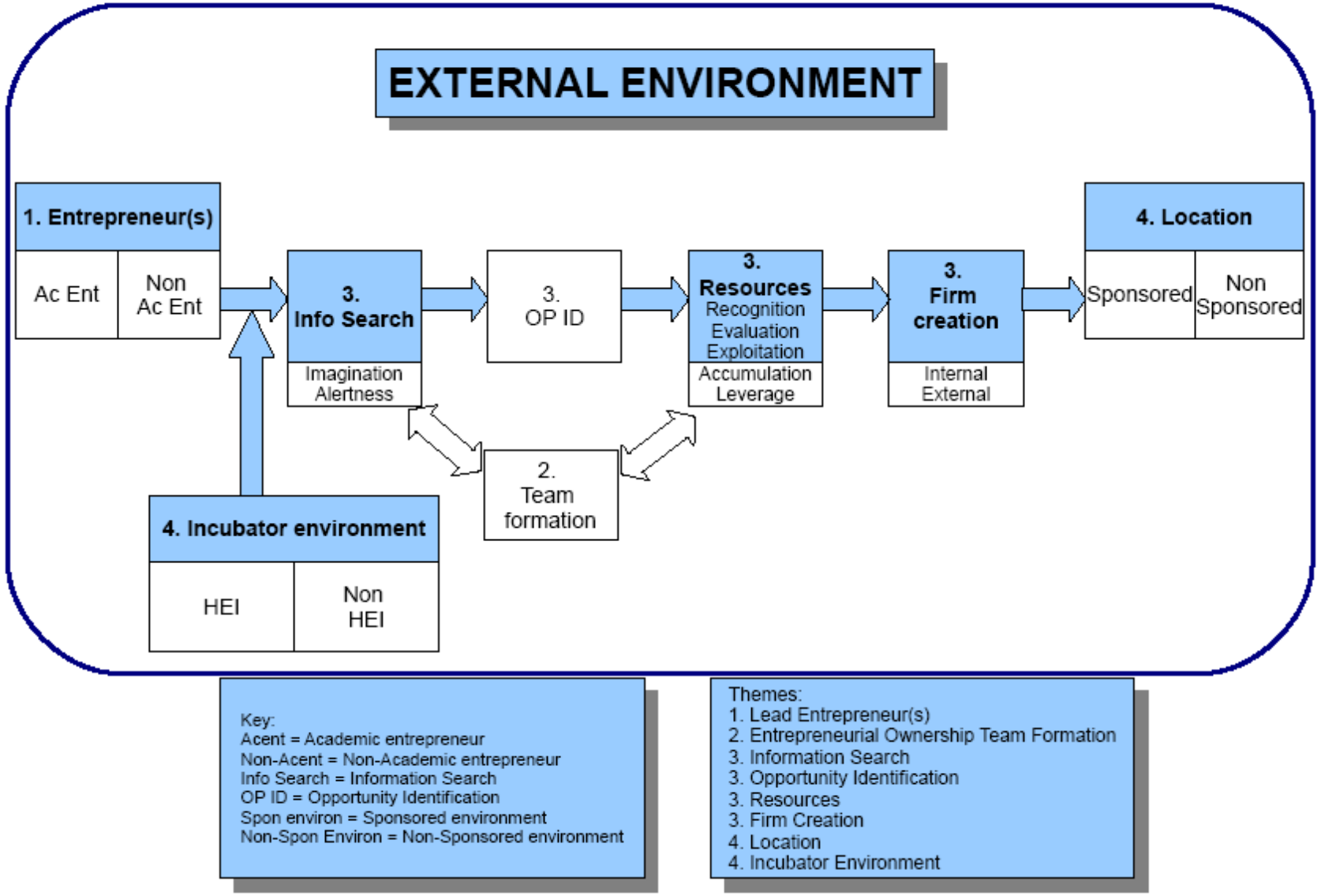
There is a long tradition of exploring the causes of firm formation. Traditionally, research has been 'outcome' driven based on cross-sectional methods and analysis which freezes processes and the people involved at one moment in time. Theories focusing on 'outcome' look for causes. This causal approach has been poor in generating theory. Change within the process has not been explained. This study will start with an opportunity-based conceptualisation of entrepreneurship, capturing a process driven procedure of change over time; a process encapsulating the identification of an opportunity, the individual(s) and the external environmental context (Bryant and Julien, 2001).

Following a conceptual framework, modelled around themes from the literature, this chapter introduces the main themes. Section 3.2 presents and summarises the model and themes. The human element is covered in Sections 3.2.1 and 3.2.2 which reviews the individual entrepreneur, team members, their human capital and their social embeddedness within their environment. The entrepreneurial process is outlined in Section 3.2.3. Section 3.2.4 covers the external environment whilst a summary is offered in Section 3.3.

3.2 Elements in the Conceptual Framework for Firm Formation

The conceptual framework is divided into four themes to include the lead entrepreneur(s), the entrepreneurial team members, resource inputs during identified components of the entrepreneurial process (i.e. information search; resource accumulation and leverage; firm formation decision) and the external environment (Figure 3.1). A dynamic rather than a static view of opportunity creation and exploitation will be presented. Thereafter, the conceptual framework is developed and used to structure and guide this study.

Figure 3.1: Conceptual Framework of the Firm Formation Process



Theme 1 deals with the intriguing issue of the lead entrepreneur, implying that this person may be different to the other entrepreneurial team members. The importance of the lead entrepreneur cannot be underestimated because they are the driver behind the identified opportunity and work towards their vision of owning and managing a firm (Ensley at al., 2000). Theme 2 explores the members of the entrepreneurial ownership team who may be made up of individuals directly known to the entrepreneur, those who hold equity and others who have advisory roles. If the lead entrepreneur is deficient in certain resources, team member recruitment may be one possible route to overcoming barriers associated with resource leverage. Strengths and weaknesses of team starts are presented. Encapsulating resources such as prior knowledge and experience, a resource-based view (RBV) of the firm and its importance in the opportunity identification process is presented. The process of opportunity identification involving information search, evaluation and exploitation encompasses Theme 3. Theme 4 discusses location and the influence of the external environment. The following sections look at each element individually.

3.2.1 Theme 1: Lead Academic and Lead Non-Academic Entrepreneurs

In this study, as stated in Chapter one, the working definition of a lead academic entrepreneur will be one who prior to or during the creation of a new firm was an academic, clinician or researcher affiliated to an HEI (Samson and Gurdon, 1993). The lead non-academic entrepreneur is defined as the person who was previously employed within the same industry sector and who used their knowledge of that sector to identify opportunities. The individual – opportunity nexus postulates that individual differences exert an influence over who identifies and exploits an opportunity (Shane, 2004).

Economic approaches to defining the entrepreneur have focused on explanations about the actions of entrepreneurs and their effect on the general economy (Galglio, 1997). However, the economic approach has been criticised for ignoring characteristics associated with the individual entrepreneur by focusing on what effects their actions have on economic development, not ‘why’ they act. The goal for economists is not to penetrate the “black box” or to understand the entrepreneurial action, only to reflect the effect of the action. Psychological and sociological approaches, on the other hand, have concentrated on ‘why’ entrepreneurs

do what they do. Within this approach, the entrepreneur becomes the unit of analysis and their traits (Aldrich, 1991) and characteristics become the key to explaining entrepreneurship as a phenomenon (Gartner, 1988; Shaver and Scott, 1991). The traits of entrepreneurs have been described in the literature as those associated with propensity for leadership, conformity, autonomy, independence, aggression, tolerance to ambiguity, need for achievement, locus of control and risk-taking (Üçbaşaran, 2004). The traits approach to entrepreneurship, growing from a body of thought centring on psychology in the 1960's, has been much criticised. A central criticism of this era has been aimed at the poor definition of entrepreneurship (Gartner, 1989). Methodological inconsistencies based on inappropriateness and ill defined samples led Chell (1985) to conclude that most of the studies based on the trait approach to entrepreneurship were inconclusive suggesting a low correlation between the assessment of the trait(s) and actual behaviour. In addition, defining the entrepreneur using attributes such as risk taking in the pursuit of opportunities without regard for available resources leads to confusion and tautology (Bruyat and Julien, 2000).

At an individual level the individual traits of academic entrepreneurs have also been examined (Radosevich, 1995; Samson and Gurdon, 1993). Motivational 'pull' and 'push' factors towards spinout firm formation, away from the HEI, have been attributed to needs for independence, challenge and financial reward (Roberts, 1991). The wish to apply results and to validate the usefulness of new discoveries whilst asserting independence, abating dissatisfaction with academic positions, and the attraction of greater financial reward have been cited as factors stimulating academics in the direction of firm formation behaviour (Smilor et al., 1990; Chiesa and Piccaluga, 2000; Shane, 2004). Although the presence of 'star' scientists has been positively associated with the creation of HEI spinouts (Di Gregorio and Shane, 2003; Powers and McDougal, 2005) it has been noted that a lack of business experience and management skills act as a potential barrier to the process (Radosevich, 1995; Samson and Gurdon, 1993; Vohora et al., 2004). From a human capital perspective, prior experience and contact with potential resource providers such as suppliers, business development agencies and potential customers has been attributed to increasing the success of spinouts from HEIs (Bower, 2003; Grandi and Grimalidi, 2003; Mosey and Wright, 2007). Having had prior contact with venture capitalists, for example, has been shown to increase the chances of support from these agencies (Shane and Stuart,

2002) and is seen as a form of instigating and developing strategic alliances (Carayannis et al., 2000). Prior joint experience with other academic entrepreneurs has also been highlighted as a factor leading to successful spinout behaviour (Grandi and Grimaldi, 2005).

Lead entrepreneurs have been defined by showing evidence of ownership (e.g. equity holding) and decision making capabilities and responsibilities for and within their firm (Ensley et al., 2000). Üçbaşaran (2004) and Üçbaşaran et al., (2003b) argue that classic entrepreneurial firms are associated with owners (i.e. principals) that combine residual risk bearing (i.e. ownership) and decision making (i.e. control) (Fama and Jensen (1983) cited in Üçbaşaran (2004)). Ownership rights have been seen as necessary for undertaking business ownership. In addition lead entrepreneurs have been seen as the individuals exploiting a product, process or technology for which they were responsible for developing. By converting their ideas into commercial opportunities they are creating value (Hindle and Yencken, 2004). Thus, lead entrepreneurs have stronger entrepreneurial vision (i.e. they see what is not there better than other entrepreneurs), and they have greater self efficacy (i.e. they have greater self confidence to act on their visions to make them real) (Ensley et al., 2000) compared to other entrepreneurs. Justification for identifying the lead entrepreneur as the principal unit of analysis in this study pertains to the fact that at the point of opportunity identification they may be the sole person with the technical information and vision to develop the idea. The lead entrepreneur becomes the starting point for the exploration. However, studies show that the establishment of knowledge-based firms are often developed by teams rather than by a single individual (Roberts, 1991; Chiesa and Piccaluga, 2000; Clarysse and Moray, 2004). An entrepreneurial team consisting of the academic inventor, other faculty members and / or experienced entrepreneurs has been found (Birley, 2002; Vanealst et al., 2006). The use of external experienced entrepreneurs (surrogate entrepreneurs), from out with the HEI, has also been a strategy used for the formation of spinout firms (Radosevich, 1995; Franklin et al., 2001).

3.2.2 Theme 2: Entrepreneurial Ownership Teams

Research questions two, three and four are formulated to explore recruitment of team members which is presented as Theme two in the conceptual model (Figure

3.1). For a lead entrepreneur with restricted knowledge, resources and skills the building of an entrepreneurial team might provide the lead entrepreneur with access to financial, social and human capital resources because of the diversity of its membership (Kor and Mahoney, 2000). If the lead entrepreneur does not possess exploitative resources to address resource deficiencies, he or she may recruit additional entrepreneurial ownership team members who have the requisite human capital profiles with regard to technical, managerial and entrepreneurial capabilities, business ownership experience, product / process and market knowledge, legitimacy and social capital contacts (Üçbaşaran et al., 2003a; Matlay and Westhead, 2005; Anderson et al., 2007). Faced with deficiencies in resources, team member entry is a viable option to pursue since entrepreneurs can fill skills gaps to facilitate the identification, evaluation and exploitation of an opportunity. There is a recognised dynamic input and interaction with different individuals throughout the opportunity identification process (Roberts and Malone, 1996; Chiesa and Piccaluga, 2000; Clarysse and Moray, 2004; Vanealst et al., 2006).

As the opportunity identification process expands, and complexities increase, so the centre of human capital resources for value creation may increasingly shift to the entrepreneurial team (Chandler and Lyon, 2001; Vohora et al., 2004). Perhaps a lead entrepreneur's human capital may have different degrees of significance at different phases of the entrepreneurial process (Birley and Stockley, 2000). Timmons (1999) extends this line of reasoning by assigning value to the lead entrepreneur who, seeking to strengthen their position, may choose a team start to capture a diversification of human capital. A team approach to firm formation may alleviate resource constraints and increase access to experience and expertise (Roure and Madique, 1986; Eisenhardt and Shoonhoven, 1990; Li and Zhang, 2002). Each member may bring different experiences (e.g. educational, functional, and industrial), which may be called upon. Considering that there are sub-sets of the identification process, it is speculated that a degree of heterogeneity of human capital could be advantageous to the lead entrepreneur during the process (Cooper and Daily, 1977).

The nature and composition of the 'entrepreneurial team' may therefore alter in response to the changing needs of the lead entrepreneur (Clarysse and Moray, 2004; Üçbaşaran, et al., 2003a). However, there is a gap in the knowledge base concerning

team membership. The literature is not enlightening about 'why', 'how', 'when' and at 'what phase' of development during opportunity identification lead entrepreneurs recruit team members to access, compensate and complement their own human capital endowment to assemble resources. The development of an entrepreneurial team (Kamm and Nurick, 1993) may therefore be seen as a resource which can lead to the accumulation of other resources to exploit new technical knowledge such as marketing knowledge (Grandi and Grimaldi, 2003). The knowledge resource held by the members of the entrepreneurial ownership team may be embedded in their human capital.

Research into team starts has generally been positive by indicating an increase in firm survival rates (Zimmerman and Zeity, 2002) and sales growth (Chandler and Lyon, 2001). The influence of an entrepreneurial team has been shown to have a positive influence on venture capitalists assessing business proposals (Cyr et al., 2000). Carter et al., (1996) exposing a number of start up behaviours found that the formation of start-up teams was a measure of serious intent by nascent entrepreneurs. Entrepreneurial teams are significant not only in their numbers within the life-science sector (Kamm et al., 1990) but also in their impact on firms' performance and growth (Cooper and Bruno, 1977). However, other studies have highlighted mismatches in human competencies between team members resulting in conflict and lack of cohesion (Eisenhardt and Bourgeois, 1988; Birley and Stockley, 2000). Potential strengths and weaknesses of team starts are presented in Table 3.1. Lead academic entrepreneurs also have additional peculiarities that make them distinct from other lead industry entrepreneurs. Previous research has shown that their entrepreneurial ownership team members, for instance, have been made up of people known to each other from their HEI work where often the lead academic entrepreneur acted as the technical project manager prior to start up (Clarysse and Moray, 2004). The entrepreneurial ownership team members, including the lead entrepreneur, have been found to have few contacts with non-technical people when they start a venture and show little industry experience (Cooper and Daily, 1997). Their human capital was homogeneous and social networks restricted. This is supported by the findings of Meyer (2003) who established that a common deficiency of science based start-up firms was a tendency to focus on technical aspects to the detriment of the business side. This indicates an over-reliance on technical specific human capital. He called for new academic

Table 3.1: Strengths and Weaknesses of Team Starts.	
Strengths	**Weaknesses**
Larger and more diverse access to human capital (Roberts, 1991; Roure and Madique, 1986; Üçbaşaran et al., 2004).	Human capital amongst members may not be complementary (Clarysse and Moray, 2004).
Human capital used to leverage social, financial and other forms of capital (Brush et al., 2001; Bergmann Lichenstein and Brush, 2001).	Mismatch of competencies over time between the team and firm requirements (Birley and Stockley, 2000).
Increased human capital is linked to increased productivity (Becker 1993a).	Difficulties in coordination and integration of team members may affect cohesion (Birley and Stockley, 2000).
Equity holders have incentive to leverage their human capital to enhance firm progress (Üçbaşaran et al., 2004).	No agreements needed over commitments of time, money, future direction, power etc. if the start is a solo start (Cooper and Daily, 1997).
Potential management of resources through entry and exit of members (Üçbaşaran et al., 2004).	Heterogeneity in top management teams linked with conflict but with fast decision making (Eisenhardt and Bourgeois, 1988)
Increases firm survival (Zimmerman and Zeitz, 2002) through cohesion (Ensley et al., 1999).	Future possibility of team member defection (Cooper and Daily, 1997).
Team size and therefore diversity of skills is correlated to sales and sales growth (Chandler and Lyon, 2001).	Academic entrepreneur may lack management skills to lead the team.
Ventures founded by teams more likely to survive (Cooper et al., 1994) because the greater human capital contributed to the increased likelihood of growth for their ventures.	Failure to clearly communicate goals between members can create problems and eventual "disaffection" between members (Timmons, 1990).
The entrepreneurial team is the single most important factor influencing professional investors to enter a firm (Cyr et al., 2000).	
Venture capitalists rarely consider a business proposal based on the talents of a single individual; rather, the skills of the entire venture team (Kamm et al., 1990)	

entrepreneurs to establish multiple partnerships in a variety of fields (e.g. financial, scientific, technological and international partnerships). Reasons for the entrepreneurs' narrow resource base may be attributed to a lack of social networks, restrictions in exposure to commercial acumen and expectations from the HEI environment which emphasise different skills to that required for entrepreneurship. For instance, the HEI environment promotes a 'publish or perish' culture amongst its members (Vohora et al., 2004) whilst opportunity identification leading to firm formation demands protection of ideas from competitors. This contradiction in expectation, although promoted through government initiatives (Etzkowitz et al., 2000; Shane, 2004; Mustar et al., 2006), creates challenges and barriers related to

opportunity identification, motivation for potential academic entrepreneurs to exploit an opportunity and access to advice and resources within the HEI for further commercialisation.

The complexity of barriers facing lead academic entrepreneurs in particular show some of the challenges involved in researching opportunity identification, evaluation and exploitation. The particular challenge of identifying 'where' resources may be found and accruing resources thereafter may be a function of 'why' they recruit entrepreneurial ownership team members or seek sources within their external environment. Hindle and Yencken's (2004) analysis of technological innovative start-ups indicated that resource accumulation did not come from one individual. The creation and exploitation of opportunities involved academics, students and other university staff. Individuals, not immediately connected to the HEI external environment, may also take on central roles in identifying opportunities. This highlights a concern which has not been fully addressed by the literature. 'Why', 'how' do lead entrepreneurs connect with such resource providers? This raises another debate within the entrepreneurial team literature. The definition of team membership has been inconclusively debated (Cooper and Daly, 1997; Ensley et al., 1999; Üçbaşaran et al., 2004). Studies focusing on entrepreneurial teams generally define team members in terms of status at start-up, ownership and control (Eisenhardt and Schoonhoven, 1990; Watson et al., 1995; Cooper and Daly, 1997). Others have defined entrepreneurial ownership team members as those with an equity stake in the venture and who have a key role in the strategic decision making of the venture at the time of founding (Üçbaşaran et al., 2003a; Cooney, 2005). However, as has been discussed, as well as equity holders, who have decision powers within the firm, there is also the role of non-equity holders to consider. These members may provide business advice or offer network contacts to other advisors. In this study, team members are broadly defined to encapsulate the lead entrepreneur, TTOs managing HEI transfers of IP to spinouts, surrogate entrepreneurs, members of research teams, business development officers from public or private bodies, venture capitalists, business angles and non-executive directors involved in the opportunity identification process. To this end, a different branch of research has begun to explore the value of 'outsiders' or network members to the entrepreneurial team and the entrepreneurial process. Ensley et al., (1999) reviewed the role 'outsiders' performed and the

profound influence they had on the development of firms. These "outsiders" or "privileged witnesses" (Vanaelst et al., 2006) included paid professionals, consultants, outside directors and business advisors who offered support systems and brought needed information and skills to the venture (e.g. they provided skills not available within the firm). The human capital they brought to the firm included specialised support (e.g. advisors for giving business advice, funding financial expertise, and marketing connections). In this study the role of both equity holding and non-equity holding team members will be explored.

3.2.3 Theme 3: The Entrepreneurial Process

This section is linked to the opportunity-based perspective of the general entrepreneurial process conceptualised to run parallel with the specific, practical entrepreneurial experience for opportunity identification, resource accumulation and exploitation leading to firm formation in the life-science sector. A link is drawn between individual lead entrepreneur's ability to search for relevant information leading to the identification of opportunities, and the various dimensions of lead entrepreneur's specific and general human capital to acquire new resources and combine them for the potential formation of a firm. This is portrayed in Figure 3.1 as Search for Information, Opportunity Identification and the Decision to Create a Firm (Alvarez and Busenitz, 2001) identified as Theme 3.

Entrepreneurial opportunities may be seen as those situations in which new, or previously unknown, goods, services, raw materials and organising methods are introduced and (potentially) sold at greater than their cost of production (Casson, 1982) or introduced through the formation of new means, ends, or means-end relationship (Eckhardt and Shane, 2003). Within the entrepreneurship literature there is a debate as to whether opportunities are discovered (Shane and Venkataraman, 2000) or whether they are enacted and developed over a period of time during the entrepreneurial process. In the life science sector, the opportunity is central because it involves formal research and for an academic entrepreneur the source of the opportunity is likely to evolve from HEI research. However, little is known about how HEI research becomes perceived as an entrepreneurial opportunity and how the academic entrepreneurs are able to convert and develop the research into a viable business concept. Shane (2004) intimates that technologies more likely to become

entrepreneurial opportunities are radical, tacit, early stage and early stage technologies with potential customer value which reflect strong technical advancement and that are protected by IP (Chiesa and Piccaluga, 2000; Nicolaou and Birley, 2003b; Pirnay et al., 2003). At such an intense level of research the product or service can only be utilised when codified in a manner that others can understand (Rogers, 2001). Since such a large share of the tacit knowledge is known only to the researchers, being included or central to the opportunity identification process seems paramount (Jensen and Thursby, 2001).

The exploitation of opportunities, processes and the individuals involved has been given more attention than opportunity identification (Busenitz et al., 2003). Less published research has focused on opportunity identification processes. The process through which knowledge is converted to commercial venture has been studied from an economic and psychological perspective. First, cognitive conceptualisations offer a logic where the individual create schemas that represent cumulative experience and these schemas (or mind maps) are used to help entrepreneurs focus on the most promising opportunities (Busenitz and Barney, 1997. Gaglio, 1997; Singh et al., 1999); second, there are incentives to incorporate (Reynolds et al., 1991); and third entrepreneurs identify opportunities through *awareness* (Kirzner, 1979) *creativity* (Schumpeter, 1976) and through what Shackle (1982) referred to as *imagination*. As stated already, this study involves itself more with the behaviour of entrepreneurs rather than their thinking. In addition, this study explores the discovery and pursuit of opportunities rather than the outcomes (e.g. performance). The setting in which these actions take place is outlined in two distinct market outlooks. The first acknowledges that most markets are inefficient (or in a state of disequilibrium) and provide some individuals with opportunities to exploit these inefficiencies (Kirzner, 1979). This is what Kirzner (1973) called *alertness,* where the logic presupposes that most opportunities are discovered through fortuitous circumstances because the ability to recognise an opportunity depends on the individuals unique knowledge set with respect to technologies and markets. This alertness allows the entrepreneur to develop insights into market trends where alertness is defined as "the ability to notice without search opportunities that have been hitherto overlooked" (Kirzer, 1979, p.48). The insight about the commercial value of the idea is the entrepreneurial opportunity. There is a flash of insight, which is superior to others governed by previous

'knowledge corridors' (Nelson and Winter, 1982). This suggests that there are variations in peoples' ability to be alert and that ability is determined by the individuals' human capital. Adopting an Austrian perspective, Shane (2000) found that individuals with higher levels of prior knowledge (i.e. part of their human capital profile), were more likely to discover opportunities. Thus, opportunity identification can be seen as the result of a collection and combination of personal, social, cultural and technological resources, which merge leading to the perception of a possible market (Fletcher, 2006). Opportunities are identified or created imaginatively by combining individual experiences and subjective understanding in a complex way. Kirzner's entrepreneur is therefore not only alert to information about the market but also aware of the commercial value of the information (e.g. aware of the market opportunities). Opportunities are also sometimes based on fortuitous manifestations rooted in the unique knowledge base of the entrepreneur which enables discovery when the entrepreneur is not actually searching (Shane, 2000).

The other premise holds that if markets reach a state of efficiency (or equilibrium), the status quo will be broken by enterprising individuals introducing new products, approaches or systems which will destroy the equilibrium (e.g. a process of creative destruction) (Schumpeter, 1976). These creative processing capabilities are what Schumpeter (1976) called *creativity*, where the logic is that searches for opportunities can be conducted only when relevant information about the technology and / or the market allows individuals to rationally define what they are seeking. The result of such processes is a continuous supply of lucrative opportunities and a supply of enterprising individuals seeking lucrative opportunities. Entrepreneurs' search for lucrative opportunities is influenced by an idiosyncratic dispersion of knowledge which is, in turn, influenced by individuals past experiences, occupation, on-the-job experiences and social relations, (e.g. specific and general human capital and social networks) etc. The possession of 'useful' information (and knowledge), based in their human capital, influences the search for and decision to exploit an opportunity. However, the need to make the connection between specific knowledge and a commercial opportunity requires another set of skills which may not be widely distributed. It has been found that two people with the same knowledge may exploit it differently. In the study of spinout firms from the Massachusetts Institute of Technology (MIT), for example, Shane (2000) found that prior knowledge of a

particular market increased the likelihood of entrepreneurs discovering an opportunity in that market. This perception indicates that the ability of entrepreneurs to accumulate and use new knowledge or experience is dependent on existing knowledge (Cohen and Levinthal, 1990). The implication is that entrepreneurs are able to combine both explicit knowledge (e.g. their formal technological knowledge from education and research) and other implicit knowledge acquired from elsewhere (e.g. information about markets). The empirical results offered by Shane (2000) confirm theoretical speculations (Venkataraman, 1997; Ardichvili et al., 2003) that different types of prior knowledge have an impact on the way opportunities are identified. Prior knowledge may, therefore, affect the entrepreneur's ability to recognise an opportunity because of exposure to different experiences (Shane 2000). Prior knowledge is crucial because it serves as a base for interaction with new experiences (Kolb, 1984) which in turn is used to understand and evaluate new stimuli (Cohen and Levinthal, 1990). From this neo-classical perspective, searches for opportunities can be conducted only when relevant information about the technology and / or the market allows individuals to rationally define what they are seeking. In addition, because there is time and resource costs involved with search and identification processes, entrepreneurs with more resources will be involved in more detailed search processes. As such, it could be argued that the ability of an entrepreneur to search for information about market and technology trends leading to the identification of an opportunity may be a function of both their human and social capital. The transferability of learned skills and networks from prior business ownership to the identification of a new opportunity (Cooper et al., 1989) may increase the desire to pursue the opportunity because learning, networking and experience may reduce the eventual costs of exploitation (Shane and Venkataraman, 2000).

3.2.4 Theme 4: The External Environment

This section explores the influence of the external environment on entrepreneurs' access to opportunities and resources and why they may rely on the external environment for resources. This is presented as Theme 4 in the conceptual model in Figure 3.1. The external environment, as an arena offering resources during the entrepreneurial process, may shape the creation and discovery of opportunities. For a resource deficient lead entrepreneur operating in a dynamic market, the development of resources is a process that will necessitate interaction with agencies in

the external environment (Delmar and Shane, 2004). The lead entrepreneurs' external networks may thus contribute to firm formation since social relationships mediate economic transactions, confer organisational credibility (Granovetter, 1985; Johannisson, 1998; Mosey et al., 2006) and promote strategic alliances facilitated by the presence of an entrepreneurial team (Birley and Stockley, 2000; Üçbaşaran et al., 2003a). Taking into account that external networks constitute access to the acquisition of resources and information (Nicolaou and Birley, 2003b), the accumulation of practical skills and expertise, including team formation, may be socially complex (Carpenter et al., 2001). Although a sponsored external environment may lower risks associated with under capitalisation, lack of information networks and liabilities of newness (Stinchcombe, 1965; Delmar and Shane, 2004), studies have disproportionately valued the sponsored environment for the birth and early survival of new firms and have assumed that firms remain in the same sponsored environment throughout their enterprise development.

Examples of a sponsored environment, open to entrepreneurs in this study, were science parks and HEI incubator units (Westhead and Batstone, 1998, 1999; Lockett et al., 2003a; 2003b). Such environments are described as supportive. In such an environment the new venture is dependent on external interactions to amass necessary resources and business information (Birley, 2002). External interactions may shape the creation and exploitation of opportunities by reducing uncertainty for inexperienced entrepreneurs (Etzkowitz et al., 2000; Vohora et al., 2004). Firms created by academic entrepreneurs, for example, may be attracted to the benefits of a sponsored environment to overcome barriers such as undercapitalisation in terms of finance and manpower and lack of information networks (Flynn, 1993; Mustar, 1997). Lead non-academic entrepreneurs, on the other hand, may have been exposed to prior opportunities to build up networks, knowledge and skills culminating in potentially more diverse human capital than lead academic entrepreneurs. Barriers facing academic entrepreneurs may be different to those encountered by non-academic entrepreneurs.

Lead academic entrepreneurs are likely to be employed in an HEI environment especially at the opportunity identification stage, whereas lead non-academic entrepreneurs may come from an industrial setting and be exposed to an external

environment dictating alternative measures of success and offering access to different resources. The initial differences in culture and working practice between industry and HEI environments is substantial and has been recognised as a potential barrier for academic entrepreneurs (Mustar et al., 2006) as they attempt to create an independent firm from their HEI.

Opportunities in the HEI setting are emerging from academic, publicly funded research, guided by academics who may operate to a different scale of priorities than their industrial counterparts. Some of these priorities may act as potential barriers to commercialisation. Priority of discovery and peer recognition for discovery is central to the working life of the academic. Commercialisation may be a sensitive area within the HEI (Ndonzuau et al., 2002). Past research has found that academic entrepreneurs offer a range of motivations and reasons why they form firms to commercialise their knowledge and change from one culture to another. Motivation has been expressed as an indication of seeking independence from HEI bureaucracy and as a source of fun (Smilor et al., 1990), as an indication of validating a new discovery (Shane, 2004) and as a way of demonstrating independence from the HEI to potential investors.

Other operational and attitudinal barriers towards academic entrepreneurs forming firms from HEIs have been identified (Mosey et al., 2006). Potential academic entrepreneurs may be working in an HEI environment where the HEI offers few contacts with the industrial world which may hamper the commercialisation of research through the formation of firms (Lambert, 2003). Academics need to enhance and understand the skills of entrepreneurship. Within the HEI environment TTOs have been exposed as having a poor understanding about legal and financial issues relating to the commercialisation of research and which was further hampered by a lack of their understanding of the HEI context which effected their interaction with potential academic entrepreneurs (Lockett et al., 2003).

Academic entrepreneurs are thus embedded within an HEI context at opportunity identification which may act as a facilitating environment or one which is constraining (Nicolaou and Birely, 2003a). The HEI context provides access to physical resources, such as laboratory space and specialised equipment (Main, 1997) and to specialist personnel (Smilor et al., 1990). As a resource provider the HEI is

seen to increase credibly of the spinout firms (Grandi and Grimaldi, 2003) and its academic reputation to have an impact on the rate of commercialisation behaviour (Di Gregorio and Shane, 2003). HEI policies and attitude towards the commercialisation of HEI knowledge also has a positive or negative effect on the process. Well defined HEI strategies in support of commercialisation (Lockett et al., 2003), access to willing surrogate entrepreneurs with prior commercialisation experience (Franklin et al., 2001) and early financial support in the form of HEI equity investment (DiGregorio and Shane, 2003) are found to encourage and support HEI spinout firm formation. HEI organisational support modes have been studied and the level of selection and support monitored. Levels of HEI support have been associated with high growth rates (Roberts and Malone, 1996; Druilhe and Garnsey, 2004; DeGroof and Roberts, 2004). Studies have returned mixed views on the effects of HEI policies towards supporting spinout development. Cultural and informational anomalies have influenced HEI policy towards offering support towards entrepreneurial endeavours (Franklin et al., 2001) whilst limited or negatives effects of these policies have been found to influence the commercialisation and spinout behaviour of academics (Meyer, 2003). Internal HEI institutional structures have also been found to have a negative effect on the spinout process by slowing it down (Steffensen et al., 2000). Physical property-based organisations like incubators (Autio and KLöfsten, 1998; Etzkowitz, 2002; Main 1996), technology transfer offices (Franklin et al., 2001; Lockett et al., 2003a; Lockett et al., 2003b) and science parks (Westhead and Storey, 1995; Siegel et al., 2003a, b) are reported to play an influential role in the stimulation and creation of spinouts.

The formation of networks in the form of innovative milieu, such as a science park, can provide a context in which the entrepreneurs and their firms access and acquire resources (Felenstein, 1994; Westhead and Batstone, 1999). Not only will the external environmental context offer access to tangible resources it may also, therefore, offer an opportunity of socialising through formal and informal network linkages. In addition, there are recorded advantages and potential linkages and learning opportunities from proximity to similar firms and organisations with a technology focus (i.e. cooperation with HEIs) (Westhead and Batstone, 1998; 1999).

3.3 Summary

The conceptual framework (Figure 3.1) allows for the observation of the entrepreneurial process prior to firm formation. First, in Themes 1 and 2 the importance of centring attention on the individual(s) involved in the entrepreneurial process prior to firm formation prioritises the entrepreneur as the unit of analysis. A human and social capital perspective gives insight into the resource base brought by the individual entrepreneurs and highlights areas of strength and weakness. Without the individual(s) there would be no identification of an opportunity or the formation of a firm.

Second, the conceptual model gives space to the investigation of the entrepreneurial process (Theme 3) through an examination of 'why' and 'how' entrepreneurs identified their opportunity for commercialisation and 'how' they potentially exploit their knowledge prior to the decision to form a firm. Accumulation of resources (human, social, organisational, information search, financial and physical) to overcome specific barriers to commercialisation is centred on how entrepreneurs accumulate and manage needed resources. Third, the general conceptual framework allows for the comparative examination of the two different types of entrepreneurs whose human resource profiles and access to social capital may be very different.

Finally, with Theme 4, the influence of the external environment is investigated to establish the importance of the environment on access to resources and to explore entrepreneurs' choice of location (i.e. on sponsored or non-sponsored environments) since it has been established that opportunity identification may be a function of the interaction between the individual and the external environment. Lead entrepreneurs may, for example, seek to maximise value or minimise their costs through their location decisions by researching the external environment for important resources. The importance of effective external networks lies not just in the reduction of transaction costs and the benefit of external economies but in the strengthening of local networks such as in a supportive environment (Flynn, 1993). Local networks have been recognised as a source of entrepreneurial learning with the focus on individual entrepreneurial learning rather than collective learning (Szarka, 1990). HEI spinout firms, for example, may be at risk from undercapitalisation in terms of finance and manpower but potential sponsorship in a supportive environment may lower risks

by developing links between the spinout and potential information and resource networks. Extant literature indicates that sponsorship is often directed at the formation of new organisations in high technology industries that operate in highly unpredictable markets (Flynn, 1993). Since resource acquisition is a major source of uncertainty for lead entrepreneurs, sponsorship may provide an increased amount of available resources and lower the level of environmental uncertainty. However, it has been noted that sponsorship, by reducing competitive disturbances and constraining the learning process, may produce unintended consequences by aiding the survival of organisations with potential weaknesses (Flynn, 1993). There is therefore the potential for a negative effect of 'benevolent dependence' resulting from sponsorship.

Extending the RBV of the firm (Barney et al., 2001b) to a RBV of entrepreneurship (Alvarez and Busenitz, 2001), this chapter has questioned how entrepreneurs build on their initial resource base (Brush et al., 2001) by exploiting their prior knowledge (Shane, 2000) through contingencies thereafter (McKelvie and Wiklund, 2004). These contingencies and in particular the entrepreneurs ability to identify opportunities may be influenced by the entrepreneurs access to specialised and general human and social capital (Becker, 1993a; Davidsson and Wiklund, 2000; Anderson et al., 2007).

Chapter 4: Research Methodology

4.1 Introduction

An interpretive research tradition was selected to explore the presented research questions. This study specifically focused on 'why' and 'how' issues. A qualitative methodology was employed to gain access to data and to inductively build theory. This chapter is structured as follows. Methodological and philosophical issues surrounding social science research are presented in Section 4.2. Research methods and instruments for gathering information focus on multiple case-studies described in Section 4.3. Section 4.4 summaries the development of the research framework including the formation of questions for the interview guide and selection of cases for the pilot and the main studies. Data storage and analysis, relying on a computer-assisted qualitative data analysis software package (NVivo), is also presented. Building theory from cases is outlined in Section 4.5. Section 4.6 offers a summary and themes for analysis in Chapters Five, Six and Seven.

4.2 Methodological Issues

My research aspiration was to compare my conceptualisation of the firm formation process (summarised as Figure 3.1) to the data collected from lead entrepreneurs and thereafter to amend or to build the model and the supporting theories. The conceptualisation grew from a review of the entrepreneurship literature associated with firm formation within the life science sector, especially firms originating from the HEI sector. This part of the methodology provided a preliminary theoretical framework about the nature and leverage of resources in general and the role of human and social capital in particular. The ensuing research was divided into two parts. First, I had to identify and distinguish lead academic from lead non-academic entrepreneurs; sponsored from non-sponsored external environments and young (i.e. those close to opportunity identification) from mature (i.e. those not close to opportunity identification) life science firms in a Scottish cluster. No literature existed which listed and differentiated the entrepreneurs or their choice of environment or the phase of their firm development.

An electronic survey of a life-science cluster in Scotland allowed the categorisation of entrepreneurs, their location and phase of firm development. A theoretical sample of life science firms was then established (Glaser and Strauss, 1968). Second, I gathered data from the people through semi-structured interviews about their skills, their connections, their location choices and their progress through the entrepreneurial process. For a comprehensive understanding of the roles and interactions within the process of firm formation, a qualitative methodological was deemed most appropriate. The aim of the research was to understand a process, not to measure contributions of key constructs. The goal was to collect data to build a complete picture of the formation of a firm (Gartner, 1985), over time, which included the entrepreneurs, team members, non-equity members, the process of resource leverage and accumulation and the entrepreneurs' interactions with the external environment set within their own 'natural' environment (Denzin and Lincoln, 1998). To achieve this an interpretive research tradition emphasising qualities of entities, the processes and meaning that occur naturally, capturing social actors' meanings and understandings of phenomena, was perceived to be fitting (Gephart, 2004).

Qualitative research, which is associated with an interpretive research tradition, "addresses questions about how social experience is created and given meaning and produces representations of the world that make the world visible" (Gephart, 2004, p 455). This approach allowed for an exploration of 'how' the participants in the research viewed their situation and 'how' they gave meaning to their experiences. Their understanding of what was happening was that which was subjectively experienced (Cope, 2005). Using the interpretive outlook my role as the researcher is viewed as one, not only to gather data and observe how often certain patterns occur, but to appreciate the different constructions and meanings that people put upon their experiences. My role in this dynamic research process is to entice data from the entrepreneurs and then to actively entice the data to talk though reflexive, inductive analysis. The research was data-driven (an inside-out view or a bottom-up driven process) prioritising the entrepreneurs' personal accounts. Such studies seek more interpretations and new associations such as preferences, associations and actions that are not easily described numerically and are specific to each case. Capturing the individual nature of each case can uncover a variety and complexity of experiences

which, if not observed phenomenologically, could be overseen or trivialised by a positivist study (Cope and Watt, 2000). Interpretive research thus inductively constructs social concepts using the words of social actors as the foundations of analytical induction (Gephart, 2004).

By interpreting phenomena in terms of the meanings respondents bring to them, qualitative research offers a detailed view that goes beyond surface appearances (Denzin and Lincoln, 1998). It offers a systematic method for constructing knowledge and reporting the respondents' opinions and views, in this case, to a series of open ended questions and replies on selected topics (Holstein and Gubrium, 2004). Explanations cannot be imposed before the phenomenon has been understood 'from within' (Cope, 2005). Data, which in this case relied on the words of the entrepreneurs, is rich, complex and subjective and thus makes it a good candidate for the generation of theories (Collis and Hussey, 2003; Eisenhardt and Graebner, 2007). For the purpose of this study, and reflecting a general criticism of the positivistic paradigm, it was deemed impossible to treat people as being independent and separate from their social context. Positivism can be referred to as an approach "which applies scientific method to human affairs conceived as belonging to a natural order open to objective enquiry" (Hollis, 1994, p.41). The lead entrepreneurs, however, could not be understood without examining their perceptions of their activities in relation to opportunity identification, team member recruitment and their rationale behind locating on sponsored and non-sponsored environments. To gather rich personalised descriptions of activities the highly structured research design, associated with the positivist paradigm, imposed potential threats to the results by not giving enough credence to the views of the individual entrepreneurs, thus ignoring potential relevant and interesting findings. The world of 'lived in' experiences does not correspond with the world of 'objective description'. Predictive knowledge gained from the construction of generalised laws which remain 'true' throughout time and space is not tenable within the interpretive research tradition (Guba and Lincoln, 2000). "Qualitative research can provide thick, detailed descriptions of actual actions in real-life contexts that recover and preserve the actual meanings that actors ascribe to these actions and settings" (Gephart, 2004, p.455).

The debate between paradigm stances is intense but the main concern for the research at hand was to identify the best tool for answering the 'why' and 'how' research questions posed in this study (Morgan and Smircich, 1980; Yin, 1989). Marshall and Rossman (1999) outlined three considerations behind overall research strategy choice (Mason, 2002) involving first, the identification of the form of research question being asked, whether it be descriptive, exploratory or explanatory; second, the type of event the research is investigating and third whether the phenomenon under study is contemporary or historical in nature (Yin, 1989). Miles and Huberman (1994) stated the "knowing what you want to find out leads inexorably to the question of how you will get the information" (Miles and Huberman, 1994, p.42). The interpretive approach was chosen over the positivist in this study because the nature of the research questions were exploratory (Miller and Glasser, 1998); because the event which the study covered was a process that involved changes relating to the opportunity, the people involved and the external environment; and because the study was approached from a longitudinal perspective, capturing a contemporary phenomenon, allowing for an examination of the continuous process of resource accumulation for opportunity identification leading to firm formation.

The research process thus encapsulated discovery (Hughes, 1990; Grant and Perren, 2002). A relativist stance was adopted such that the diversity of meanings is assumed to exist that influence people's understanding of the objective world (Gephart, 2004). The qualitative approach fitted better with the inductive form of research (Cope, 2005) and only after there was the systematic interpretation of the data was it used to generate propositions about the social context (Glaser and Strauss, 1968) for future research (Yin, 1984; Creswell, 1998). In other words, the aim of this interpretive research is to bring the essence of experiences to describe underlying reasons for outcomes (Burrell and Morgan, 1979; Cope, 2005). The focus of the inquiry is, therefore, located in the 'context of discovery' rather than the 'context of justification' (Guba and Lincoln, 2000) and aims to understand the subjective nature of the experience from the perspective of those who experience it by exploring the meanings and explanations that individuals attribute to their experiences (Gartner and Birley, 2002). The principal aim of the research is to go beyond the simple description and to work towards an interpretive explanation that will help account for the different

human and social capital resource profiles brought by lead entrepreneurs; 'why' and 'how' they dealt with anomalies in their resource bases and 'what' influence their location choices made to access resources. This was to ensure that description was balanced with analysis and interpretation (Patton, 2002; Suddaby, 2006) and ultimately to create theoretical propositions that were embedded within the chosen cases.

A longitudinal comparative multi case study approach (Eisenhardt, 1989) was considered better suited to study the broad research questions in this study investigating change, taking the people, the process and the context into account (Pettigrew, 1990). Studying a changing process and the interplay between concepts influencing access, accumulation and leverage of resources is better studied from a longitudinal perspective (Leonard-Barton, 1990). Hoang and Antoncic (2003) proposed that longitudinal studies are necessary to better understand the interplay between network development and entrepreneurship. Having identified the call from literature to follow a longitudinal perspective, few examples were actually found.

Whilst looking for details relating to the analysis of themes, data was examined and explored (Chell and Allman, 2003) through a process of constant comparison (Silverman, 2004) and analytical induction (Glaser and Strauss, 1968). Within case and between case comparisons were made to determine and distinguish emerging patterns of similar and dissimilar behaviour. Data from interviews were able to capture and make sense of many concepts that were relevant to opportunity identification leading to firm formation e.g. events, changing relationships, education, past experiences, thoughts, feelings and interpretations (Langley, 1999; Perren and Ram, 2004). Such data were capable of capturing patterns of events and processes leading to the formation of a firm and the barriers and facilitators of that process. To aid data analysis themes were identified from literature: the lead entrepreneur and team formation (i.e. networks, human capital, social capital); opportunity identification (i.e. information search, recognition, discovery, firm formation); the external environment (resource access, accumulation and leverage), and learning. Triangulation of data relied on multiple respondent interviews (Yin, 1989). Analysis was further influenced by the multilevel theoretical approach and emergent themes

associated with qualities and weaknesses of the theoretical approaches described earlier (e.g. qualities and weaknesses associated with the RBV of the firm, human and social capital theory) (Figure 2.6). The chosen theoretical perspectives linked to this study complimented the research approach because they allow for an inductive view of the data.

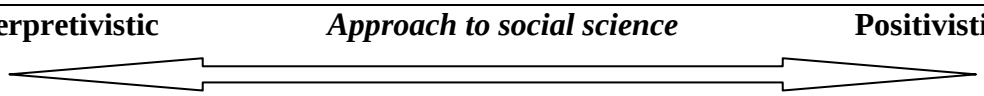
The aim of the research was thus to move beyond mere description towards an interpretive explanation (Patton, 2002) by encompassing the who, why, how and when (Van de Ven, 1989) in the complex process of opportunity identification and resource leverage leading to firm formation. Going beyond description by using theory as an underlying framework for both asking questions about the phenomena being studied and for probing the data for answers to those questions is recognised as important (Aldrich and Baker, 1997; Gartner and Birely, 2002) because "…when it comes to understanding the process of opportunity recognition, beyond descriptive mapping or linear models, understandings of how and why business ideas 'locate' with particular individuals at particular points in time are still fairly under-developed" (Fletcher, 2006, p.436). Looking for causal relationships encompassing the identification of an opportunity and the subsequent development of a firm may not be sufficiently explained by simply describing necessary conditions associated with the external environment but may be subject to individual influences of or access to resources. Observing the changing process leading to firm formation may reveal patterns that are necessary, although not sufficient for new firm formation. The formation of the firm is thus a social process which develops over time and within a particular external environmental contextual setting. As noted by Fletcher (2006), cultural, technological and societal changes affect human and organisational life in such a way as to make a particular study dependent on the time, place and human influence of that study.

4.3 Case Studies

There are a number of research methodologies, some of which lend themselves more favourably to one paradigm than another. In Figure 4.1, different methodologies are listed under two main paradigms. As Collis and Hussey (2003) indicate, the two paradigms are at extremities of a continuum and each methodology may move along

the continuum according to researcher's philosophical assumptions. Although there is an array of qualitative methodologies including, ethnography (Humphreys, 1999), critical incidence (Chell and Allman, 2003), case studies (Eisenhardt, 1989; Yin, 1989; Stake, 1998), grounded theory (Glaser and Strauss, 1968; Strauss and Corbin, 1998) discourse analysis, focus groups, history, interpretive practice, participatory action research and clinical research (Hindle, 2004; Perren and Ram, 2004), a case-study method was appropriate for this study for a number of reasons.

Figure 4.1 Methodological assumptions of the main paradigms



Associated methodologies	***Associated methodologies***
Action research	Cross-sectional studies
Case studies	Experimental studies
Ethnography	Longitudinal studies
Feminist perspective	Surveys
Grounded theory	
Hermeneutics	
Participative enquiry	

Adapted from Hussey and Hussey, 1997, p59.

First, case-studies can be used to provide descriptions, test theory or, as in this study, generate or build theory (Eisenhardt, 1989). Second, the case-study is not a methodological choice but an indication of what is to be studied (Stake, 2000) and may be defined as an "empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (Yin, 1989, p23). This study focused on comparing two different types of entrepreneurs (e.g. academic and non-academic) during the process of identifying opportunities, recruiting team members and choosing external environments as a means of leveraging resources for firm formation. Third, "the case-study approach allows the researcher to examine the phenomena of interest within its context, to tease out, trace, and recreate mechanisms that connect events and relationships" (Chell and Allman, 2003, p.130). Fourth, a case-study thus gives scope to seek information about

a process because it is an extensive examination of a single instance of a phenomenon (Collis and Hussey, 2003) or "a research study which focuses on understanding the dynamics present within a single setting," (Eisenhardt, 1989, p.534).

Case-studies have been labelled as exploratory research, used in areas where there is little knowledge or few theories. However, several different types of case-study have been identified. There is the intrinsic case-study undertaken solely to understand a particular case; the instrumental case-study examines insights into an issue to draw generalisations and the collective case-study is an instrumental study extended to several cases (Stake, 1998). For the latter, "they may be similar or dissimilar, redundancy and variety each important. They are chosen because it is believed that understanding them will lead to better understanding, perhaps better theorising, about a still larger collection of cases" (Stake, 1998, p. 437). White (1992) categorised case-studies for identity, explanation and control. Hussey and Collis (2003) offer further categorisation, outlining case-studies to be exploratory research which may consist of descriptive, illustrative, experimental or explanatory elements. Each is used for different purposes (Table 4.1).

The notion of the intrinsic case (Table 4.1) has been attributed to Stake (1998) and fits with an objective perspective because the purpose of the intrinsic case-study is not to come to understand some abstract concept but to undertake the study because

Table 4.1 Types of case-studies

Intrinsic	Undertaken to understand a particular case
Instrumental	Examines insights into an issue to draw generalisations
Collective	Extends to several cases
Descriptive	Objective is to describe current practice
Illustrative	Illustrates new and possibly innovative practices adopted by particular companies
Experimental	Perhaps examines the difficulties in implementing new procedures in an organisation and evaluating the benefits
Explanatory	Existing theory is used to understand and explain what is happening

of interest in the case (Stake, 1998). Instrumental cases, however, fit with the subjective perspective, where a particular case is examined to provide insight into an issue or refinement of theory (Stake, 1998) (Table 4.1). A parallel could be drawn between this explanation and the 'exploratory' (subjective) and 'explanatory' (objective) cases outlined by Yin (1989) and between the 'descriptive' and illustrative'

(subjective) to the 'experimental' and 'explanatory' case-studies (objective) (Table 4.1). However, the taxonomies are not clear cut and some overlap exists between the subjective and objective perspectives. Exploration and explanation best describe the intent of this multiple case-study study each reflecting a unique history of past or current events, drawn from multiple sources of relational evidence concerning the people, the things they said, the external environment, involved institutions and the knowledge and experiences held by the people, over time (Leonard-Barton, 1990).

There are, however, criticisms specifically against the case-study method. There are the pitfalls of complexity and the sheer quantity of information. To avoid being labelled as inaccurate, biased and imprecise the researcher must be accountable for the claims and quality of the data. The case-study, for example, should be systematically and rigorously conducted to account for human subjectivity. In this study I tried to standardise my face-to-face approach and after initial introductions, guided the respondents into the interview. Often the interview flowed according (more or less) to the interview guide with minimum prompting. At other times respondents opted to talk of other issues or to pass comment on my proposed research. At these times, the importance of good listening skills and courtesy allowed the respondents to pass comment or judgement. It could have been easy to allow personal views and influences to direct the findings especially in cases where respondents were highly critical. To account for these weaknesses, the case-studies were conducted strategically yet with built-in flexibility based on the challenges faced in each individual circumstance in which the research took place. The role of subjectivity was accounted for by critical self-scrutiny on behalf of the researcher and active reflection (Mason, 2002). I did not make judgemental comment on respondents' criticisms of their HEIs, business development agencies, venture capitalists, lead entrepreneurs or of myself in one case where I probed for some evidence of management skills in a team made up of academics. I recognised that interviewees' responses could be influenced by my own bias or bias created by me in the interview setting. In this case, bias referred to the ways I could have distorted data due to my own theories, values, agendas or pre-conceptions. On another occasion, when I was asked if I would like to buy shares in one project I had to make clear to the lead entrepreneur that my role was a researcher and not a potential investor. In another I detected some degree of

discomfort and a lack of full transparency. These observations were sparked by an over zealous optimism on half of a lead entrepreneur. My suspicions were confirmed by information given by one team member near the end of his interview. I therefore noted the variance that I might bring to the study. Notwithstanding, a research framework was designed to make transparent the research process.

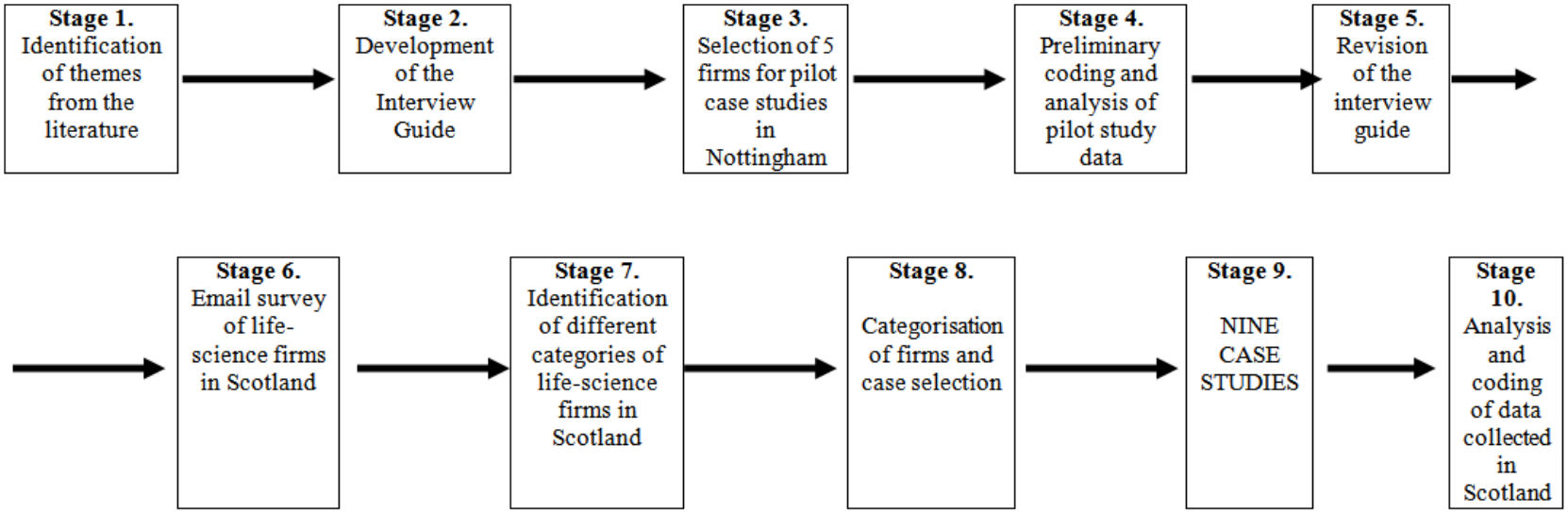
In addition a debate has arisen as to whether a single case-study has more or less attributes than a multiple case-study approach (Eisenhardt, 1991 versus Dyer and Wilkins, 1991). Central to the debate is the role of methodological rigour stressing the importance of the composition of the research questions; the design of the research instruments; theoretical and sampling controls; and the creation of precise and measurable constructs in relation to multiple case-studies (Eisenhardt, 1991) as opposed to the story telling benefits and "thick description approach" (Geertz, 1973) of a single case-study (Dyer and Wilkins, 1991). It has been argued that the complex description of a specific case, however, is less concerned with the development of generalisable theory. As a precaution, a single case-study was dismissed because of the limits in generalisability and potential bias (Eisenhardt and Graebner, 2007). A multiple case approach was preferred to argue external validity and help guard against any bias I might bring. Additionally, each case was selected, as Yin (1989) stated, to either predict similar results (e.g. a literal replication) or produce contrary results but for predictable reasons (e.g. a theoretical replication) (Yin, 1989). Within this study there was an opportunity for within and across case comparisons. Working with the evidence from multiple case-studies forces researchers to seek new insights resulting in a theory building exercise which "attempts to reconcile evidence across cases, types of data, and different investigators, and between cases and literature *(to)* increase the likelihood of creative reframing into a new theoretical vision" (Eisenhardt, 1989, p.546). The emphasis on comparisons between cases allows for replication logic (Eisenhardt and Graebner, 2007) where each case-study serves as a replication, contrast and extension to the emerging theory. The early formation of research questions, "tightly scoped within the context of existing theory" (Eisenhardt and Graebner, 2007, p26) allowed an exploration of access and influence of accumulated resources across all cases. In addition, because these multiple cases offer varied data based on respondent triangulation, the propositions were considered more robust. The

multiple approaches also enabled a broader exploration of the research questions because the study was a comparative one.

4.4 Research Framework

Several stages were considered in the data collection process. The research process included stages such as the selection of cases, preliminary investigations, data collection analysis and reporting (Siegel et al., 2001; Collis and Hussey, 2003). Stake (1998) also outlined a summary of the major conceptual responsibilities for the researcher as conceptualising the object of study; selecting research questions; triangulating key observations and bases for interpretation; selecting alternative interpretations to pursue and developing generalisations and assertions about cases. Eisenhardt (1989) provided an outline for the structure of study and stressed the importance of defining research questions; case specification; flexible instrumentation; cross-case analysis and tactics; overlap of data collection and data analysis and use of literature. Figure 4.2 outlines an overview of the data collection process. Although shown as a linear model the process of conducting the research was not so rigid. The purpose of such an explanation is to clarify the unit of analysis, come to terms with time, identify analytical themes, be precise about the techniques of data collection and display and make explicit the theory of method. Having well defined research goals and questions and recognising the strengths and limitations of the chosen method of research also have implications for the level of analysis. The overall process of capturing the complex reality of opportunity identification and subsequent search for resources is covered in Stages 1-10 in an effort to both simplify and make open the research process. Crucially, the stages cover many of the key elements in the research process – from the development of research questions related to gaps identified in extant literature in Stage 1, to outputs and the creation of propositions for future research in Stage 10.

Figure 4.2: Stages in the Data Collection Process



Key:
Stage 1. Themes identified from literature (2003) (Opportunity Identification; Team Membership; External Environment; Learning).
Stage 2. Development of the Interview Guide (2004).
Stage 3. Pilot study conducted in Nottingham (2004).
Stage 4. Preliminary coding and analysis.
Stage 5. Revision of the interview guide.
Stage 6. Email-survey of companies in the Life-science sector in Scotland (2004).
Stage 7. Identification of different categories of Life-science firms in Scotland.
Stage 8. Categorisation of firms and case selection.
Stage 9. Nine Case Studies in Scotland (2005).
Stage 10. Analysis and coding of data collected in Scotland.

4.4.1 Stage 1: Themes Identified from Literature

Recommendations for generating or building theory from data ask for an early establishment of research questions to focus and guide the study (Easterby-Smith et al., 1997). This is done to control the volume of information. Research questions in this study, following the recommendations of Strauss and Cobin, (1998), were grounded in the literature surrounding the initial themes of interest based in opportunity identification, team formation and the external environment as illustrated in the contextual framework in Chapter 3 (Figure 3.1). During the process of conducting a literature review, based broadly around the topic of the commercialisation of knowledge from HEIs, several areas of interest, empirically, conceptually and theoretically emerged. The phenomenon of 'why' and 'how' entrepreneurs leverage resources to identify an opportunity and to thereafter form a firm came to the fore. Lacking in resources, entrepreneurs were found to accommodate their deficits through team formation or from sourcing resources from their external environmental context. However neither had been studied specifically within the realms of a comparative study focusing on lead academic and lead non-academic entrepreneurs within the life-science sector. This was not done, however, to the exclusion of the possible emergence of new themes that might arise during the data collection process. The core themes guiding this study, the factors influencing the identification and selection of the opportunity, the recruitment of team members and the external environment, evolved from an extensive literature review outlined in Chapters 1 and 2 (Stage 1: Figure 4.2). None of the identified themes were considered in isolation. The subsequent data collection process and analysis was guided by the research questions and data collection research framework.

4.4.2 Stage 2: Development of the Interview Guide

Stage 2 for the fieldwork entailed designing an interview guide and conducting pilot case studies to test the questions using face-to-face interviews. The design and development of the interview guide was also directed by the themes identified from and grounded in the literature and also linked to the theoretical insights directing the study (Table 4.2). The questions in Section 1 pertaining to opportunity identification were related to the human capital perspective and social capital. Theoretical perspectives relating to Section 2, team formation, were dominated by a human capital perspective but access to people was linked to resource dependency. The RBV was

associated with developments in section 3, the external environment. Section 4 revolved around issues of entrepreneurial learning and was linked to the human capital perspective. Every effort was made to keep these questions "open-ended" because this approach was deemed important for inductive study and to elicit from the participants their interpretation of given situations. Table 4.2 outlines the questions in the initial interview guide.

Supporting prompts, sourced from the literature, encouraged the interviewees to talk about their experiences, limitations, frustrations and successes in opportunity identification and exploitation during the entrepreneurial process (Appendices 1, 2, 3, and 4). This was done to control the volume of data and as a control over the time to adequately cover all topics (Patton, 2002). Respondents in the life-science sector were inevitably pressed for time and such an approach was appropriate for eliciting responses with as little interruption to the respondent's routine as possible (Patton, 2002). The interview guide acted as an aide memoir (Appendix 5). Flexibility was ensured to enable participants to air concerns about topics which they deemed important but not covered in the interview guide. This proved particularly important in connection to changes in the external environment.

Table 4.2: Development of the interview guide	
Questions	**Type of question**
Section 1: Opportunity identification	*Theoretical perspective*
1. What factors influenced the identification and selection of the commercial idea (opportunity) behind the spinout firm?	How *Human and Social Capital*
2. What factors influenced the decision to form the spinout firm?	Why *Human and Social Capital RBV*
3. What factors (people and events) hindered the decision to form the spinout firm?	Why *Human and Social Capital RBV*
4. What challenges were faced when forming the spinout firm?	How *RBV*
5. What influence did the university (parent organisation) have in the process of forming the spinout firm and commercialising the idea?	How *RBV*
Section 2: Team formation	
6. What people assisted in the formation of the spinout firm?	Why *Human and Social Capital*
7. What factors influenced the access to people to assist in the formation of the spinout firm?	How *Human and Social Capital*
8. What factors in your past work/education/training experience have influenced your ability to assist in the formation of a spinout firm?	Why *Human Capital*
9. What factors influenced the changing composition of the people in the firm e.g. (entry) recruitment or (exit) dismissal of the people who assisted in the formation of the spinout firm?	Why & How *Human and Social Capital*
Section 3: External environment	
10. What factors influenced the decision to establish the spinout in this environment?	Why *Human and Social Capital*
11. When did the move occur?	When and where
12. What challenges were faced when moving from the parent organisation to this environment?	Why *RBV*
13. What advantages are gained for the spinout firm from this environment?	How *Human and Social Capital*
14. What disadvantages are experienced for the spinout firm from this location?	How *RBV*
15. Did the spinout firm use office space and laboratory equipment from the (university) parent organisation at formation?	Why *RBV*
Section 4: Entrepreneur Learning	
16. What problems have you faced during the formation of the spinout firm and what and how did you learn from them?	How *RBV Human and Social Capital*
17. Would you have done anything differently?	Why *RBV Human Capital*

The interview guide comprised of four main sections: Opportunity Identification, Team Formation, External Environment and Learning. The first section

contained questions about factors such as people, events and promotions that influenced the identification and selection of the commercial idea. Section 2 was focused on the team members and 'why' and 'how' they were recruited and from where. Section 3 related to reasons for locating on sponsored or non-sponsored environment and access to resources thereafter. The final section probed for information concerning how and a reflection on what the entrepreneur had learned. The research questions are identified through correspondence with those in the interview guide (Table 4.3).

Table 4.3: Correspondence of Research Questions to those in the Interview Guide.

Research Questions	**Interview Guide Question**
1.'How' different are lead academic and lead non-academic entrepreneurs' initial resource profiles?	1,2,3,4,5
2. 'Why' do academic and non-academic entrepreneurs form entrepreneurial ownership teams?	6,7,8,9,10,11
3. 'How' do academic and non-academic entrepreneurs form entrepreneurial ownership teams?	6,7,8,9,10,11
4. 'Where' do lead academic and lead non-academic entrepreneurs form potential entrepreneurial ownership teams?	10,11,12,13,14,15
5. 'How' do academic and non-academic entrepreneurs identify opportunities for creating a firm?	1,2,3,4,5,6,7,
6. 'What' types of opportunities do lead academic and non-academic entrepreneurs identify?	1,2,3,4,5,6,7,16,17
7. To what extent are opportunity identification and exploitation activities related to the actual and perceived human capital characteristics of the entrepreneur/ entrepreneurial team?	1,2,3,5,7,8,9,10,11
7. To what extent are opportunity identification and exploitation activities related to the actual and perceived social capital characteristics of the entrepreneur/ entrepreneurial team?	1,2,3,5,7,8,9,10,11
9. 'How' does the external environment impact on the entrepreneur/entrepreneurial team's access to resources?	12,13,14,15,16,17

4.4.2.1 Semi-structured In-depth Interviews for Data Collection

The in-depth, or phenomenological (Cope, 2005) interviews necessitated a careful capturing of 'how' people experience some phenomenon –'how' they perceive it, describe it, feel about it, remember it, talk about it and make sense of it. To gather such information requires the undertaking of an in-depth interview with the people who have experienced this directly (Patton, 2002). The rationale for interviewing more than one person per organisation, using general observation and company literature, especially web sites, allowed for triangulation and confirmation of data. The richness of the ensuing data allowed for the inductive conceptualisation of opportunity identification and team recruitment within the context of sponsored and

non-sponsored environments. Although interviewing was conducted using a guide, when new themes emerged, adjustments to the questionnaire allowed further probing (Eisenhardt, 1989). This is considered acceptable in studies which focus on theory building because the researcher is trying to understand each case individually and with as much insight as possible. This opportunistic approach was taken advantage of to enhance themes supporting the emergence of resultant theory.

Semi-structured, in-depth interviews aim to give a rich picture of research description (Van Maanen, 1983; Silverman, 2004) and account of the perceptions of the interviewee. The purpose of qualitative interviewing (Patton, 2002) is to capture how those being interviewed view their world, to learn their terminology, perceptions and experiences (Miller and Glasser, 1998). Methodologically, the qualitative interview "stresses the importance of letting one's subject unfurl its nature and characteristics during the process of investigation" (Burrell and Morgan, 1979, p.6). With this openness comes perspectives, information and ideas not documented in earlier research (e.g. reasons 'why' and 'how' lead entrepreneurs changed their external environments). By sharing the subjective views of the interviewee, the researcher tries to make sense out of what is said. Meaning is not merely elicited through apt questioning; it is "actively communicatively assembled in the interview encounter. Respondents are not so much repositories of knowledge as they are constructors of knowledge in collaboration with interviewers. Participation in an interview involves meaning-making work" (Holstein and Gubrium, 2004 p.141).

The emergence of meaning-making activities of groups and individuals (Morgan and Smircich, 1980) are of central interest to interpretive researchers, "simply because it is the meaning-making/sense-making/attributional activities that shape reality or validity and make sense of their worlds" (Guba and Lincoln, 2000, p.167). Not only are people the primary data source they also provide the 'insider view' rather than an imposed 'outsider view' (Mason, 2000). Each case-study is thus embedded in its own historical, social, political, and personal contexts and is focused on their own circumstantial uniqueness (Collis and Hussey, 2003). The interview becomes the productive source of the knowledge (Kvale, 1996). In this research entrepreneurs talked about past experiences, their reasons for choosing a certain

action, their reason for recruiting a certain team member and the rational behind a choice of external environment. This process allowed for more complex and varied descriptions to be ascertained for analysis (Fontana and Frey, 1994).

4.4.2.2 Interview Criticism

There has, however, been criticism of interviews as a data collection method. They have been criticised as being false and limited to being 'context specific' to fit the 'reality' created in the interview "in which both participants create and construct narrative versions of the social world" (Miller and Glasser, 1998, p.99). When eliciting entrepreneurs' perceptions about 'why' and 'how' they did something it was difficult to perceive whether they attached a single meaning to their experiences (Silverman, 2004). If someone else other than the researcher, for example, had asked the question would the response have been different? The responses from the individual entrepreneurs and team members were treated as narratives which included not only an expression of experiences but also actions which required analysis (Holstein and Gubrium, 2004; Silverman, 2004).

Throughout the study, reliability and validity of interview data presented specific challenges. Documentary evidence and direct observation were two other tools used to supplement data from the qualitative interviews. The aim of triangulation is to gather different types of information that might be cross-tabulated. This reduces the risk that conclusions reflect systematic biases or limitations of the interview method of gathering data. The interviews, for example, were supplemented with documents offering factual information about individual firms and, to a lesser extent, complemented by direct observation during the actual interview process. When I was invited to interview three members within the same organisation the interviews tended to happen on the same day, which allowed some time for observation of group processes. In addition, to give depth to understanding, other data sources were used to establish a line of interlinking evidence. These included government documents, internal documents, publications, web sites, moods within the interview settings; the atmosphere in the environment, seeing working conditions first-hand and observing informal / formal meetings (Yin 1989; Miles and Huberman, 1994). On two occasions I was shown a prototype of a potential product and on all

occasions the ‘feel good factor’ could be gauged from the general atmosphere of the interview setting. In an attempt to verify accounts of interviews, web sites confirmed data such as dates of founding, addresses, changes of addresses, and contact names and numbers. Company status and members was confirmed from documents of accounts from Companies House (www.companieshouse.gov.uk) whilst a few companies produced additional literature presented at interview. One company asked me to sign a confidentiality clause. In retrospect, better use may have been made of the archival material on each company and a corroboration of archival material presented. This type of material, for example, could have been put to better use to identify past and present team members. On the whole, however, this research relied on key informant triangulation.

Using respondent triangulation infers that sets of responses can be checked by collecting and comparing responses from others. Interviewing an array of team members involved exploring their multiple perceptions to clarify meaning and verify observations or interpretations. By adopting this perspective it served to clarify meaning by identifying different ways the phenomena of team membership was seen, opportunities perceived, location chosen and lessons learned. Respondent triangulation was a means of checking not only the integrity of the inferences drawn from the data but also a means of discovering which inferences were valid and consistent or inconsistent (Hammersley and Atkinson, 1983; Silverman, 2004). Conclusions were thus examined from more than one vantage point (Schwandt, 2001). Resulting themes were, therefore, both grounded in the literature and evolved as the data revealed itself. Reliability was not fully focused on replication but on dependability (e.g. there was an agreement by all parties that the data made sense). Reliability was further improved through use of an internal research audit trail to make transparent how the data was obtained.

Reactivity, on the other hand, was more difficult to control. Within the interview situation what the interviewee says is always a function of the interviewer and interview situation. Neutrality of influence is an impossible goal. “What is important is to understand *how* you are influencing what the interviewee says, and how this affects the validity of the inferences you can draw from the interview”

(Bickman and Rog, 1998, p.92). Strategies were therefore put in place in anticipation of these threats to validity and reliability. Interviews were sought, as explained already, from three members of the same firm to elicit a degree of respondent triangulation. The interviews were sought from the three respondents within their own office / lab setting and on the same day. Respondent triangulation was gathered for cross checking data. In this respect triangulation acted as a kind of navigation tool for surveying the data (Hammersley and Atkinson, 1983). To promote triangulation and reliability, although the lead entrepreneur was the 'primary unit of analysis' (Miles and Hubberman, 1994) and a 'boundary' (Stake, 1994) set around the lead entrepreneur, the specific people consulted went beyond the lead entrepreneurs and included the supporting entrepreneurial ownership team members. A recognised concern in designing and conducting case-studies is the setting of a boundary around the unit of analysis and deciding what elements be include and which be exclude. How the boundary is set, and how the case is defined, and at what stage of the research process these definitions should be made, is also open to question. Stake (1998), for examples favours early well-defined boundaries. Ragin (1992) argues that such strict conceptual development early in the research may be restrictive whilst Miles and Huberman (1994) suggest that the researcher think intuitively, think of the focus and build outwards to define the case as early as possible. In this study the lead entrepreneur was the unit of analysis and a boundary imposed early in the study.

Although the entrepreneurs and team members offered data in real time on two occasions there was the barrier of retrospection and inaccuracies of recounting past events whilst recounting the opportunity identification phase. The entrepreneurs re-called their experiences about the opportunity identification phase retrospectively. A fuller understanding, it is argued, can only be achieved by experiencing the contexts of events to which the respondent refers in 'real time'. Experiencing the actual point of opportunity identification, in 'real time', was not possible. In this study, a recognised limitation of retrospective data is the difficulty in determining accuracy of recall and cause and effect from reconstructed events. Although studies have shown that participants in organisational processes tend not to forget key events (Leonard-Barton, 1989) it is difficult to gauge the accuracy or importance attached to the process of opportunity identification by the individual entrepreneurs. "Therefore, whereas

multiple retrospective studies increase the external validity of a research design, a longitudinal, real time study can increase internal validity by enabling one to track cause and effect" (Leonard-Barton, 1989, p. 250).

Notwithstanding, reflection of the opportunity identification process allowed the uncovering of the logistics which gave the event meaning and significance. Understanding the logistics in a process of change "requires data on events, interpretations of patterns in those events, when they occur in socially meaningful time cycles, and the logics which may explain how and why these patterns occur in particular chronological sequences" (Pettigrew, 1990, p. 273). The logistics, inherent in this research, covered the recruitment of entrepreneurial ownership team members, changes in external environment locations, mapped over three points in time. Using the critical junctures model, outlined in Chapter 2, three of the identified junctures are used in this study to pinpoint the entrepreneurial process in general and resource requirements at these phases in particular (Vohora, et a., 2004). None of the firms in this study had reached the venture sustainability phase. The first point in time, opportunity identification, was discussed retrospectively whilst conducting the interviews for data collection in 2005. The second, entrepreneurial commitment was mapped during an electronic survey of firms conducted in 2004, whilst the third, venture credibility, was recognised and noted during face-to-face interviews in 2005. Only two out of the three reference points were captured in 'real time'.

4.4.3 Stage 3: Pilot Study

For the pilot study, 'snowballing or chain sampling' (Patton, 2002) for a 'convenience sample' was used to identify life-science firms from contacts known to me. Hence, for the pilot, all the cases were chosen from a personal network in and around the University of Nottingham (UK). A convenience sample of four life-science firms based in and around Nottingham was selected to test the interview guide. The selection of ten interviewees within the four firms was based on a conscious effort to target major decision makers and equity holders. As outlined in Chapter 1, the working definition of the lead academic entrepreneur was an academic or researcher whose occupation, prior to playing a lead role in an enterprise start-up, and possibly concurrent with that process, was that of an academic, clinician or researcher,

affiliated with an HEI. The non-academic entrepreneur was defined as a person who had previously been employed in the same industry sector and who used their knowledge of that sector to identify opportunities. Team members were those who held equity within the firm, or were representatives of equity holders, such as a TTO working on behalf of an HEI who held equity, and who had decision making powers. The firms represented a cross section of different life-science firms from different backgrounds, locations and phase of development. All interviews were tested face-to-face except for one where a telephone interview had to be scheduled.

A small convenience sample was deemed acceptable for the inductive, exploratory pilot study because there was a limited access to funding and time. A novel typology of different entrepreneurs on different environments emerged. In respect to the two types of lead entrepreneurs and the two differing external environments, a two-by-two conceptual typology was created to manage the categorisation of identified entrepreneurs. Typology construction (Figure 4.3) helped identify, manage and compare data from four different scenarios.

Figure: 4.3: Typology of firms established from the electronic survey

	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** academic entrepreneur on a science park/incubator unit	**B** academic entrepreneur on an independent site
NON-ACADEMIC ENTREPRENEUR	**C** non-academic entrepreneur on a science park/incubator unit	**D** non-academic entrepreneur on an independent site

Possible candidates were contacted and chosen using the same criteria as selecting the firms for the actual study which was identifying a firm from each quadrant of the typology. Using a personal network representing contacts from the University of Nottingham Institute for Enterprise and Innovation (UNIEI), a representative from the Nottingham University Research and Business Support Group, and the Personal Assistant to the Director of a local business incubation unit geared to promote life-science firms, the identification of potential firms was established. The latter was influential in gaining permission to approach firms on the sponsored site and promoting contact with firms wishing to locate on site. Further assistance with the

identification of firms was established from secondary data. This came from information on the web site for the Nottingham University Science Park and from the commercial web site of the local governmental business development agency.

In total five firms initially agreed to participate and interviews were conducted over May to August 2004 (Figure 4.4). Gaining respondent co-operation called upon a number of strategies. The first point of contact with the firms was through the use the personal network of personnel and related actors as already stated. Research intent and guaranteed confidentiality outlined in letters and phone calls was also offered. Thereafter, two firms originating from university backgrounds and located on a sponsored environment agreed to be interviewed (Firms A1 and 2, Figure 4.4);

Figure: 4.4: Typology of Firms for the Pilot Study

	SPONSORED ENVIRONMENT	NON-SPONSORED ENVIRONMENT
ACADEMIC ENTREPRENEUR	**A** **1.Food:** Firm created by academics in conjunction with the university to explore the DNA composition of food products. Firm located within a department and using facilities at the university. This firm was at the opportunity development phase. **2.Lab Testing:** Firm created by academics to offer laboratory testing facilities to other pharmaceutical companies. Firm located on Science Park adjacent to the university. Connections to their university department strong. This firm was at the sustainable phase of development and was re-locating to a business park in a conscious effort to professionalise their image to clients by distancing themselves geographically from the university.	**B** **3.Sustainable Firm:** Firm created by academic entrepreneur to offer testing facilities. Firm grew from the university and located on a non-sponsored environment. This firm was at the sustainable phase of development. Ultimately the entrepreneurs from this firm were not interviewed.
NON-ACADEMIC ENTREPRENEUR	**C** 4.**Bio Process**: Firm created by a non-academic entrepreneur. Firm grew from the experience and knowledge of one scientist with many years experience in industry. Located in an incubator unit for biotech firms. This firm was at the opportunity identification phase.	**D** **5.Animals:** Firm created by a non-academic entrepreneur. Knowledge gained from industrial experience and previous start-up experience from two scientists. One had substantial industrial experience. A previous start-up had been sold to large American company. This firm is at the opportunity identification phase and wishes to locate in the incubator unit for biotech firms but is at present at an office location.

one from a non-university background located on a sponsored environment agreed to be interviewed (Firm C4) and two representatives from a non-university formulated firm based on a non sponsored environment agreed to be interviewed (Firm D5). However, ultimately, the spinout firm from Nottingham University located on a non-sponsored environment and led by an academic entrepreneur (Firm B3) declined to

invite the researcher for interview. This firm was mature and trading. The work schedules of targeted personnel did not accommodate time for interview.

Using a stratified approach, contact was made with a target to interview five people per firm:

1. lead academic or non-academic entrepreneur(s)
2. equity holding team members
3. non-equity holding network members
4. staff from the commercial arm of the HEI
5. and members of professional business advisory bodies

The number of people interviewed varied between organisations and the target of five proved to be optimistic. In only one firm were five people interviewed (Firm A1, Figure 4.4). These included two academic entrepreneurs, one business adviser, a surrogate entrepreneur and a member of the HEI from the Technology Transfer Office (TTO). In another two firms two people were interviewed (e.g. academic entrepreneurs and scientists) (Firms A2 and D5), whilst in the firm at the sustainable stage only one person had time to be interviewed (Firm C4, Figure 4.4). In total ten people were interviewed. No interviews were conducted with an academic entrepreneur on a non-sponsored environment (Firm B3).

During both the pilot study over May to August 2004 and the main study over January to April 2005 I wished to generate consistency and understanding through analysis of the data across the four categories. Rather than ensuring similar number of cases in each quadrant, theoretical sampling allowed for one case per quadrant. Each identified firm was at a similar phase of development. They had passed through their opportunity identification phase, but none of the firms in the main study were trading. However, access to identified organisations was difficult to negotiate. This was a recognised weakness in the case-study approach. In the main study different numbers of firms were sampled in each quadrant. A new target of three interviews per organisation proved manageable and contact was normally and consistently made with the lead entrepreneurs and equity holding team members. Some firms at early stages in development offered a limited choice of candidates for interview. Membership was

often restricted and individual roles blurred. For this reason, on two occasions, the lead entrepreneurs requested that 'privileged witnesses' or non-equity team members, be interviewed because there were insufficient equity holders.

After firms were identified, face-to-face 'qualitative interviews' were used as the main instrument for gathering data. All interviews were taped. The interview situation became the centre of production of meanings that addressed issues relating to the research concerns. The goal was thus to analyse the way in which respondents considered events, the reasons they offered for doing so, and attributing meaning to their reasons. It was anticipated that not all opportunities for commercialisation would have been identified in exactly the same way. This primary data was for preliminary analysis and to test the data collection methods and tools. The interview guide allowed for this flexibility but at the same time provided a structure for comparability between cases. Key questions were identified but clarification and elaboration from the respondents was sought.

4.4.4 Stage 4: Preliminary Coding and Analysis of the Pilot Study

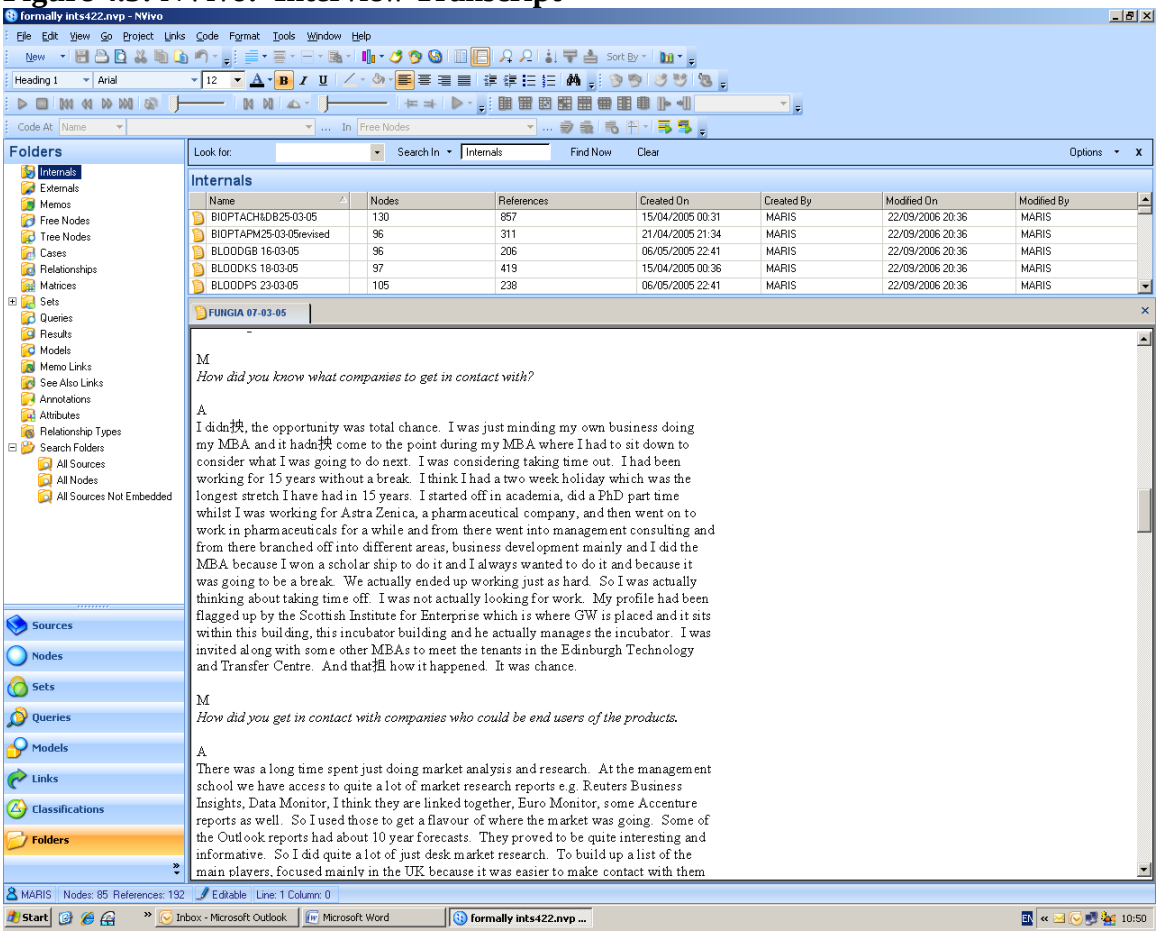
In examining the interview data, the first phase in analysis involved the full transcription of each interview. All interviews in the pilot study were taped and transcribed literally. Interviews were all face-to-face except for one where a telephone interview was conducted due to distance and workload schedules. The interviews lasted from 45 minutes to 1 hour and 10 minutes and in total the interviews lasted 10.5 hours. In total 109 pages of transcript were produced. All interviewees were initially asked for a 45 minute slot. The interview was divided into four sections and often the seam between sections was naturally bridged by participants without prompting. Most interviews took place in the offices of the interviewees but two requested that interviews be conducted at Nottingham University Business School (NUBS). On average it took the researcher 6 to 8 hours to transcribe one interview.

The second phase of the analysis of the pilot case-studies involved returning the transcripts to the interviewees for confirmation and accuracy (Lincoln and Guba, 1985). The transcripts were found to be too literal. The literal versions were messy and sentences disjointed. Interviewees inevitably tried to rewrite their scripts correcting grammar. This detracted from the 'sense' of the data and wasted time.

Later transcripts were, therefore, returned for confirmation as coherent synopsis. From the perspective of the researcher, transcription and the process of transcribing allowed for a familiarisation of each participant. Each transcript was read several times and detailed notes made. This initiated the first stages in content analysis. Qualitative data in the form of field notes made by the researcher immediately after each interview also permitted a familiarity and closeness with data.

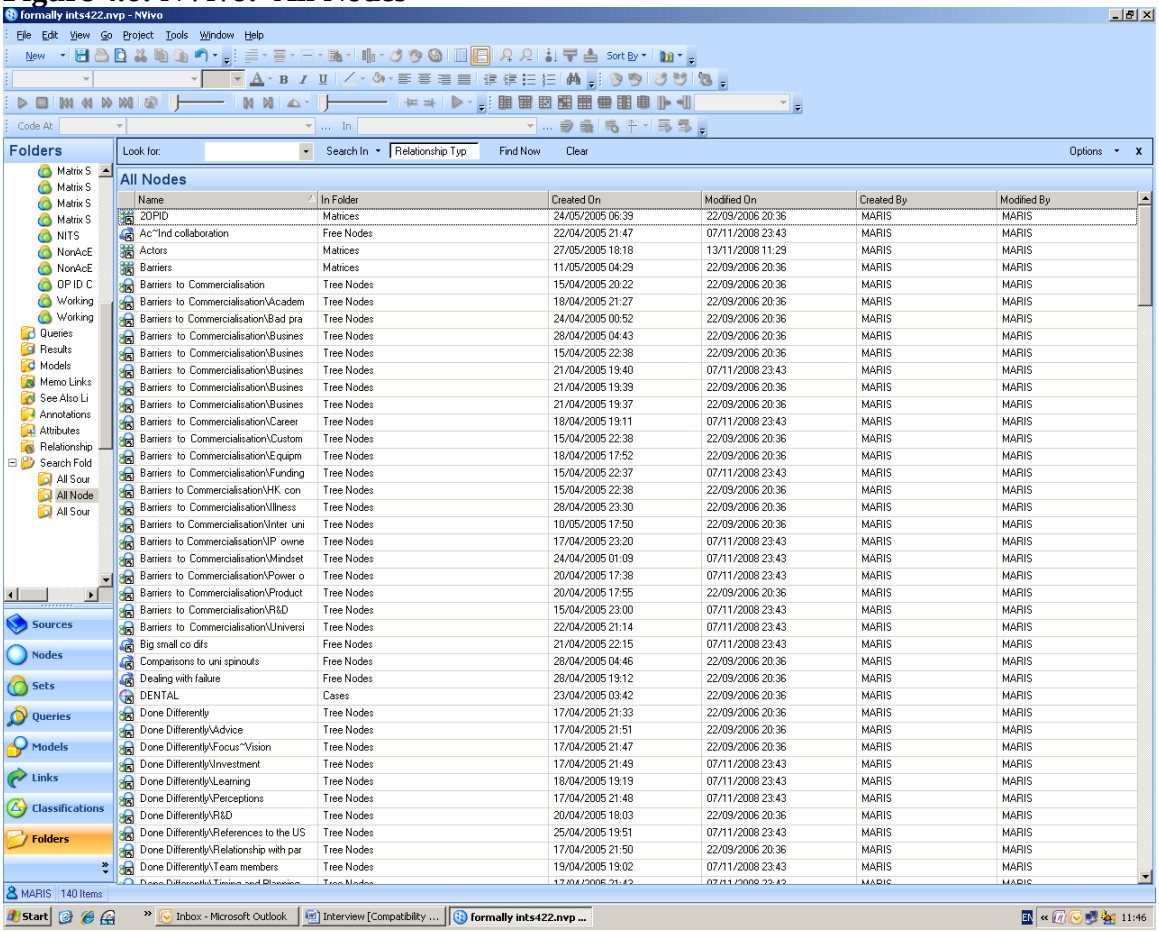
The transcriptions were then transferred in rich text to a computer assisted qualitative data analysis software package (CQDAS) called NVivo (Figure 4.5).

Figure 4.5: NVivo: Interview Transcript



NVivo has been used as a technique for storing and analysing qualitative data (e.g. transcripts of interviews). NVivo is categorised as a 'code-based-theory-building' program designed to store, code, retrieve and analyse texts (Gibbs, 2002). With such ability it was possible for the researcher to divide the text into segments and to store each segment under a certain name (e.g. a node) (Figure 4.6).

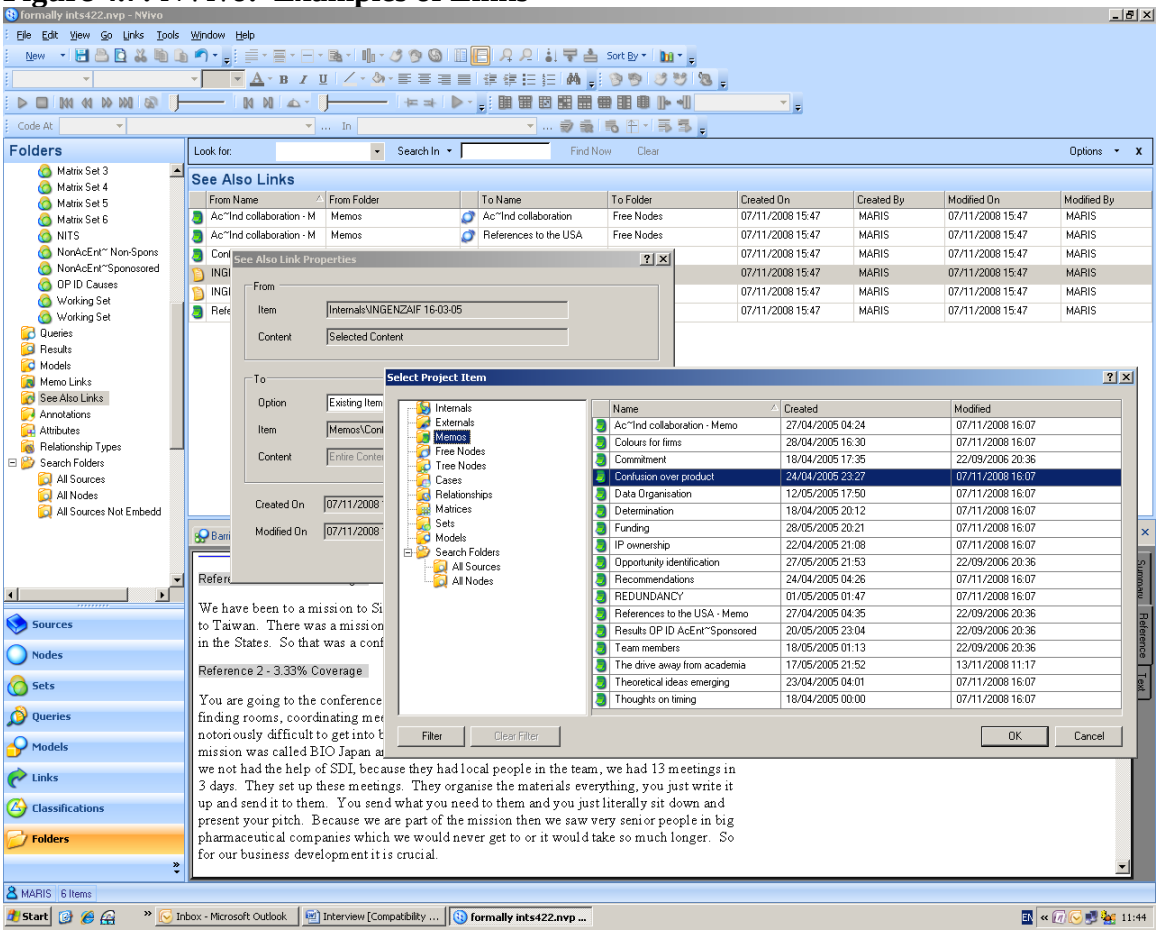
Figure 4.6: NVivo: All Nodes



The link that was created between the text and code was then maintained, in order for more analysis to take place. One strength of NVivo is that it can be used for theory building because it holds the connections between codes in order to develop more abstract categories (Figure 4.7).

This assisted in a further stage in analysis, namely that of identifying themes that contributed to a deeper understanding of opportunity identification, team formation, learning and the influence of the external environment. Data was analysed in a multi-stage process using a process of open coding, axial coding and then core coding (Gibbs, 2002). Open coding reflected where the text within the transcripts was categorised and given a 'node title' which reflected a general phenomena. These open codes revolved around general themes identified from literature but also reflected new

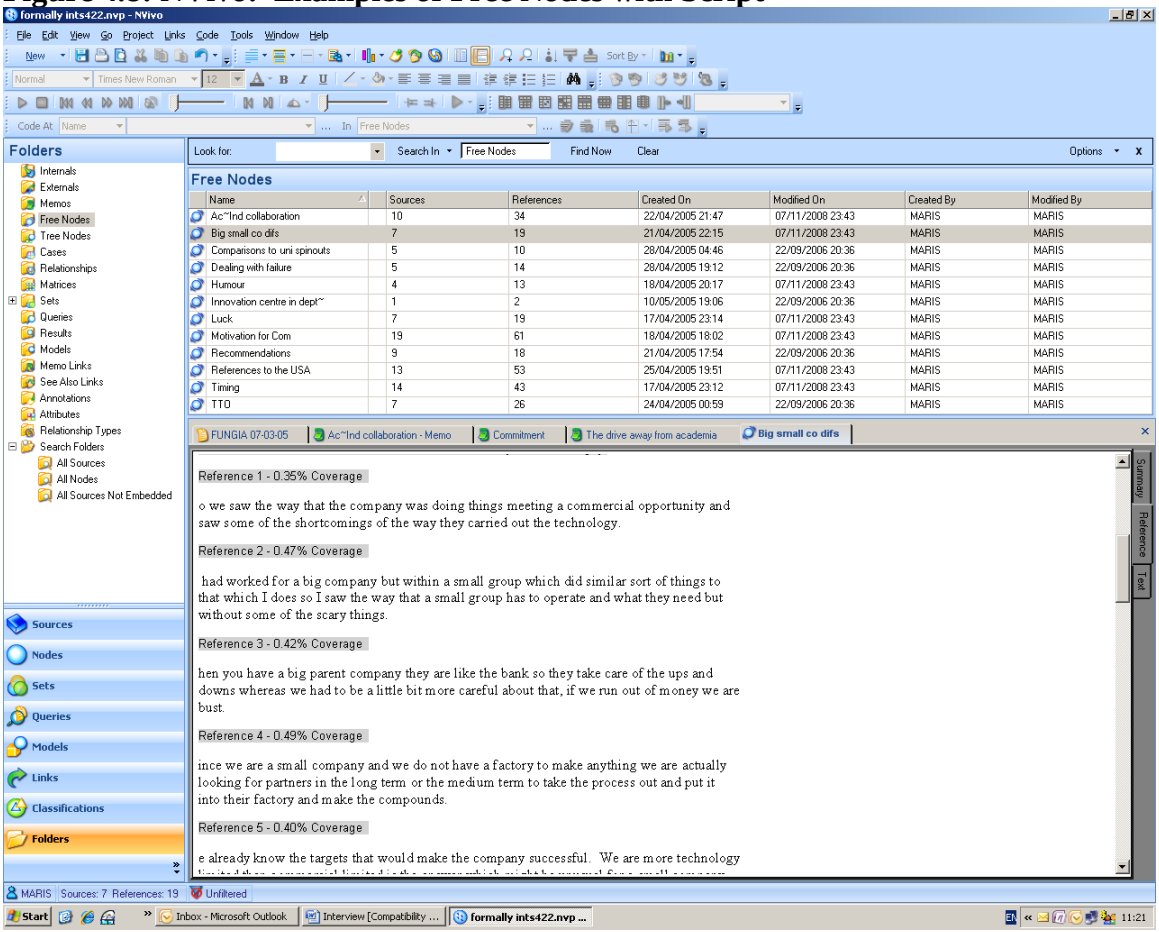
Figure 4.7: NVivo: Examples of Links



themes categorised under 'free nodes'. Examples of free nodes included humour in the face of risk; industrial/academic collaboration and links with the USA (Figure 4.8). 'Axial coding' helped reduce the number of categories by refining, developing and relating categories to central themes. Interviewees gave examples of skills brought by other members in their teams and highlighted the importance of human capital within the team, where it came from and to what use it was put. At this stage quotes were presented and examples of questions offered which were used to interrogate the data to encourage the emergence of other concepts.

The final stage of the analysis involved 'selective or core coding' where the intention was to relate all central categories into a theory (Strauss and Corbin, 1990). This part of the analysis involved the clustering of data that confirmed emergent relationships. As an experiment, and to emphasise the inductive approach to theory development, emergent theoretical propositions were written up from the data without due consideration being given to the theoretical perspectives influencing this study.

Figure 4.8: NVivo: Examples of Free Nodes with Script



However, I had to constantly remind myself that the themes under study were linked to the reviewed literature. The 'unfolding literature' allowed for development of theory which, grounded in the data, meant that the resultant theory had stronger credibility and deeper conceptual insight. "An essential part of theory building is comparison of emergent concepts, theory, or hypotheses with the extant literature. This involves asking what is this similar to, what does it contradict, and why" (Eisnehardt, 1989, p. 544).

Theory building was enhanced through the development of a coding and category structure within the NVivo program allowing quotes to be stored, matched for similarities or differences under headings or codes. The initial number of headings were organised and reduced to create a more coherent structure. Analytical closeness was demonstrated by quoting directly from the entrepreneurs and team members and through a process of self questioning used to disentangle quotes in search of a potential categories properties or dimensions. This included looking for quotes identifying opportunities. I then fished behind the narratives for reasons and

relationships leading to the identification of the opportunity. Matrices of within and across case quotations were compared to emphasise differences (Figures 4.9 and 4.10).

4.4.5 Stage 5: Revision of the Interview Guide

The interview guide was tested pre-pilot for content validity on colleagues and reviewed by my supervisors. Pre-testing the research instruments was completed for the detection of flaws, biases, vocabulary, timing and general understanding. It also allowed for the revision of problem areas (Oppenheim, 2000). During the pilot interviews, the interviewees were asked for their general impression of the interview guide. Usually feedback extended beyond impressions of the contents of the interview guide to encompass pointers about the actual interview process and how questions were asked. For example, after one of the earliest pilot interviews the interviewee stated that he felt that I could have been more inquiring in my style. Listening skills improved and confidence increased throughout the process to ask more inquiring questions.

Figure 4.9: NVivo: Matrices

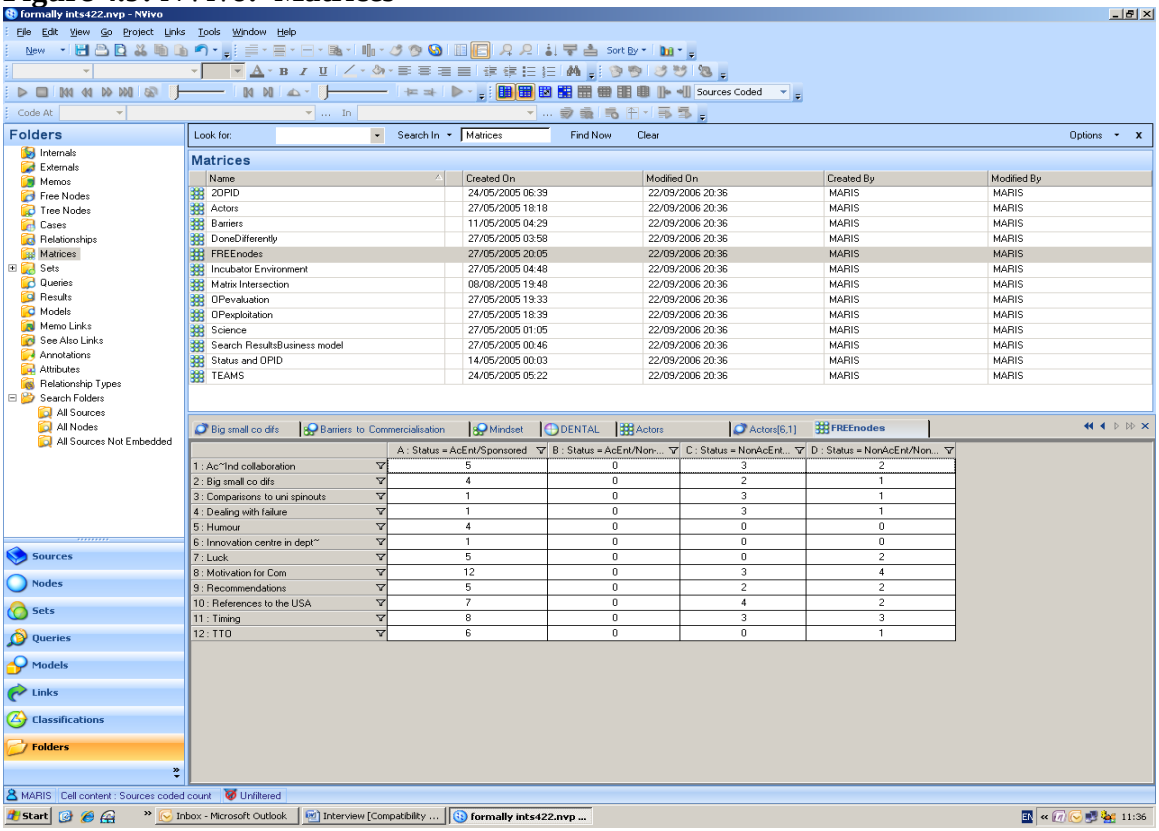
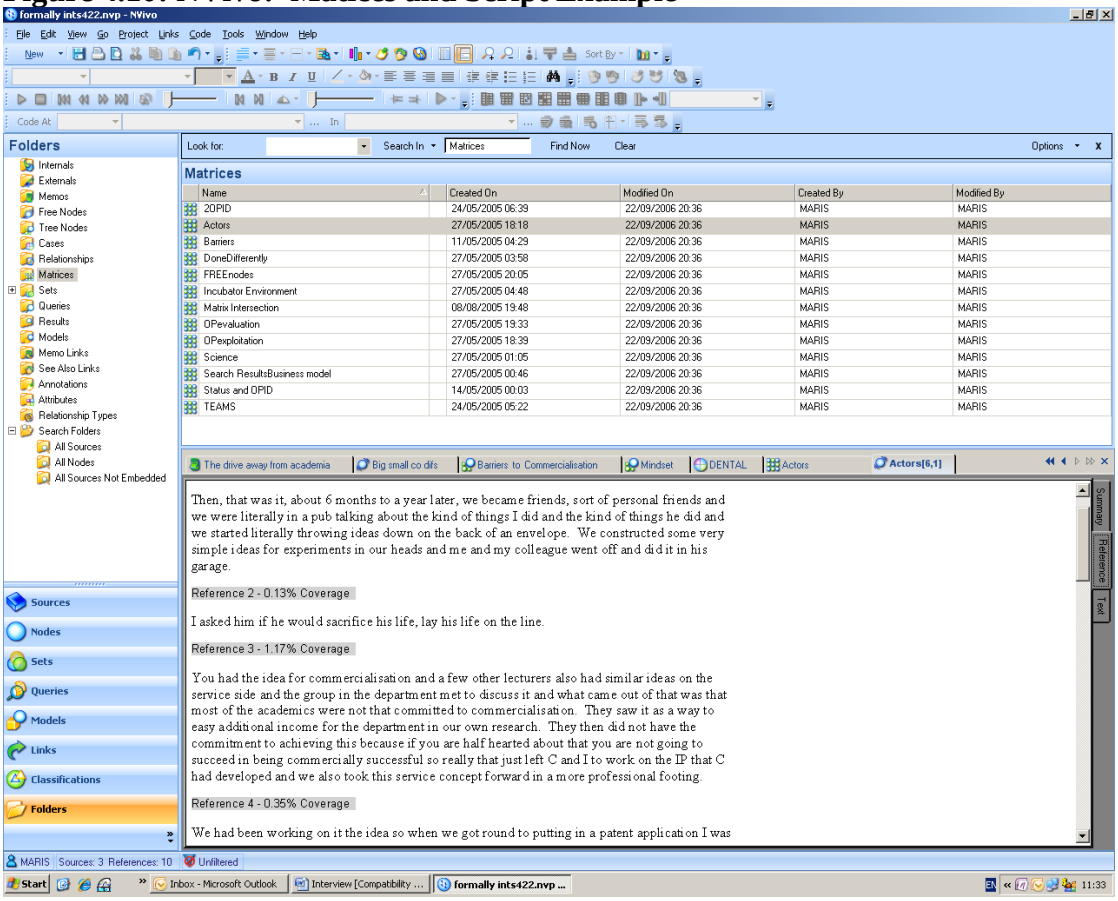


Figure 4.10: NVivo: Matices and Script Example



Checks were also made on interviewees' general responses and non-verbal responses. Comments were collected about the general vocabulary used during the interview and words changed to make the inquiry clearer. Accordingly, the interview guide was revisited several times and adjusted in accordance with feedback. I was asked what I meant by one word on numerous occasions. The word 'factor' was considered ambiguous and substituted with more descriptive words such as people, events, promotions etc. and the word 'spinout' was replaced by 'firm' because some entrepreneurs did not consider their firms to be spinouts from their parent HEI. The original pilot survey used the terms university / non-university to describe the differences between companies. This categorisation proved to be inefficient in describing the companies because companies based on university sites and led by academic entrepreneurs did not describe themselves as university spinouts. The main reason for this contention lay with Intellectual Property (IP) ownership of which there were several combinations. The inconsistency observed around issues of IP ownership made categorisation difficult according to the original division. There was

consistency however, based on the status of the lead entrepreneur (e.g. academic or non-academic).

The questions themselves however remained open ended. The order of questions and the practicalities of using both digital and traditional cassette tape recorders explored. Specific checks were made about the length of time allocated to questions and averages of time taken to answer questions. The questions asked first were more general relating to factual information about the firm and the interviewee (e.g. length of service and role within the firm). This was an effort to put the interviewees at ease. The questions became more focused thereafter. I then honed in on specific topics and inquired further about new issues as they arose. The interviews were standardised in their presentation to the interviewees to allow for a harmonisation of general introduction, guarantee of confidentiality and research purpose. The protocol took the following format. I introduced myself, stated which institution I represented and the motivations behind my research. The purpose of the research as part of a PhD programme was explained and how the data would be used was clarified. A brief outline of the interview format was offered and how the data would be handled, maintaining confidentiality and anonymity. Some of this information was volunteered prior to the actual interview date and permission to tape the interviews established preceding the meetings. Reaction was gauged to the further request for the interviewee to check their interview transcript to confirm authenticity. At this stage an opportunity was offered to the interviewee to add to the transcript or make further comment.

In an effort to overlap data collection and data analysis, transcriptions of detailed interviews were processed promptly and general observations and descriptions recorded. Patterns were established both within cases and across cases. Dimensions or categories within cases were dictated by the type of environment in which it was located and by whom they were led (e.g. paired cases led by similar types of entrepreneurs but in different environments). Listing similarities and differences between the cases forced me to look more closely at the cases. These processes were conducted during and after interviews. All the lead entrepreneurs had formed a firm but were still close to their opportunity identification phase of development. All interviewees were asked to reflect on the process of opportunity identification using

re-call. The entrepreneurs inevitably moved their stories forward to include events leading to firm formation. The process was not tidy but this comparative case-study approach offered an iterative experience dictated to by an evolving and increasing interest in the firm formation process reflected in recent journal articles. The process of data collection uncovered new themes and patterns within and between cases involving academic versus non-academic on sponsored versus non-sponsored environments.

4.4.6 Stage 6: Email-Survey in Scotland

Following on from the pilot study an electronic survey of life-science firms in Scotland was conducted. The initial population of life-science firms in Scotland was identified from the following main data sources: Scottish Enterprise: Biotechnology Scotland Source Book (2003); Scottish Institute for Enterprise and MIT Entrepreneurship Centre, (2004); websites run by Scottish Enterprise (e.g. www.talentscotland.com). Using this information a population of 125 independent and subsidiary life-science firms was identified in Scotland during the summer of 2004. A geographical boundary was set between the three cities of Dundee, Edinburgh and Glasgow, where there is recognised life-science activity (Forbes and Low, 2004). Those firms lying north of Dundee and in the Borders or Islands were not contacted because time was limited. The selection of cases for this study was governed by a boundary spanning exercise conducted early in the research process. This was done due to time, resource and travel limitations. Only independent and subsidiary firms were targeted in the geographical confine. Within this area 109 firms were identified. The focus of the study identified lead entrepreneurs as individuals engaged in opportunity identification. Independent firms were, therefore, sought and not multinationals or joint ventures. Nine were eliminated (e.g. non-contacts) at this early stage because they were either multinationals or had no contact details available; websites were under construction and offered no information; access was denied to sites; incorrect URLs were provided; firms had stopped trading or there had been a misrepresentation of firm status (e.g. not life-science firms but were distributors or venture capitalists). Contact was thereafter made with the 100 independent firms. The survey related to visible firms listed in the selected trade directory which may not have related to the population of all life-science firms. Nevertheless, this was not considered to pose a problem given the focus of this study.

The survey included a covering letter requesting participation, stating the objectives of the survey, the purpose of the survey and guaranteeing confidentiality. The letter contained three questions and was used as a preliminary, exploratory tool to gather data from firms about origin, location and phase of development (Appendix 6). Such a descriptive survey answered 'how many' questions and provided descriptive information about the firms. The purpose of the survey was to gather, name and allocate valid firms to each quadrant. As in the pilot study, cases were linked to a theoretical sampling framework where the aim was to identify examples in each quadrant, not to have correspondingly equal numbers.

The explanatory letter accompanying the survey ensured confidentiality and anonymity whilst at the same time establishing contact with one targeted member in the organisation (Appendix 6). It was decided to administer the survey via email for convenience, speed and ease of access for both the researcher and the recipients. The questions were factual and took only a few minutes to answer. It was considered that there could be little misinterpretation of the questions because of the factual nature of the questions. No control, however, was built in to check who answered the survey. Respondent identity was usually revealed through email signatures and noted if different from the original addressee. Email was considered the most expeditious way of reaching the firms that were dispersed within and around a geographical triangle reaching between Edinburgh, Glasgow and Dundee. Table 4.4 provides a timetable review of events leading to the design and implementation of the survey.

Table 4.4: Survey Design and Development

Date	Task
May & June 2004	Identification of firms from secondary data (Biotechnology Scotland Source Book (2003); Scotland Institute for Enterprise and MIT Entrepreneurship (2004); Talent Scotland: www.talentscotland.com
June/July 2004	Geographical division and coding of firms. Boundary setting around a geographical triangle between Edinburgh, Glasgow and Dundee to control for time and travel restrictions using a population of 125 firms.
July 2004	Design of email survey; accompanying statement of purpose and intent.
July/August 2004	Sourcing of contact names and details of firms. Email distributed.
August/September 2004	Email reminders and phone follow up. Collection of data. Total number of respondents was 63.

The email survey was conducted to distinguish between firms in terms of origin, location and phase of development (Appendix 6) and led to a polarisation of cases e.g. :

- Academic entrepreneur versus non-academic entrepreneur
- Located on sponsored versus non-sponsored external environments
- Phase of development of the firm

This led to a four-way categorisation of firms as follows:

- A: Academic entrepreneurs located on a sponsored environment.
- B: Academic entrepreneurs located on a non-sponsored environment.
- C: Non-academic entrepreneurs located on a sponsored environment.
- D: Non-academic entrepreneurs located on a non-sponsored environment.

4.4.7 Stage 7: Survey Results and Identification of Firms

Thirty firms declined to participate or simply did not respond to follow on emails or follow up phone calls. With the 70 respondents a typology of firms was developed identifying firms from different origins, located in different external environments and representing different phases of development. During the process of categorising a further 7 firms were dropped because they were not life science firms. Sixty-three firms remained in the valid sample. The remaining 63 valid responses were then mapped onto the conceptual typology (Figure 4.11)

Figure: 4.11: Typology of life-science firms identified from the email survey

	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	A Led by an academic entrepreneur on a science park/incubator unit **29**	**B** Led by an academic entrepreneur on an independent site **5**
NON-ACADEMIC ENTREPRENEUR	**C** Led by a non-academic entrepreneur on a science park/incubator unit **10**	**D** Led by a non-academic entrepreneur on an independent site **19**

Of the 63 valid responses, 28 were identified as valid respondents from the opportunity identification phase. Figure 4.12 shows that 14 respondents were allocated to Quadrant A; in Quadrant B 1 respondent was allocated; six respondents were allocated to Quadrant C and 7 respondents were allocated to Quadrant D.

Figure: 4.12: Typology of valid respondents

	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** Led by an academic entrepreneur on a science park/incubator unit **14**	**B** Led by an academic entrepreneur on an independent site **1**
NON- ACADEMIC ENTREPRENEUR	**C** Led by a non-academic entrepreneur on a science park/incubator unit **6**	**D** Led by a non-academic entrepreneur on an independent site **7**

The main study relied on a theoretical sample (Glaser and Strauss, 1968). Since the purpose of the study was to build theory, not to test it, theoretical sampling was acceptable (Eisenhardt and Graebner, 2007). The theoretical sample included cases that provided good comparison and were examples of polar types (e.g. academic and non-academic entrepreneurs on sponsored and non-sponsored external environments) to highlight potential differences or similarities (Eisenhardt, 1989). Eisenhardt and Bourgeois (1988) in a study of strategic decision making used this 'polarising' technique to include cases such as founder versus professional management; high versus low performance; first versus second generation product and large versus small. Comparing academic and non-academic entrepreneurs allowed contact with several 'like' types of entrepreneurs and allowed for comparisons between 'like' and polar types of cases (Eisenhardt, 1989), forcing explanation and exploration for causal relationships (e.g. between past experience and present choices). Pettigrew (1990) suggests that an important guideline for choosing polar types is to select cases that may disconfirm patterns from earlier case-studies. Another recommendation from Pettigrew (1990) is to consider the choice of case-studies where progress is "transparently observable" (Pettigrew, 1990, p. 275) (e.g. at a critical incident). The intention was to choose case-studies at a particular phase of

development (e.g. the opportunity identification phase). Theoretical sampling thus allowed a process of collecting data for comparative analysis.

This will be discussed later but suffice to note that the sample was not representative of a population nor the results generalisable to a representative population. Ultimately, each participant was chosen because they represented a unique position amongst academic or non-academic entrepreneurs located on sponsored or non-sponsored environments. However, from the richness of the personalised data comes forth a weakness in the form of low reliability. Generalisation can only take place to the theoretical and not the statistical as can be done with quantitative data. Notwithstanding, the cases were chosen to deliberately vary the context of 'how' different entrepreneurs dealt with opportunity identification and the resources required for firm formation. All of the cases were located in Scotland and governed by one blanket governmental policy towards the commercialisation of life-science knowledge. The choice of cases across the four quadrants offered an opportunity for comparison and research to address the research objectives from four different perspectives. These comparisons have not been dealt with in earlier research. Earlier case-study research examined spinout firms from university and research institute backgrounds only. None have looked at differences in the entrepreneurs leading firms from HEI and industry backgrounds. However, as will be seen in the analysis, during the research several firms were fluid in their approach to the entrepreneurial process and re-visited the opportunity identification phase depending on availability of resources.

4.4.8 Stage 8: Categorisation of Firms and Case Selection

A one page letter of explanation, endorsed by my supervisors, was sent to the 28 identified independent and subsidiary life-science firms outlining the purpose and nature of the academic research, guaranteeing confidentiality and requesting co-operation (Appendix 7). Full anonymity was also promised. Thereafter, phone calls were made to support the initial request for interviews. Nine lead entrepreneurs agreed to allow me access to interview three members of their organisations, including themselves (Figure 4.13). In Quadrant A, 4 firms were interviewed; Quadrant B, 1 firm was interviewed; Quadrant C, 1 firm was interviewed and in Quadrant D, 3 firms were interviewed. Since the external conditions were considered to be similar over all

cases the numbers needed to be explored were deemed fewer. Nine cases were deemed to be sufficient for the purpose of the research. Less than four was considered insufficient (Eisenhardt, 1989). "Between four and ten cases usually works well. With fewer than four cases, it is often difficult to generate theory with much complexity, and its empirical grounding is likely to be unconvincing, unless the case has several mini-cases within it" (Eisenhardt, 1989, p. 545).

Figure: 4.13: Typology of firms selected for study

	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** Led by an academic entrepreneur on a science park/incubator unit **4**	**B** Led by an academic entrepreneur on an independent site **1**
NON-ACADEMIC ENTREPRENEUR	**C** Led by a non-academic entrepreneur on a science park/incubator unit **1**	**D** Led by a non-academic entrepreneur on an independent site **3**

In all cases the lead entrepreneur remained the main contact. The contact with the lead entrepreneur was consistent during the initial email survey, during the time for organising interviews and during the interview session. The lead entrepreneur also identified team members to be interviewed. They were asked to identify team members who were equity holders and decision makers. This request was mostly fulfilled but several firms had too few team members and in these cases the lead entrepreneur identified the TTOs or an influential board member as being significant contributors to the opportunity identification process. This was accepted knowing that they did not fulfil the criteria set in the definition of an equity holding team member. Although a target of three people per firm was sought in two firms only two people were interviewed because either the lead entrepreneurs could not identify another suitable person to interview or other team members were inaccessible. Lead entrepreneurs were contacted over a period of a year on a minimum of five occasions. The first was to complete the email survey; the second was to request cooperation in

the form of an interview; the third was to organise interviews and with whom; the fourth was to conduct the interview and fifth to confirm transcript manuscripts.

4.4.9 Stage 9: Case-Studies in Scotland

Gaining respondent co-operation and motivation to be interviewed called upon a consistent and clear communication and coordination with the nine lead entrepreneurs representing opportunity identification life-science firms at the time of the email survey. Although the history of the movement of the companies is traced, the choice of companies was made according to their initial categorisation as a result of the email survey conducted in September 2004. Face-to-face interviews were scheduled during a period January to April 2005. Twenty five interviews were conducted on a one-to-one basis except for one occasion where a lead entrepreneur and team member from the same company had to be interviewed together because of time constraints. Companies were given case numbers for ease of identification and anonymity and are summarised in Figure 4.14.

Figure: 4.14: Typology of firms at the time of the email survey

	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** Company 1 Company 2 Company 3 Company 4	**B** Company 5
NON-ACADEMIC ENTREPRENEUR	**C** Company 7	**D** Company 6 Company 8 Company 9

Fourteen of the interviewees were lead entrepreneurs. The lead entrepreneurs were always the first to be interviewed. Five interviews were with team members and three were with Technology Transfer Officers from three different HEIs. Three interviews were conducted with non-executive board members (Table 4.5).

Table 4.5 Interviewees					
Company	**Lead Entrepreneurs**	**Team Members**	**Technical Transfer Officers**	**Board Members**	**Total**
Company 1	1	2			3
Company 2	2		1		3
Company 3	2		1		3
Company 4	1	1		1	3
Company 5	2		1		3
Company 6	1	1		1	3
Company 7	2				2
Company 8	2			1	3
Company 9	1	1			2
Total	14	5	3	3	**25**

A fuller description of each firm in relation to who led them, where they were located, the origins of ideas for commercialisation, an outline of their research and development and the role of the interviewee is offered in Table 4.6. Table 4.6 shows that Companies 1, 5, 6, and 8 were involved in creating instrumentation for testing drugs, toxicity levels or for the separation of DNA. Companies 2 and 7 were researching the creation of new enzymes or cell lines. Two companies, Companies 2 and 7 researched new and innovative devices for the dental and medical market whilst Company 9 was creating a new pesticide. The origin of these opportunities and ideas was related to the past experiences of the lead entrepreneurs either through direct basic academic research, past industrial experience, past start up experience or from practical hands on experience like farming (Company 9). Their location, either on or off a sponsored environment, is recorded as are any previous locations. This aspect of the study revealed more changes once interviews were concluded. The changes in the external environment were mapped. All people interviewed and their roles within the firms recorded.

Table 4.6: Profile of opportunity identification firms at the time of the Electronic Survey 2004					
Company	**Technology**	**Origin of idea**	**Location**	**Previous location**	**Role of interviewees**
Company 1	Instrumentation (luminescence for toxicity)	Idea came from process used to complete a PhD	Sponsored. University incubator	Smaller office in the same incubator unit	Lead entrepreneur and two entrepreneurial ownership team members
Company 2	Biochemical (intermediate enzymes)	Idea came from observations in the laboratory and market knowledge	Sponsored. University department	Same university department.	Two lead entrepreneurs and a TTO.
Company 3	Test Kit (dental)	Idea came from clinical observations, the literature and research in the laboratory	Sponsored. Technology park	Incubated in the TTO offices of the HEI with access to HEI laboratory space.	Two lead entrepreneurs and a TTO.
Company 4	Medical device (blood flow)	Idea came from observations in the laboratory	Sponsored. Technology park	Incubated within the laboratory space of the hospital trust.	The lead entrepreneur, a board member and a team member.
Company 5	Instrumentation (drug testing)	Idea came from previous company	Non-Sponsored. Industrial site	Incubated within the HEI department, moved to an industrial site (and finally back to an incubator unit within another HEI).	One lead entrepreneur, an entrepreneurial team member and the TTO.
Company 6	Instrumentation (drug testing)	Idea came from previous start up	Non-Sponsored. Residential premises	Technology came from a previous start-up. Located in rent-free accommodation from the local HEI.	The lead entrepreneur, a team member and a board member.
Company 7	Biotechnology (cell lines)	Idea came from research with previous employer	Sponsored. Science park	Worked from home until they won their first contract and then sub leased a lab from a larger company.	Two lead entrepreneurs.
Company 8	Instrumentation (separation of DNA)	Idea came from combining engineering and science skills for a laboratory process	Non-Sponsored. Industrial park	Incubated within an HEI department.	Two lead entrepreneurs and a board member.
Company 9	Pesticides (insect repellent)	Idea came from farming experience	Non-Sponsored. Office	Incubated within the sponsored environment of a management consultancy group.	One lead entrepreneur and a team member.

The longitudinal aspect of the study evolved after initial contact. Real time data emerged at two points in time:

- Venture credibility 1st phase identified during the electronic survey
- Venture credibility 2nd phase identified during face-to-face interviews
- Opportunity identification phase and entrepreneurial commitment phase were gathered retrospectively (Figure 4.15).

Entrepreneurs experiencing early phases of firm formation were identified because a method to identify entrepreneurs at the point of opportunity identification proved difficult. Approaching TTOs, attached to HEIs, and asking them to identify potential academic entrepreneurs was possible but the same method could not be replicated for non-academic entrepreneurs. Firms close to the opportunity identification phase were identified from an electronic survey of life science firms established in and around central Scotland. Following the cases in real time, thereafter, allowed for the mapping of resource leverage from the entrepreneurs' own human and social capital, from recruited team members and from the external environment. Using such a method, the process of opportunity identification revealed itself not to be a one off event in the entrepreneurial process but one which was influenced by resource inputs and one which was often re-visited depending on resources allocation. Data collection from each case took place over a period of a year. Semi-structured in-depth interviews with the lead entrepreneurs and team members were substantiated with individual firm literature, where available.

Figure 4.15: Location changes

	Opportunity Identification Phase		Entrepreneurial Commitment Phase		Venture Credibility 1st Phase		Venture Credibility 2nd Phase	
	Sponsored environment	Non-sponsored environment	Sponsored environment	Non-sponsored environment	Sponsored environment	Non-sponsored environment	Sponsored environment	Non-sponsored environment
Academic entrepreneur(s)	Company 1 2 3 4	Company 5	Company 1 2 3 4 5	Company	Company 1 2 3 4	Company 5	Company 1 2 3 4 5	Company
Non Academic entrepreneur(s)	Company 8	Company 6 7 9	Company 8 9	Company 6 7	Company 7	Company 6 8 9	Company 6 7	Company 8 9
Information collection dates	Information on location gathered retrospectively during face-to-face interviews in 2005		Information on location gathered retrospectively during face-to-face interviews in 2005		**Information on location gathered during electronic survey 2004**		Information on location gathered during face-to-face interviews in 2005	

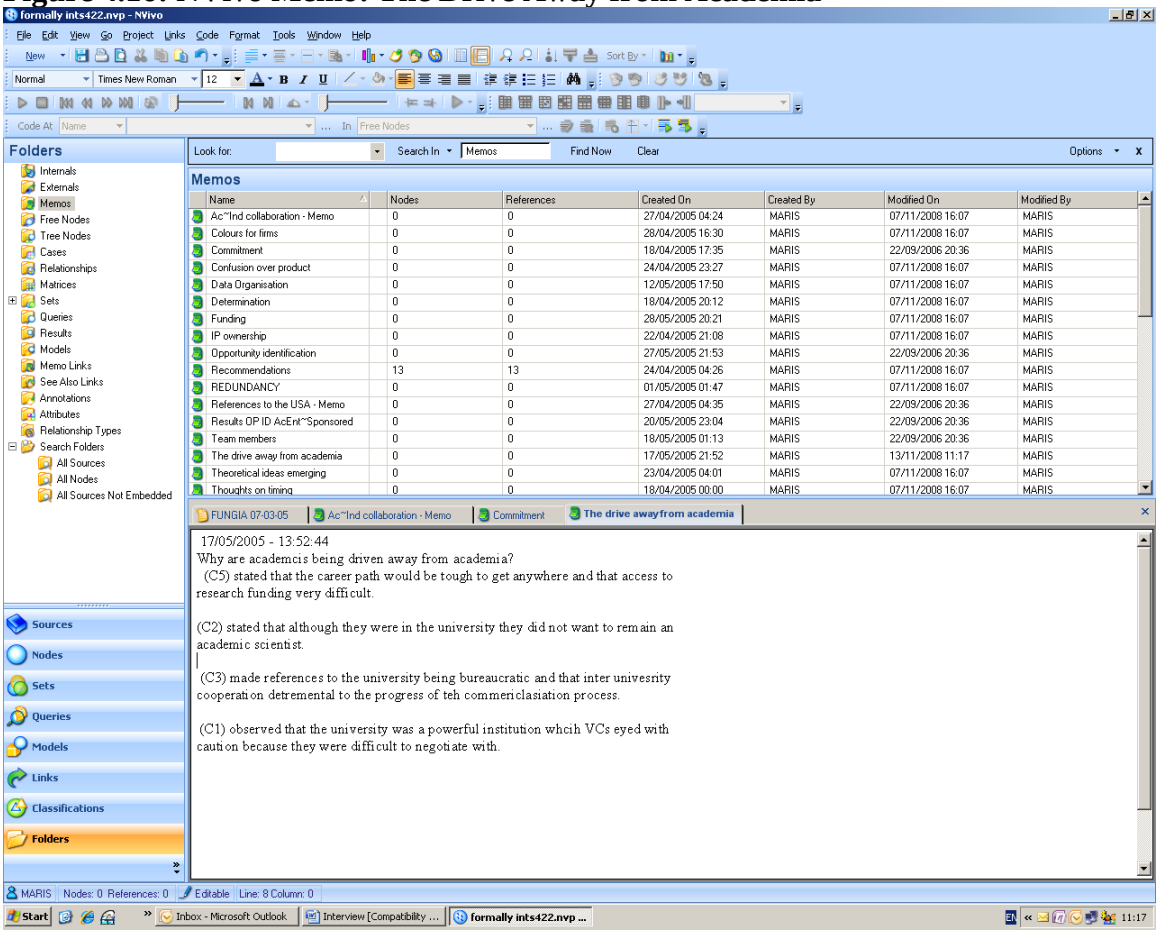
4.4.10 Stage 10: Coding and Analysis of Data Collected in Scotland

Additional demographic information relating to the individual firms was stored according to their status at the time of interview. Information pertaining to their date of formation, date IP was registered, industrial sector and legal form of the firm (Table 4.7). All nine firms had been founded and formed between the years of 1997 and 2003. Two were founded prior to 2000 and the others between 2001 and 2003. Registration of IP, for the protection of new knowledge, normally occurred some years prior to firm formation. Lead entrepreneurs reported spending time and resources protecting their knowledge with patent agents. If there was a strong academic connection within the firm it was possible that the IP had been registered as part of the academic process prior to the conception of a commercial application or venturing. All nine firms were limited companies whilst one entered the AIM market during the duration of the study.

Transcripts were returned to the interviewees for confirmation that they reflected an accurate description of the interview. The interviewee was asked to add or subtract information at this stage. All but eight interviewees returned their scripts. The transcripts were then converted into rich texts and transferred to NVivo, a computer-assisted qualitative data analysis software (CASQDAS) programme. An advantage of the program was that it stored transcripts and simplified and speeded the mechanical aspect of analysis. The program did not make conceptual decisions. Interpretation of the data was left to me. Additionally, field notes and memos from individual interviews were transcribed based on reflections and observations made after each interview (Figure 4.16). The chronological ordering of the data was vital in specific connection to the entrepreneurial process, external location, and the recruitment of team members.

Table 4.7: Companies interviewed January-April 2005						
Company/ Interviewee	Date of Formation	Date when IP was created	Life-science Sector	Legal Form of Firm	Role of Interviewee	Status of firm at time of interview
Company 1 (A1)	2001/6/1	1999/2000	Test kit (toxicity)	Limited Company	Team member	Ac Ent/Spon
Company 1 (B1)					Lead entrepreneur	
Company 1 (C1)					Team member	
Company 2 (A2)	2002/9/1	1998	Biochemical enzymes	Limited Company	TTO	Ac Ent/Spon
Company 2 (B2)					Lead entrepreneur	
Company 2 (C2)					Lead entrepreneur	
Company 3 (A3)	2001/10/1	1996	Test kit (dental)	PLC (AIM 2004)	Lead entrepreneur	AcEnt/Spon
Company 3 (B3)					TTO	
Company 3 (C3)					Lead entrepreneur	
Company 4 (A4)	1998/10/1	1990/91	Medical Device	Limited Company	Board member	AcEnt/Spon
Company 4 (B4)					Team member	
Company 4 (C4)					Lead entrepreneur	
Company 5(A5)	2002/9/1	2002	Instrumentation (pharmaceuticals)	Limited Company	Lead entrepreneur	AcEnt/Spon
Company 5 (B5)					Team member	
Company 5 (C5)					TTO	
Company 6 (A6)	2002/4/2	1997	Instrumentation (pharmaceuticals)	Limited Company	Team member	NonAcEnt/Spon
Company 6 (B6)					Lead entrepreneur	
Company 6 (C6)					Board member	
Company 7 (A7)	2003/1/1	2002	Biotechnology (cell lines)	Limited Company	Lead entrepreneur	NonAcEnt/Spon
Company 7 (B7)					Lead entrepreneur	
Company 8 (A8)	2001/11/1	2001	Instrumentation (DNA separation)	Limited Company	Board member	NonAcEnt/NonSpon
Company 8 (B8)					Lead entrepreneur	
Company 8 (C8)					Lead entrepreneur	
Company 9 (A9)	1997/12/31	1996/97	Pesticides (insect repellent)	Limited Company	Lead entrepreneur	NonAcEnt/NonSpon
Company 9 (B9)					Team member	

Figure 4.16: NVivo Memo: The Drive Away from Academia



During the course of the research some of the lead entrepreneurs experienced changes and progression in the entrepreneurial process because they were able to access resources to overcome barriers to commercialisation. Sometimes this was accompanied by a change in the external environmental location. Information pertaining to three points in time were identified first, through an electronic survey of the life-science firms completed in 2004 to confirm the origin of the lead entrepreneur (e.g. academic or non-academic entrepreneur), the location of the entrepreneur and the proposed opportunity (e.g. on a sponsored or non-sponsored environment) and the phase of entrepreneurial development (e.g. opportunity identification or not). Second, during the time of face-to-face interviews in 2005, identified lead entrepreneurs and team members were questioned about their choice of environments and access to resources and reasons for choice of external environment. It was during interviews that a third point in time was established (e.g. location at the opportunity identification phase). It became apparent that there was a dynamic process in play whereby entrepreneurs changed environments. These observed changes made for challenging

and interesting research because it was not anticipated. Results may be a general reflection of the movement and progress of firms close to opportunity identification within the life-science sector. Arranging data into chronological order allowed me to determine the cause for events over time. One of the most obvious changes was seen when people moved from sponsored to non-sponsored environments and then back again. Changes were mapped and a fuller discussion is offered in Chapter 7.

Although none of the firms in the study reached the entrepreneurial phase of sustainability, they fluctuated between phases in the entrepreneurial process. Mapping those changes chronologically indicated that the process was not linear but iterative. The data allowed a search for possible reasons to such events. The reasons offered conjecture both for the success of crossing a critical juncture to a growth phase and also for the failure to cross a critical juncture to return to a previous phase in development. The identification of sequences of events and rationale helped answer the 'why' and 'how' questions set to guide the study associated with human capital profiles, the recruitment of team members and the effect of the external environment on entrepreneurs' access to resources.

Preliminary coding headings were created based on past literature to help give structure to the coding process. Once a preliminary examination of the transcripts had been carried out, a process of open coding continued (Figure 4.17 and Figure 4.18). Open coding dealt with initial analysis by labelling and categorising phenomena as indicated by the data. The concepts produced from this process allowed for a search of similarities and difference across the cases. Open coding required the constant asking of questions by me about what, where, how, when, why etc. Subsequently, similar incidents were compared across cases and grouped together. Some examples of questions asked are: Why had a lead entrepreneur had chosen a particular external environment? What resource benefits did they gain from it? Who did they have contact with in that setting? How did the lead entrepreneur gain access to that external environment? When did they change their external environment? What, (why and how) did they say they got out of it? Similar incidents were given the same conceptual label. This focused my attention to make links between data to reduce it and to link it to extant literature.

Figure 4.17: NVivo: Tree Nodes

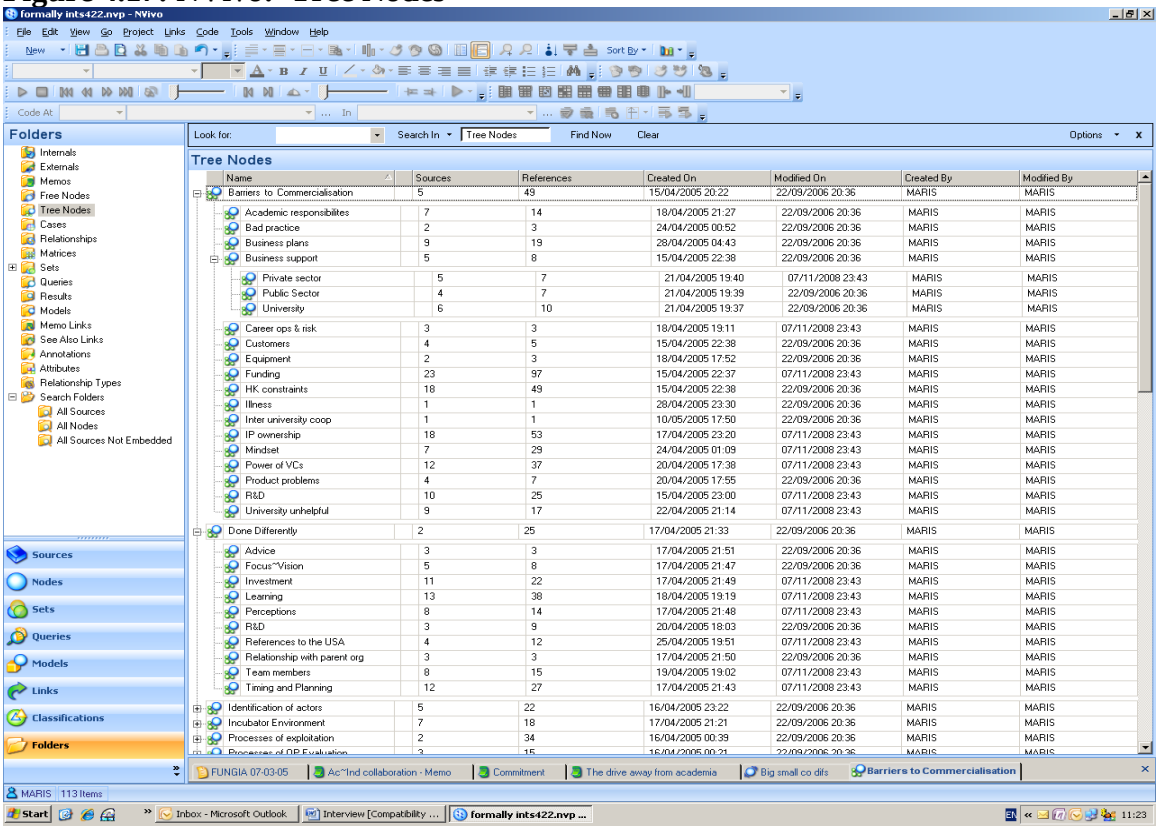
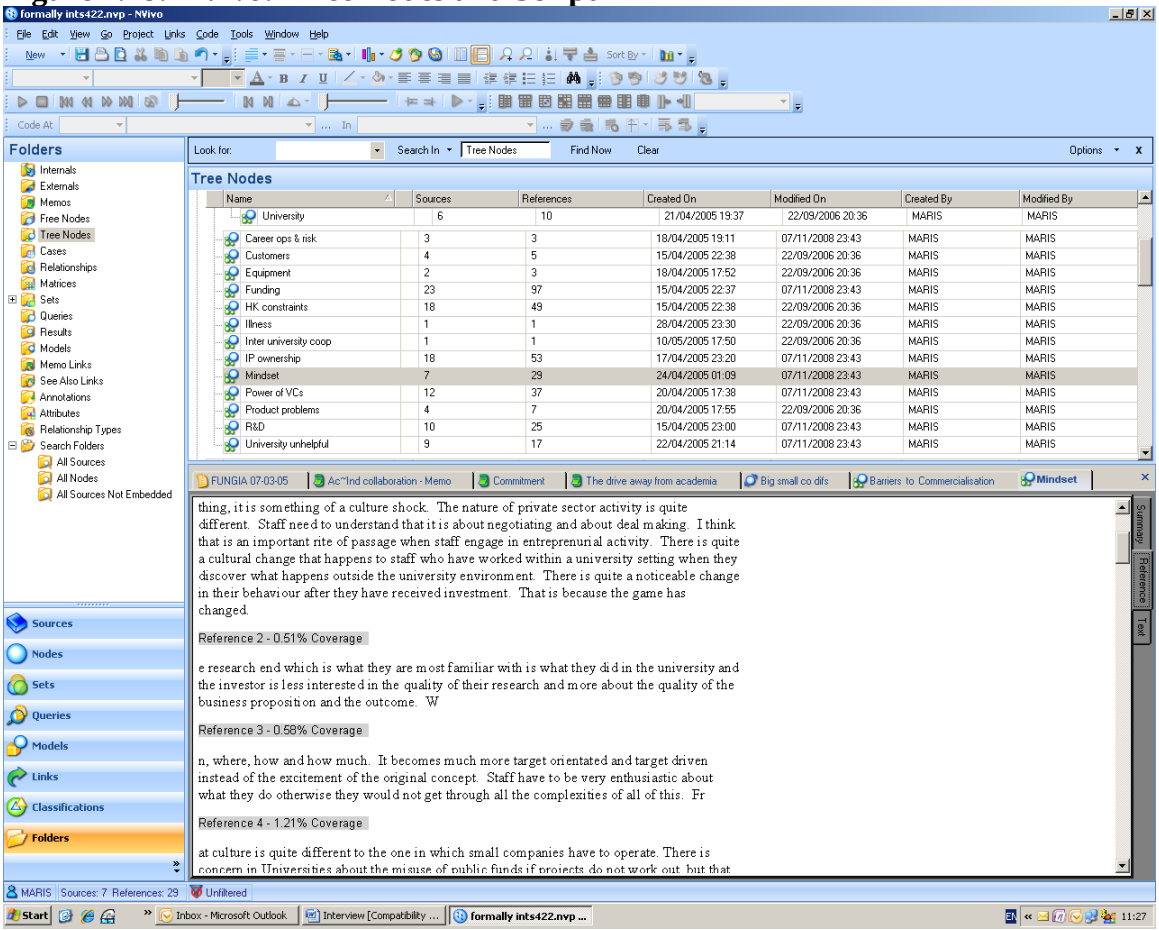


Figure 4.18: NVivo: Tree Nodes and Script

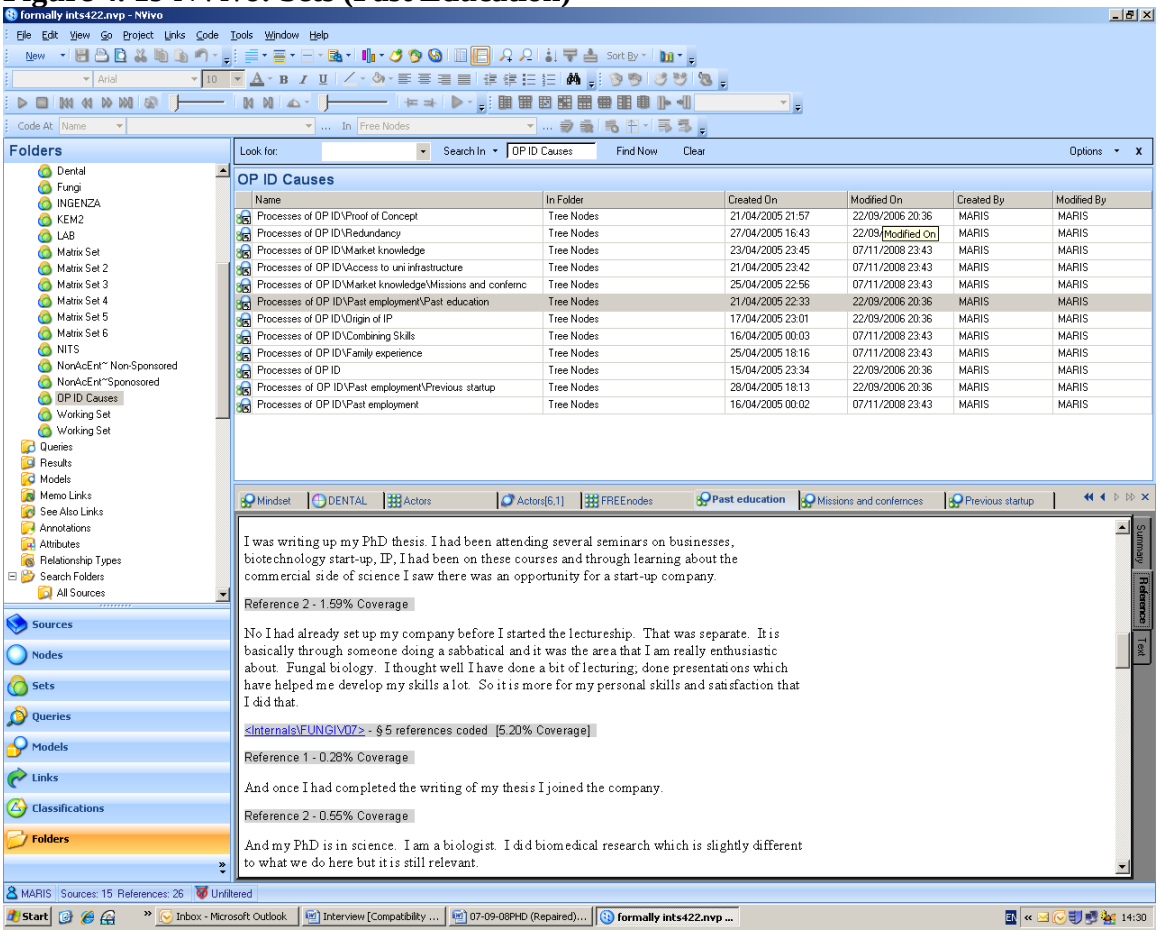


Although the research questions centred on ‘why’ and ‘how’ issues, the aim of coding was not necessarily to find new ‘categories’ as in grounded theory, but to ‘categorise’ reasons for these events happening and then to subsequently make cross-case comparisons. Main themes had been identified from the literature but there had been gaps or insufficient information provided to speculate why certain actions and events within the entrepreneurial process happened. Most coding was done in-vivo and a new and extensive list of nodes created which looked for answers to the main research questions. This group of nodes yielded some localised concepts specific to individual cases. However, the next stage of axial coding allowed for a categorisation of nodes within similar cases and across cases. Nodes were thus combined to make interconnected tree nodes and every effort was made to focus on the original research questions to centre results.

Axial coding, exploring relationships between categories and consequences of the evolving concepts, was performed to look for causal reasons. Some of the causal reasons could be linked to the prior empirical evidence, some to substantiate theoretical linkages to resource search, leverage and accumulation and some to expanding existing knowledge. The connection of categories was done by linking codes to contexts, to consequences, to patterns of interaction and to causes. The link that was created between the text and the code was maintained in the computer package allowing for more analysis and refinements to take place. Axial coding therefore brought back together data by making connections between a category and sub-categories, between and across cases.

Matrices and Sets were then created to compare attributes of the four different quadrants recognised in the typology of firms using different coding themes. This allowed for cross-case analysis. Within cases and between cases, groups of quotes and observations emerged in respect to the themes, which were the core of the study (Figure 4.19). In this analysis, interviews were coded according to experiences during opportunity identification; during team formation; recording the resource benefits of locating in certain environments and exploring how learning was initiated during the opportunity identification phase of spinout firm formation. Each experience included a number of concepts that were central and common to the respondents in the study and that characterised their experiences. The subdivisions connected to each central

Figure 4. 19 NVivo: Sets (Past Education)



concept facilitated a deeper understanding of each theme. Whilst similarities and differences in the data were noted during axial coding, the phase of core coding allowed for the identification of core categories which systematically linked to the other categories, validating relationships across cases for further refinement of explanation and development. Causal conditions were sought which related events leading to the core categories. This process allowed for the conceptualisation of the theoretical framework as it brought codes, concepts and categories together.

Education, for example, attributed to general human capital, not only was a necessary prerequisite for the discovery of an opportunity, through a process of experimentation and research, but also had a bearing on lead entrepreneurs ability to win backing from resource providers. This was especially true of lead entrepreneurs who had gained full professor status. Their academic status, education level and subsequently attributed reputation compensated for their lack of commercial experience when applying for first round funding from venture capitalists. In terms of

the external environmental context, there was a general trend for lead academic entrepreneurs to be 'pushed' away from their original sponsored environments whilst non-academic entrepreneurs were attracted towards sponsored environments. This observation resulted in movements between sponsored and non-sponsored environments. Resource providers attributed the required movement away from sponsored environments to a potential over reliance, on behalf of the lead entrepreneurs, on easy access resources in a sponsored environment. As a process, opportunity identification was seen as a phase which was re-visited on repeated occasions, depending on resource availability. Lead entrepreneurs' prime initial motivations for forming a firm may have included the manufacture of a product, but as they developed their product and skills as entrepreneurs, their strategies for taking their products to market changed as did their actual products on several occasions. As the lead academic entrepreneurs extended their market knowledge and increased their commercial understanding, for example, their aspirations for their potential product or process changed. The final phase in the coding and analysis procedure was deriving propositions from the data which consisted of linking each proposition with supporting evidence from the data, in the form of quotations and then drawing out a more detached logic for more forward thinking. This forward thinking included an evaluation and building or refining of the theoretical stances used to guide the study.

4.5 Building Theory from Case Studies

Building theory from case-study research as an inductive process is well documented (Glaser and Strauss, 1968; Eisenhardt, 1989; Strauss and Cobin, 1990). A previous criticism of case-study method is that it has relied on combining observations from previous literature and experience without paying sufficient attention to the actual data generated (Eisenhardt, 1989). In this research the data are used to provide description, prepare propositions and build theory. Past research focusing on firm formation by academic entrepreneurs has failed to fully cover the opportunity identification phase of the entrepreneurial process leading to firm formation and has been preoccupied with the latter stages of growth. Through the theoretical lenses of human and social capital theory and the RBV of the firm theoretical propositions emerged from the accounts of experiences offered by the individual entrepreneurs and team members. This was done by being attentive to

subjective experiences which in turn were "abstracted into theoretical statements about causal relations between actors" (Suddaby, 2006, p.635). Ultimately, the goal was to lift data to a level of abstraction above what the data represents itself; "to develop 'bottom-up' interpretive theories that are inextricably 'grounded' in the lived-world" (Cope, 2005, p171). The intent of the study was to build on theory, inductively, and enable a better explanation and understanding of the opportunity identification phase. Theory was emergent when patterns of relationships were recognised within and across cases and rested on the variety of contexts to which it held descriptive power (Cope, 2005; Eisenhardt and Graebner, 2007). This interpretive practice was achieved by developing a 'trustworthy' account of the phenomenon in question (Lincoln and Guba, 1985). Rich description played an important role in the process of inductive theory building through a continual and iterative relationship with the data.

Another strength of building theory from case studies is that the resulting propositions may be used in future studies to test verifiability. The inductive leads to the deductive: "with inductive theory building from cases producing new theory from data and deductive theory testing completing the cycle by using data (*or the propositions resulting from data analysis)* to test theory" (Eisenhardt, 1989; Eisenhardt and Graebner, 2007). Thus, an inductive model begins with observations leading to the building of theory through inductive reasoning. From case studies theory building using the empirical data, from within, can be used to create theoretical constructs and propositions (Colquitt and Zapata, 2007). The resultant theory and propositions are likely to be empirically valid because the proposition building process and the theory building process are intimately tied to empirical observations (Strauss and Corbin, 1990). Because the researcher is close to the data, the interaction with the actual evidence is likely to produce theory that reflects reasons for events described by the interviewees and interpreted by the researcher. In other words, theories are not built with the actual activities or words spoken but through a process of analysing these indicators that are relationally and communally constituted and for which conceptual labels or themes are given.

However, on the negative side, the volume of rich data exuded from the empirical evidence can yield theory that is overly complex. It may be difficult to

assess which are the most important relationships and which are simply idiosyncratic to a particular case (Eisenhardt, 1989). The generated theory itself may also be narrow and idiosyncratic. Since case-study theory building is a bottom up approach, idiosyncrasies may impede the level of generalisation of the theory. In this investigation, the theory building process relied on past literature and empirical observation as well as insight from the researcher to build theory around the inter-related phenomena of resource profiles, opportunity identification and the external environment. Additionally, data extrapolated about the external environment revealed unanticipated changes occurring over a period of time. These changes in external environment are not adequately accounted for in the extant literature. This study allowed for a detailed longitudinal investigation of 'why' and 'how' entrepreneurs chose and changed their environment. The overall aim was to elicit good theory that was parsimonious, testable and logically coherent (Eisenhardt, 1989), grounded in strength of method and evidence so that resulting propositions could be further tested and verified by future research.

Some researchers, in the extreme, claim that, for the purpose of theory building, research questions should emerge from the data rather than the data being guided by the research questions (for a contrary view see Suddaby, 2006). In this case, the research questions were firmly established from extant literature. This approach lies contrary to claims that, as part of the inductive process, "theory-building research is begun as close as possible to the ideal of no theory under consideration and no hypotheses to test" (Eisenhardt, 1989, p 536). In this study, questions were not only linked to extant literature but also linked to several theoretical perspectives. In my defence, this was seen to support the formulation and generation of formal theory building directly from data (Suddaby, 2006). In addition, since the questions asked during the interview were based in the literature, criticisms of the case-study method that any attempt to build theory is limited by the researcher's preconceptions were overcome (Eisenhardt, 1989). The purpose of designing an interview guide was two-fold. One, it focused the study to cope with large volumes of data and two, it permitted me to identify potential and as yet, uncharted differences between different types of lead entrepreneur. The concern was with the relationship between elements

and the rationale behind ‘how things were done’ rather than ‘what things were done’ (Fletcher, 2006).

The final phase in the systematic ordering of data was the comparison of emergent theory with that of extant literature to probe for new and emerging patterns. “Tying the emergent theory to existing literature enhances the internal validity, generalisability, and theoretical level of the theory building from case study research…because the findings often rest on a very limited number of cases” (Eisenhardt 1989, p.545). Some data substantiated previous research whilst others were used to build new theoretical understanding. This theory building process “was suited to efforts to understand the process by which the actors construct meaning out of their intersubjective experience” (Suddabay, 2006, p 634). A process of cross case comparison and within case comparisons ensued, sifting through the narratives for individuals interpretations of processes, reactions to barriers, resources accumulation through team member recruitment and consequences of their actions. Links between narratives, between and within cases, were made by identifying different or similar interpretations about similar events, processes and contact with team members. New themes were also identified. The theory building processes was managed using a software program NVivo, computer assisted qualitative data analysis software (CAQDAS), which stored all the narratives and made cross referencing and comparison accessible. During each comparison, the program managed, dated and ordered each step and allowed notes to be attached to each decision for later reflection. The program did not direct the analysis but provided a system of storage and provide a means of keeping an audit trail for conceptual development (e.g. developing abstract thoughts into more clearly thought out ones).

4.6. Summary

This chapter outlined my key paradigm stance. The interpretivist paradigm was selected to explore the research questions which probed for reasons behind a process influenced by human behaviour. Using a process approach to the study the intention was to elicit from lead entrepreneurs a narrative interpretation of their actions and behaviour towards the identification of an opportunity leading to， but prior to， the decision to form a firm. Relying on an interpretation of events, processes and

reactions to people a qualitative methodology allowed the interpretation of data provided (not imposed on) by the 'social actors'. Accordingly, the methods used to gain access to information about opportunity identification, team membership and the external environment, consisted predominantly of a case-study approach using active interview techniques where participants were given an opportunity to answer questions guided by an interview schedule. A grounded theory approach was rejected because empirical observation was initially framed in a conceptual model, influenced by prior research. There was an awareness of what had gone before in terms of literature and theory (Suddaby, 2007). Theories allowing an inductive or 'inside out' view of processes were identified relating to the resource strengths of human capital and the influence of social capital; the advantages of attracting and leveraging resources from a RBV perspective from within and from the external environment (e.g. information search and resource accumulation leading to firm formation behaviour). The aim was build on theory from these theoretical perspectives and to build propositions which could be used for future deductive study. The data, events and characteristics were related to the opportunity identification process through induction. Theoretical explanations for the processes observed were elicited from observations about the data which matched already standing theoretical concepts but also sought new explanations. As stated, three theoretical perspectives were used to capture different aspects of the multi-level process of opportunity identification. This allowed a matching of theoretical perspectives to evolving empirical rich data in an interactive process. Concerns about reliability and validity were emphasised centring on participant triangulation of information and to a lesser extent secondary data in the form of publications and general observation. This chapter covered all aspects of data collection and analysis with respect to the pilot study, to pre-testing of the investigative tools, the electronic survey leading to the selection of cases and the process used to analyse the interviews.

The following chapters present the findings, results and analysis of the case studies. Chapter 5 covers the findings associated with people and are related to The Entrepreneur (Theme one) and Team Formation (Theme two) outlined in the conceptual model in Chapter 2. Chapter 6 summarises the findings covering The Entrepreneurial Process (Theme 3) and explores how lead entrepreneurs identify and

exploit opportunities for firm creation. The influence of the external environment on access to resources, Location (Theme 4) is the subject of Chapter 7.

Chapter 5: Case Analysis:

The Entrepreneur and Team Membership

5.1 Introduction

In this chapter the role of intangible resources (e.g. human capital and social capital) brought by and embedded within the individuals influencing opportunity identification is explored. Cases are with regard to the typology presented in Chapter 4 (Figure 4.14). The following sections explore 'people' associated with opportunity identification as the central theme and are structured as follows. The conceptual model, as presented in Chapter 3 (Figure 3.1) is reviewed in Section 5.2. Section 5.3 relates to lead entrepreneurs (Theme 1 of the conceptual model) giving a brief synopsis of their identified opportunities, their resource profiles and the external environment in which they locate. A cross case comparison of resource profiles is offered in Section 5.4. The entrepreneurial ownership team is considered in section 5.5 (Theme 2) which concludes with a cross-case and between case comparison of resource profiles brought by individual members in Section 5.6. Propositions are derived from the comparative and between case analysis. Presented conclusions are summarised in Section 5.7.

5.2 The Conceptual Model Re-visited

Using the conceptual model as a guide (Figure 3.1), two themes will be explored. The first concentrates on the individual cases and in particular the lead entrepreneur(s) (Theme 1) who were associated with and instigated the opportunity identification process. The lead entrepreneur(s) in this study had, either individually or with the aid of team members, identified entrepreneurial opportunities, within the life-science sector, and in response all had chosen to start a new independent company to evaluate and potentially exploit their discovery. A comparison of these opportunities allows for an exploration of individual resource profiles, perceived barriers to commercialisation and differences in individual approach. Comparison helps to answer the following research question:

Research Question 1: 'How' different are lead academic and lead non-academic entrepreneurs' initial resource profiles?

Second, team formation (Theme 2) explores the role of social and human capital in relation to resource accumulation as it relates to team member recruitment and in particular 'how' the lead entrepreneurs knew of and knew where to look for team members. In other words, how they supported their tacit scientific knowledge (e.g. know how) and their explicit knowledge conveyed in procedures (e.g. know what) with social capital (e.g. know-who) (Anderson and Jack, 2002). In past studies team members have been identified because they held equity stakes in the business (e.g. entrepreneurial ownership team members) and had a key role to play in strategic decision-making during opportunity identification, in order to exploit their human capital (Ucbasaran et al., 2003a). In this study that definition is extended to include non-equity holding members such as advisers and mentors or 'privileged witnesses' (Vanaelst et al., 2006) who sometimes work on behalf of an HEI or a governmental business development agency. Access to 'privileged witnesses', through a social network, increased some entrepreneurs understanding of the entrepreneurial process. Human capital, however, was influential in opening up social networks. Comparison between lead academic and lead non-academic entrepreneurs on sponsored and non-sponsored environments helps to explore the following research questions:

Research Question 2: 'Why' do lead academic and lead non-academic entrepreneurs form entrepreneurial ownership teams?

Research Question 3: 'How' do lead academic and lead non-academic entrepreneurs form entrepreneurial ownership teams?

Research Question 4: 'Where' do lead academic and lead non-academic entrepreneurs find potential entrepreneurial ownership team members?

5.3 Entrepreneur(s): The Context (Theme 1)

Data was gathered from lead entrepreneurs relating to 'why', 'how' and 'when' they identified their opportunities for commercialisation. It has been proposed that "without developing or accessing the capability to combine scientific knowledge with a commercially feasible offering that satisfies an unfulfilled market need, academic scientists would not be able to proceed towards commercializing their technologies" (Vohora et al, 2004, p.161). For this to happen, there has to be processes to develop new business concepts and processes to access and reconfigure resources for firm formation. In my analysis of 'why', 'how' and 'when' this happened I shall present data (e.g. quotes from the entrepreneurs) in series of comparative quadrants. These

'quote quadrants' offer reflections on resource leverage and exploitation, and the influence of human capital on social capital (and vice versa) and their effect on resources accumulation. Descriptive personal profiles of lead entrepreneurs are summarised from observed and spoken responses elicited during interview.

5.3.1 Lead Academic Entrepreneurs on Sponsored Environments

With regard to lead academic entrepreneurs on the sponsored environments, four companies were studied in Quadrant 1 (Q1, Table 5.1). Company 1 was considered a solo start founded by a PhD student at an HEI. He was researching and developing a test kit to detect toxicity using florescent fungi as the detection medium. The technology was created during his PhD project. Design faults in a similar product, identified at a trade conference, sparked the idea for his new product. The founder owned the intellectual property (IP) attached to his technology. An MBA student has since joined the company, as an equity holder, and brings experience from prior exposure in the pharmaceutical industry. To help with market research another scientist from the same HEI was recruited. The product is targeted at companies in the pharmaceutical and biotechnology sector and is a stand-alone unit that does not rely on external sources of power. The company is based within the incubator unit of the HEI.

Company 2 was founded by four people, three of whom were originally employees of the same HEI. The fourth is an entrepreneur owning and managing a chemical business in the United States of America (USA). Company 2 researches the development of a catalytic enzyme for the chemical industry (Q1, Table 5.1). The technology was taken out of the HEI as an academic technology working in the laboratory with the intention of taking it to large-scale industrial manufacture. Negotiation over the use of the IP, attached to the bioprocess, was conducted between the entrepreneurial ownership team and the owners of the IP, the university and a pharmaceutical company presently employing the university on contract work to create the new catalytic enzyme. Currently, the entrepreneurs are subsidising research and development work with contract research. The company is using redundant laboratory space based within a department in the HEI.

Table 5.1: Human Capital (HK) Profiles of Lead Academic and Non-Academic Entrepreneurs Related to Opportunity Identification.

	Sponsored Environment				Non–Sponsored Environment			
	Co.	*HK related to Opportunity Identification*	*HK related to product / process*	*HK related to market need*	Co.	*HK related to Opportunity Identification*	*HK related to product / process*	*HK related to market need*
Academic Entrepreneur	***Q1*** **1**	Doctorate; HEI research experience; business classes	Novel knowledge from PhD research	Knowledge of weaknesses of competitors' products	***Q2*** **5**	Doctorate; HEI & contract research experience	Combining engineering and science based skills	Designed and tested prototype on instrument which makes easier drug testing; contract work experience
	2	Doctorate; HEI research experience; industrial experience	Work experience; research skills; business ownership; entrepreneurship fellowship	Acclaimed academic reputation; known and identified customer; contact with industrial sector at conferences				
	3	Doctorate; clinical and HEI research; contact with industrial players	Dentistry; contact with industrial players at conferences	Knowledge of dental hygiene sector from clinical and industrial perspective				
	4	Doctorate; clinical and HEI research; patient contact	Surgery; contact with a manufacturer of medical devises	Knowledge of weaknesses of competitors products				
Non-Academic Entrepreneur	***Q3*** **8**	Professional; prior business ownership experience; market survey	Combining skills; academic and engineering reputations	Prior work and contract work; market survey; scientific expertise	***Q4*** **6**	Doctorate; prior business ownership experience; customer contact	Knowledge of instrument design from past work experience	Knowledge of instrumentation and customer needs
					7	Doctorate; work and industrial research experience	Scientific expertise; no commercial experience	Work experience in the pharmaceutical sector; knowledge of competitors' strategies
					9	Professional; knowledge of ill effects of pesticides	No knowledge of industrial sector or certification process	No prior knowledge of market or of commercialisation

Two clinicians working as academics within the same HEI formed Company 3. The development of their product, an instrument for detecting tooth decay, was the result of combined research at two HEIs. Dealing with two HEIs was considered a barrier to commercialisation by the lead entrepreneurs because they had to negotiate with both HEIs over the use of the IP. Opportunity identification took place within the scientific setting of laboratories of the two HEIs over a number of years (Q1, Table 5.1). The practising dental clinicians leading the project processed knowledge of the need for their product from their dental hygiene work, from their laboratory work and from their network of contacts, within academia and industry, met at technical conferences. As dentists, they are potential end users of their product. One industrial player, a toothpaste manufacturer, had offered to buy the license to their knowledge, confirming that there was a commercial interest in and a market need for their product. The company was incubated in the Technology Transfer Office (TTO) of the lead HEI and eventually relocated to a local technology park.

Company 4 was founded by three clinicians working within the same hospital trust. Their product, a vascular graft of revolutionary design and made of new material, originated from observations made by the lead entrepreneur, a surgeon, during laboratory research investigating blood flow (Q1, Table 5.1). Negotiations with the HEI were conducted for use of the IP. The need for the vascular graft was obvious to the doctors because there was a high failure rate of currently available products (i.e. measured by the number of amputations conducted). They are potential end users of their own product. Using new blood flow technology the clinicians developed a human prototype vascular graft. To date the product has not been tested in humans. The company was formed at the HEI and is being incubated on a technology park.

5.3.2 Lead Academic Entrepreneurs on Non-Sponsored Environments

In Quadrant 2, the latest version of Company 5 grew out of a previous commercial venture created by a biologist and an opto-electronics engineer working out of a garage (Q2, Table 5.1). The lead entrepreneur (the biologist) and the engineer formed a company to combine their talents and skills. The formation of a company enabled them to access local business development funding. With the funding they were able to conduct experiments to further their understanding of the technology for

instrumentation to test pharmaceuticals. Although initial results were positive the company was short lived. The lead entrepreneur (the biologist) moved to a new HEI and he assigned the Intellectual Property (IP) to the university. Additionally, he sought the assistance of another academic and together they conducted more research and development on an instrument to test the effect of drugs using ethically donated human tissue. Subsequently, Company 5 was created in a university department. In parallel, the academics also offered contract research to the pharmaceutical sector to support the research and development of their own instrument. After a short period of incubation within the HEI department Company 5 moved to a business park. Once sufficient funding was raised the entrepreneurs moved back into an incubator unit at another HEI and resigned from their duties as academics at their original HEI.

5.3.3 Lead Non-Academic Entrepreneurs on Sponsored Environments

In Quadrant 3 (Q3, Table 5.1) an entrepreneurial ownership team consisting of two engineers and two academics founded Company 8. Currently the engineers, who are the lead entrepreneurs, are involved in the design and development of a miniaturised tape product to allow for high-through-put information for DNA separation for use in laboratories. Opportunity identification centred on the miniaturisation of a cumbersome laboratory process identified by the academics. The academics remain full-time employees of the HEI and act as scientific advisors to the engineers who devote all their time to the formation and incubation of the company. Opportunity identification and initial company incubation began in a borrowed HEI laboratory. Further development and prototype manufacture of the tape is now conducted at an industrial unit. The academics in the team are examples of potential customers.

5.3.4 Lead Non-Academic Entrepreneurs on Non-Sponsored Environments

Quadrant 4 housed three cases. A lead non-academic ‘serial entrepreneur’ had liquidated his earlier firm, involved in the distribution of new technology equipment, to found Company 6 (Q4, Table 5.1). The IP associated with the research, development and design of a new instrument to test drugs using scatter light technology, originated from the previous company. A prototype instrument was available for demonstrations. Using previous market knowledge and based on perceived customer need, the lead entrepreneur identified this type of instrument as

having market value. The company recently moved from residential premises to a local technology park.

Two scientists who had been made redundant from a large pharmaceutical company founded Company 7. One had a background in molecular biology and in cell line development whilst the other scientist had a background in project management and diagnostic product developments, specifically with human monoclonal antibodies. A global change in research strategy within the pharmaceutical sector meant that the majority of primary research was being licensed in from outside companies. The two lead entrepreneurs took advantage of this knowledge. Their underlying goal was to create special diagnostic products to treat or prevent infectious diseases. To underpin the financial needs of the company, contract research services were offered to other bio-tech or bio-pharmaceutical companies involving the development of special cell lines (Q4, Table 5.1). The lead entrepreneurs identified the market opportunity whilst working for their previous employer. They incubated the company in residential premises and only after winning a contract relocated the business to sub-let laboratory space and, more recently, to an independent unit within the same science park.

Three friends, an architect (the lead entrepreneur), a shepherd and a scientist founded Company 9, located on a hill sheep farm (Q4, Table 5.1). They formed a company in response to the negative publicity associated with the ill health of farmers related to the use of organo-phosphate found in sheep dip. None of the original team had business experience. Recognition of the need for an alternative chemical led to preliminary testing. Lacking in business experience the entrepreneurs opted for a managed model approach to the incubation of their company and hired a managerial company promoting early ventures. Due to a lack of diligence over the filing of a patent, the lead entrepreneur dismissed the management company and hired a skeleton staff to run a reformed company. Additionally, there was a product change. Through further development and testing of their original compound, new products for the eradication of head-lice and mosquitoes have been produced but are, as yet, still uncertified. Company 9 has relocated three times. From the farm they moved to offices within the managerial company and thereafter they re-located to independent office space.

5.4 Cross-Case Comparison of Resource Profiles of Lead Entrepreneurs

The following section explores and compares the resource profiles of lead entrepreneurs (Brush et al., 2001) at opportunity identification and helps answer:

Research Question 1: 'How' different are lead academic and lead non-academic entrepreneurs' initial resource profiles?

All lead academic HEI entrepreneurs located on sponsored and non-sponsored environments were male and they were educated to doctoral level. Three of the lead academic entrepreneurs were full professors. Similarly, all the lead non-academic entrepreneurs, excluding two, had acquired a doctorate, but they had pursued a variety of professions. Only one was a woman. Companies 6 and 7 relate to scientists, Company 8 was an engineer and Company 9 was an architect. Lead academic entrepreneurs focusing upon technological solutions leveraged knowledge acquired from PhD investigation, contract work or personal, basic academic research.

Company 1 illustrates that a doctoral study led to a novel medium for testing toxicity (e.g. through the illumination of fungi). The lead entrepreneur's knowledge of the weaknesses of competitors' products also gave him competitive advantage. However, it was the lead entrepreneur's personal network interaction, more than his resource profile associated with education, which allowed access to valuable information. His interaction with actors in the market place (Q1a, Table 5.2) and with other scientists allowed assessment of available testing kits on the market

Table 5.2: Human and Social Capital Related to Opportunity Identification

	Q1 Sponsored Environment	Q2 Non-Sponsored Environment
Academic Entrepreneur	**Human Capital**: Doctoral education; Clinical practice; Patient feedback; Contract work from industry; Individual academic research; Market knowledge; Multi-disciplinary teams; Business classes and fellowship courses. **Social Capital**: Industrial and technical contacts. **a)** *"So, fungi, I specialise in them and I think there is definitely a market for sensors using fungi in this kit. That was the first thing I identified and then around that time I was looking for glow in the dark genes to put in the fungi and I got to know this company in the States .. and he offered us the deal to distribute their products and gave us licences to use their genes as well"* (Lead Entrepreneur, Academic, Company1). **b)** *"I had done my PhD on caries detection. I was a clinician and knew how difficult it was. At that time X was a member of a European organization for caries research and it was clear from the literature and from the technical conferences that really this was an important area for clinicians because the fluoride toothpaste effect had decreased decay overall but had made detection more difficult"* (Lead Entrepreneur, Dentist, Company 3)	**Human Capital**: Education; Contract research experience. Multi-disciplinary technical knowledge. **Social Capital**: Multi-disciplinary technical contacts. **c)** *"I was working in a particular area of biology and socially (*I met*) an optical engineer ……we became friends… and we started literally throwing ideas down on the back of an envelope. We constructed some very simple ideas for experiments …and me and my colleague went off and did it in his garage…….It then became a bit more formal in as much as we started to get successful results and we started to figure out some key experiments…..We were quite commercially grounded at that point .. we didn't want to do this in any particular university…"* (Lead Entrepreneur, Biologist, Company 5).
Non-Academic Entrepreneur Q3	**Human Capital**: Education; Professional skills; Market knowledge through survey; Specialist professional knowledge; Multi-disciplinary teams; Previous start up experience. **Social Capital**: Industrial, business adviser (SE) and academic networks. **d)** *" So we asked them (Scottish Enterprise) to commission us to go and look at the opportunities for laboratory automation. They did and they gave us some money and we did our tour of the biotech cluster in Scotland and part of that early on we realised that early on we would need biotech expertise"* (Lead Entrepreneur, Engineer, Company 8). **e)** *"I have been in product development for a long time. Accumulated 30, 30 something years. From hands on engineer to departmental manager. I have also had a couple of other start-ups. Been through the start-up loop already"* (Lead Entrepreneur, Engineer, Company 8).	**Human Capital**: Education; Technical knowledge; Industrial research experience; Market knowledge in connection to strategy; Previous (and no) start up experience. **Social Capital**: Industrial and commercial contacts **f)** *"I had another company based down in North X where the intention had been to sell it off when we were launching Company 6 but 2001 was not a good time to be doing anything of that sort so we ended up liquidating it. This is a new start-up in that sense but all the ideas were obviously from the old company and some being intellectual property"* (Lead Entrepreneur, Company 6). **g)** *"As a market place especially in the area of antibodies there are quite a few companies out there developing antibodies. …We wanted to avoid competing in those areas and I can say how we chose infectious disease. We knew the market was growing and that there were not that many players and ultimately we never intended to manufacture our own products we would always be out licensing it to a larger bio tech or pharmaceutical company"*(Lead Entrepreneur, Scientist, Company 7).

and access to glow in the dark genes. He created these network bridges within the science community through exposure of his research to the academic community and accumulated a broader legitimacy for commercialisation by "getting to know" a company in the States with whom he developed a reciprocal and mutually beneficial relationship. Educational attainment, industrial contract research and subsequent developments stimulated two opportunities relating to the potential discovery of an intermediate chemical compound (Company 2). Again, prior interpersonal interaction with industrial players sparked opportunities with commercial potential. The importance of a network association between academics and industrial players has been recognised in earlier studies (Johannssion, 1998; Shane and Stuart, 2000; Nicolaou and Birley, 2003b). In these two cases the academic entrepreneurs, although restricted to the non-commercial HEI environment, were able to develop social capital because of a proactive search for a specific product (Company1) and because of previous exposure to industrial contract work and previous connections with the industrial community established from prior work experience and through the network of a surrogate entrepreneur (Company 2).

Companies 3 and 4 housed highly respected lead academic entrepreneurs who had honed their technical capabilities with regard to novel dental and medical devices (Q1b, Table 5.2). Both entrepreneurs, who were potential end users of their new devices, constantly received feedback from patients about the weaknesses of current products. In a study of the Massachusetts Institute of Technology (MIT) Shane (2000) found that prior knowledge of a particular market increased the likelihood of discovering an opportunity in that market. This kind of knowledge was transferred from a technical and strategic perspective as lead entrepreneurs searched for information sources to support their opportunities. Prior knowledge, about patients' problems, in the case of clinicians, influenced the opportunities they discovered and supports findings from Davidsson and Honig (2003) that demonstrated the importance of using specific human capital to identify opportunities. The academic entrepreneurs had one major competitive advantage over non-academic entrepreneurs: they were both the inventors of a new technology, and, the potential end users. A gap between the identification of a need and the customers' ability to communicate the need has been highlighted as a challenge (Cohen and Levinthal, 1990). In Companies 3 and 4, the academic entrepreneurs were the transmitters of new tacit knowledge (the need),

and at the same time the recipients of the new knowledge (the solution) (Nonaka, 1995). They were the people who identified the need and were able to articulate a solution. They could identify gaps in the market relating to their area of expertise which allowed them to identify opportunities in that area. Academic lead entrepreneurs thus had an insight into market needs 'from an insider' perspective and also displayed sufficient human capital (e.g. scientific knowledge) to seek solutions to these challenges. However, embedded human capital relating to knowledge of their areas of speciality (e.g. their academic and research skills and expertise) was not well supported by a social network which extended to the industrial sector. Connections with industrial players were known because of prior contractual work with an industrial player (Company 2) or through serendipitous meetings (Company 1) which increased their understanding of market knowledge. However, the lead entrepreneurs of Companies 3 and 4 reported that their contact was restricted to meetings with industrial players at technical conferences. In respect to commercial sector entrepreneurs the latter two companies displayed a lack of broad social networks (Westhead and Wright, 1998)

Where their research concerned medical or dental technologies it was not unusual for the lead academic entrepreneurs to be working as clinicians in parallel with their academic career. The academic reputation of the lead academic entrepreneur(s) acted as a positive influence on industrial players who often knew the academic entrepreneurs as academics or clinicians prior to their embarkation on an entrepreneurial career. Their academic reputations acted as compensation to counterbalance a lack of reputation within the business community (Meyer and Rowan, 1977) and increased their chances of gaining private equity. This finding lies contrary to Mosey and Wright's (2007) finding that novice academic entrepreneurs encountered structural holes to providers of equity finance and management knowledge. In this study the likelihood of a firm winning private equity finance was related to the reputational attainments. Similarly, in a recent study relating to founder's human capital and the growth of new technology-based firms (NTBFs) in a sample composed of 506 Italian young companies (Colombo and Grilli, 2005), levels of education (i.e. general human capital) had a positive influence on raising finance.

With reference to Quadrant 2 the lead academic entrepreneur (biologist) and entrepreneurial ownership team member (engineer) in Company 5 selected a non-sponsored environment at opportunity identification. They originated from different HEIs and displayed a forte for basic research in their individual fields. Both wished to test their ideas for a new technology whilst maintaining ownership of their IP (Q2c, Table 5.2). In nearly all cases involving lead academic entrepreneurs, the HEI laid claim to all knowledge generated from their institutions.

With regard to Quadrant 3, Company 8 is led by a non-academic entrepreneur who exhibited diverse technical and entrepreneurship-specific human capital (Q3d and e, Table 5.2). He was known to and had prior connections to the national, governmental business advice sector (Scottish Enterprise). This engineer selected a sponsored environment to acquire detailed knowledge of a scientific procedure. A difference between lead academic entrepreneurs and non-academic entrepreneurs, on sponsored environments was noted. Lead academic entrepreneurs with no commercial experience sought advice from the support structures within the HEI system. Non-academic entrepreneurs selected sponsored environments because they lacked technical scientific knowledge and needed to be in close proximity to the scientists during the opportunity identification process to define their product / process. What the engineers lacked in the knowledge about the scientific process was compensated for by their specialist engineering knowledge and previous start up experience. Their past successful start up experiences also gave them privileged access to known resource providers (e.g. business advisers and funders). Networks and network structures represented facets of social capital that influenced the range of information available and attainable from previous contacts. During the qualitative interviews with lead non-academic entrepreneurs on sponsored environments it became evident that they gave credence to their past employment experiences and drew from their tacit knowledge strategies, customer preferences, an array of contacts including customers, suppliers and other industrial players (Brüderl et al., 1992; Gimeno et al., 1997; Brush et al., 2001). Industrial specific knowledge gave distinctive competitive advantage to the lead non-academic entrepreneurs for value creation when forming the companies. The advantage came from previous business ownership, knowledge of the market, managerial experience and anticipation of market trends.

With respect to Quadrant 4, the lead non-academic entrepreneur relating to Company 6 did not require a sponsored environment because he had already accumulated business ownership experience and detailed industry know-how. He amassed managerial capabilities and conducted in-depth evaluations of actual and potential customer needs (Q4f, Table 5.2). Non-academic entrepreneurs relating to Companies 7 and 9 did not have any prior business ownership experience to leverage and had limited access to social networks outside their immediate environments, data which substantiated research on nascent entrepreneurs by Mosey and Wright (2007). The lead entrepreneurs relating to Company 7 had previous knowledge of the pharmaceutical industry (Q4g, Table 5.2). Lead non-academic entrepreneurs in Companies 6 and 7 were educated to doctoral level and had substantial working experience within specialist areas of science. The lead entrepreneurs associated with company 6 had accumulated knowledge about customer needs whilst in Company 7 their advantage came from having 'inside' information about competitors' products and strategies from years of working experience.

Similarities between the resource profiles of lead academic and lead non-academic entrepreneurs related to their ability to identify opportunities, which were either connected to their research expertise or to their work expertise. Lead academic entrepreneurs were often forerunners in their field of research and non-academic entrepreneurs possessed specialised expertise associated with prior or current work experiences. Knowledge of their respective areas of research and work experience were utilised to identify opportunities leading to the development of a product or process. More lead non-academic entrepreneurs had specific human capital pertaining to prior entrepreneurial experience. Generally, in contrast to the superior technical human capital that the lead academic entrepreneurs possessed, human capital relating to managerial and entrepreneurial capabilities had to be sought from external sources. Similarity between the proposed new venture and past experiences, gathered from clinical or research exposure, allowed some lead academic entrepreneurs to build on prior relationships with relevant stakeholders.

These observations lead to the following propositions:

Proposition 1: Lead academic entrepreneurs are more likely to identify opportunities from their basic research and are technology focused whereas non-academic entrepreneurs are focused on opportunities identified from market needs and market knowledge.

Proposition 2: Lead academic entrepreneurs are more likely than non-academic entrepreneurs to be potential end users of their identified opportunities.

Proposition 3: Lead non-academic entrepreneurs are more likely to be known within governmental business advisory networks from their prior start up experience whereas lead academic entrepreneurs with less or no start-up experience are forced to rely on the advice offered by the HEI.

5.4.1 Cross-Case Comparison of Location Choice of Lead Entrepreneurs

On the whole, lead academic entrepreneurs on sponsored environments had access to a greater number of information sources than non-academic entrepreneurs on non-sponsored environments. Academic entrepreneurs were less likely to have network contacts to people with commercial knowledge and relied on the resources within their external environment (e.g. the physical facilities of the HEI and resource networks of the TTOs). Non-academic entrepreneurs on non-sponsored environments with entrepreneurial specific capital and with managerial experience from former employment systematically sought out information, both technical and commercial, from other sources (e.g. business advisory agencies and academics).

There appeared to be differences between the two external environments. Lead academic entrepreneurs generally located on sponsored environments because their research originated within the protected environment of the HEIs (Q1a, Table 5.3). They were encouraged by their HEIs and their technology transfer officers (TTOs) to use the facilities of the HEI which included incubator units and laboratory space. Additionally, TTOs were also responsible for accessing preliminary funding sources which were necessary for firm formation and market exploitation. Their task was to synergise resource combinations using contacts within and outside the HEI. This often took the form of introducing the local business development agency to the lead entrepreneur. Generally, combining the resources held by the lead entrepreneur with those at the disposal of the business agency enhanced the chances of firm formation. Such linkages were positive in gaining access to people with experience in finding

Table 5.3: Location Choice Influences

	Q1 → → Sponsored Environment	Q2 → → Non-Sponsored Environment
Academic Entrepreneur	**Resource profile**: Clinical practice and access to patients; Access to HEI facilities; Network with industrial players and academics at conferences; Ability to network and run international trials; Ability to negotiate use of IP or IP ownership. **a)** *"Because we were here* (the HEI) *to start with. We saw there was an opportunity for us to get some facilities here and it has numerous advantages to being here e.g. proximity to equipment and the people we are already familiar with. It is cheap compared to going out of the university ...Our overheads allows us to operate the business when we have proximity to* The Professor *and the procurement stores, services, so access to broadband, library facilities, on line journals. I think initially the big thing was the facilities"* (Team Member, Post Doc, Company 2).	**Resource profile**: Ability to combine engineering and science based skills; Ability to negotiate IP ownership. **b)** *"I'll tell you an anecdotal story. I was supervising a girl who was doing an honours project while I was doing my PhD and her husband came to pick her up from work and he was an optical engineer and he was asking us what we were doing so we described it. We just started chatting about how his work interacted with what we were trying to do. Then, that was it, about 6 months to a year later, we became friends, sort of personal friends and we were literally in a pub talking about the kind of things I did and the kind of things he did and we started literally throwing ideas down on the back of an envelope. We constructed some very simple ideas for experiments in our heads and me and my colleague went off and did it in his garage. Very much your standard inventor type stuff."* (Lead Entrepreneur, Biologist, Company 5).
Non-Academic Entrepreneur → Q3	**Resource profile**: Ability to combine engineering and science based skills with business acumen. **c)** *"I have an engineering background and so does* (the lead entrepreneur) *and we were in this world of Life-science. One of the first places we visited was the* HEI *Centre which had recently been created at* HEI's *Medical School and a chap there called Professor, who had recently come back from the States, he was heading up a group and ....we decided to get our heads together and come up with some ideas. They presented us with some problems and we came up with some solutions"* ...(Team Member, Engineer, Company 8) **d)** *"So at the very initial stage we had ...permission from the university and the appropriate people ...to use some vacated labs some old redundant lab space in which they could set up and do their market research and consultancy work that they were doing but also use it as a base which we could use and formulate and work with them to develop business plans, have meetings, think about future directions etc ....It has always been quite a close relationship between* Company 8 *and* the HEI*"* (Team Member, Academic, Company 8)	**Resource profile**: Prior start up experience; Awareness of social problems associated with scientific practice; Scientific expertise. **e)** *"We came to* this location *from North XX. We started the company with some office accommodation from* the local HEI which they *lent to us. We were talking to* the HEI *and* the local business development agency *about trying to re-locate here and* the local business development agency *were very proactive in trying to encourage us to start up again. They gave us access to lawyers and accountants and things like that."* (Lead Entrepreneur, Company 6). **f)** "We started *initially on a farm in East Lothian which was our home. But we moved to* another location *when XX Company invested in us. After 2/3 years the company changed its name to Company 9 and a dedicated management team were found and appointed and Company 9 left that engineering group and moved to offices in the middle of Edinburgh. All trials and chemical scientific work has been sub contracted."* (Lead Entrepreneur, Architect, Company 9).

funding, improving management within the firm and providing avenues for experimenting with new ideas.

Thereafter, if the entrepreneurs chose to relocate, or were forced to re-locate, other forms of sponsored environments were considered, again recommended by the TTOs (e.g. science parks, technology parks). The lead academic entrepreneur relating to Company 5 did not develop his technology within the confines of his HEI because he worked with another professional from another HEI. Their aim was to test the new technology and not develop a product and for this reason they required ownership of their IP which was later assigned to a new HEI (Q2b, Table 5.3). The lead non-academic entrepreneur relating to Company 8 had previous start up experience and selected a sponsored environment because he had no knowledge of life-science. He decided to remain close to the academic entrepreneurial ownership team members in order to gain access to basic and vital information (Q3c and d, Table 5.3). Two out of the three lead non-academic entrepreneurs located on non-sponsored environments cited prior knowledge about markets and customer needs but chose non-sponsored environments (Q4e, Table 5.3). Company 9, however, had no previous market, customer or commercial experience and started life as a farm project prior to a history of location changes (Q4f, Table 5.3). Overall, non-academic entrepreneurs knew the value of seeking information prior to identifying and exploiting an idea. One reason for this was that the opportunities identified by academic entrepreneurs were firmly anchored in their basic research work within the HEI whilst non-academic entrepreneurs based their opportunities on observing market opportunities. Those academic entrepreneurs with greater leaning towards technical searches had to be encouraged and trained, through entrepreneurial fellowship training, to increase their searches because they were less aware of commercial needs and market requirements. This discussion suggests the following propositions:

Proposition 4: Lead academic entrepreneurs on sponsored environments have access to more physical, social, financial and business advisory resources than lead non-academic entrepreneurs on non-sponsored environments.

Proposition 5: Lead non-academic entrepreneurs wish to locate on sponsored environments to seek proximity to scientists during opportunity identification in order to identify and define their product whereas lead academic entrepreneurs wish to remain on sponsored environments because of the superior access to resources.

5.4.2 Cross-Case Comparison of Social Capital of Lead Entrepreneurs

Some lead entrepreneurs increased their commercial knowledge by attending classes in business development (Company 1) and participating in a sponsored fellowship course in entrepreneurship, designed and facilitated by the HEI for post doctoral academics in the life-science sector interested in commercialisation (Companies 2 and 5). Company 2 was also able to use the knowledge and skills of one of their lead entrepreneurs who was a practicing entrepreneur. The Industrial Fellow brought to Company 2 useful managerial experience. This tacit knowledge in management and supervision was gained whilst working in small autonomous units in a large company in the USA. Both brought prior known contacts to the industrial sector and potential customers. These knowledge based resources, in contrast to property based resources (e.g. machinery, equipment etc.), were tacit in nature and cannot be protected easily against loss or transference (Miller and Shamie, 1996). Combing and leveraging knowledge based resources and creating firm specific ties clearly adds value to the organisation (Leana and Van Buren, 1999). These observations tie in neatly with the RBV of the firm which advocates that advantages and value creation accrues from the creation of unique bundles of resources that competitors are unable to imitate (Barney, 1991; Wernerfelt, 1984).

The lead entrepreneurs in Companies 3 and 4 were not only highly qualified and respected academics they were clinicians and advisers in dentistry and medicine. They were, however, aware of their entrepreneurial limitations and cognisant of the importance of their entrepreneurial ownership team sourced through the help of business development agents (Q1a, Table 5.4). Out of the body of academic entrepreneurs only one, from Company 5, had previous start-up experience but he admitted to attaching much importance to a piece of market research work sponsored by the governmental business development agency (Q2b, Table 5.4). One of the findings in a recent study about serial, novice and portfolio entrepreneurs indicates that serial entrepreneurs may require support in terms of addressing market-related aspects when identifying business opportunities (Westhead et al., 2005). This was substantiated from evidence from Company 5 whose academic entrepreneur, a serial entrepreneur, pinned importance on subsidised market research conducted by the local business development agency. He was also open and willing to interact and network with industrial players who offered substantial market information.

Table 5.4: Social Capital Networks

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**Social Capital**: Ability to attract and recruit people and develop a network of contacts to apply for funding and investment; Attendance at business classes and fellowship foundation courses for entrepreneurship. **a)** *"The key issues spinning out were knowing what we don't know and as wet behind the ears dentists we know we didn't know about finance, we know we didn't know about management we know we didn't know about quality control systems and having the appropriate corporate governance. So if you like what has been successful has been the marriage of an atypical clinician who is obstinate and doesn't give in and a very focused chairman with a very well established network of connections both in the city and with individuals. ...We have always been very clear about our limitations. Success such that we have comes out of a team that is totally committed to performing as a team."* (Lead Entrepreneur, Dentist, Company 3).	**Social Capital**: Ability to network and recruit people with industry experience and recruit business development expertise. **b)** *She* (from Scottish Enterprise) *funded a feasibility study. It was 12,000 pounds for a feasibility study. Now that is a lot of money for anyone to give to a company to do a feasibility study. So they gave it to an independent company called XX Technologies ....XX came up and did a series of meetings with us and then just went out and tested the market. The key thing that they did was that they did transcripts of the conversations and we still use them today. They interviewed key opinion leaders in the States and in Europe and did a really good job. I know it cost 12,000 but it is still the best piece of consultancy we have had done. That document, that report came back with certain criticisms and certain problems but 90% of it was positive. It said you guys are onto something."* (Lead Entrepreneur, Biologist, Company 5).
Q3 Non-Academic Entrepreneur	**Social Capital**: Ability to attract and recruit people and develop a network of contacts to apply for funding and investment. **c)** *"One of the things they* (investors) *liked about the founding team is that as well as combining engineering and science, there was a bit of commercial savvy as well. There was good industrial management skills. We were all tagged as techies but we all knew how to manage what we were doing and I think historically a lot of this stuff has spun out of universities and a lot of interesting ventures have floundered because the founding team does not have the breadth of exposure to managing projects"* (Lead Entrepreneur, Engineer, Company 8).	**Social Capital**: Ability to attract and recruit people and develop a network of contacts to apply for funding, investment and technical assistance. **d)** *"Neither R nor I had tried to set up a company before and did not have a lot of experience in developing business plans."* (Lead Entrepreneur, Company, 7) **e)** *"We also realised that we needed expertise to develop the idea so we went to; after quite a long assessment; we went to a firm in XXX who were offering management of early stage companies, management and funding for early stage companies. These people were called XXX. But they had no experience in bioscience or biotech companies but they took us on, the company which we formed called Company 9"* (Lead Entrepreneur, Architect, Company 9).

Lead non-academic entrepreneurs on sponsored and non-sponsored environments came from an array of different professions. The lead engineering entrepreneur in Company 8 brought with him very specific entrepreneurial human capital and skills associated with his profession. His network with the business advisory sector was strong based on his past successful entrepreneurial experiences. The knowledge he lacked about the life-science sector was compensated for by the technical specific human capital of the two academics (Q3c, Table 5.4) whom he met at a networking conference between academics, business advisors and interested people. We may speculate that "while human capital refers to individual ability, social capital refers to opportunity" (Burt, 1997, p339) and combining the two encourages leverage of other knowledge resources. It may be suggested that lead entrepreneurs added value to their opportunities by coordinating people by building relationships with individuals in order to create combinations to help develop their opportunities. The diverse, credible and experienced entrepreneurial team in Company 8 had understanding of current and future market and customer needs (Q3c, Table 5.4). This lead non-academic entrepreneur with a strong network of relationships was valuable in terms of having access to both information and resources for his firm. He also attracted other high-performing individuals (e.g. the academics) and maintained a strong network ties with external stakeholders, creating knowledge platforms from which new resource combinations could emerge (Nonaka, 1994). Several variations of the product were on the market, but they developed and targeted an improved model to satisfy the specific needs of additional customers. The diversity of human and social capital within this team attracted business angel funding.

The non-academic entrepreneur leading Company 6 had greater industry-specific and entrepreneur-specific human capital than any academic entrepreneur and was therefore in an ideal position to spot a potential unbridled entrepreneurial opportunity. His conduct was ruled by past employment, previous start up experience and a recent liquidation of his business. These experiences allowed him to learn and practice managerial skills and monitor the actual and perceived needs of his potential customers. Both his technical and market knowledge was strong. Past research has indicated that entrepreneurs with prior business ownership experience can acquire assets relating to broader managerial and entrepreneurial capabilities, and they can leverage an enhanced reputation (if successful) to obtain additional resources

(Westhead and Wright, 1998). On the downside, prior business ownership experience can lead to the acquisition of several liabilities such as over-confidence. For the lead non-academic entrepreneur of Company 6, his inability to share and communicate his future plans and aspirations accurately disorientated people around him. His over optimism painted inaccurate pictures of the status of the development of the potential product and the people available to promote the product. Conversely, the lead non-academic entrepreneurs relating to Companies 7 and nine, located on non-sponsored environments, with no prior business ownership to tarnish their reputations, utilized external agents from business development agencies and venture capital companies (Q4d and e, Table 5.4). However, gaining information about such organisations was problematic for both these nascent entrepreneurs. The lead entrepreneurs in Company 7 were well versed in the management of contract projects but had no concept of commercialisation either from past experience or family input. Experiences within a large pharmaceutical organisation did not expose them with relationships to managers or decision makers who could provide information about funding or management knowledge for new firms, a finding observed by Mosey and Wright (2007). Similarly, the lead entrepreneurs in Company 9 had no previous start-up knowledge or exposure to commercialisation. They also had no technical or scientific knowledge about the development of or the regulatory process of certification for a new chemical. Companies 7 and 9 relied on public sector sponsored development agency agents, to whom they were directed by friends and professional colleagues, to provide insights on how to address barriers to opportunity identification.

Although it might have been speculated that lead non-academic entrepreneurs with past commercial experience might have had a greater depth and wider breadth of contacts and networks relating to social capital, the data indicates that academic entrepreneurs have greater access to resource providers. Initially lead academic entrepreneurs were lacking in social capital in relation to access to business advisers and funders but with assistance from TTOs it became evident that their reputation attached to their significant levels of general human capital increased their capacity to access resource providers. It would appear that it was their general human capital (or level of education and reputation) which increased their attractiveness to resource providers but that the resource providers, who were unknown to them, were introduced to them by TTOs. In addition, the role of the TTOs was replaced by

surrogate entrepreneurs as the entrepreneurial process progressed, thus extending the lead academic entrepreneurs social network. These observations suggest the following propositions:

Proposition 6: Lead academic entrepreneurs' general human capital has a greater influence on enhancing their social network than lead non-academic entrepreneurs' general human capital influence on their social network.

5.5 Entrepreneurial Team Membership: The Context (Theme 2)

Although lead entrepreneurs were responsible for the identification of their opportunity because they generally had access to technological resources, they often lacked access to or knowledge about financial resources and had only a general or rudimentary idea of the potential market application. They lacked knowledge about conducting detailed analysis of potential markets or what product or part of the product to present to the market. Funding remained a constant challenge to inexperienced lead entrepreneurs with no knowledge of the investment sector. There was, therefore, a need for lead entrepreneurs to access people with knowledge of the market place, management and connections to the investment sector. The following section, therefore, presents data from lead entrepreneurs and their team members about how crucial resources were identified and how resources were sought through the recruitment of a variety of venture team members (Ucbasaran et al., 2003a). As stated earlier, team members consisted of both those who held equity (entrepreneurial ownership team members) and those who did not (team members). Prior research imposed a strict equity stake condition on the definition of entrepreneurial team membership (Ucbasaran et al., 2003a). In this study human capital was given priority over the equity ownership definition to establish a resource network and exploitation. Research questions outlined below, pertaining to team membership, are answered in this section:

Research Question 2: 'Why' do lead academic and lead non-academic entrepreneurs form entrepreneurial ownership teams?

Research Question 3: 'How' do lead academic and lead non-academic entrepreneurs form entrepreneurial ownership teams?

Research Question 4: 'Where' do lead academic and lead non-academic entrepreneurs find potential entrepreneurial ownership team members?

5.5.1 Lead Academic Entrepreneurs and Team Membership on Sponsored Environments

Recognising their own limitations the lead academic entrepreneurs sought to recruit team members to compensate for deficiencies in business acumen. With assistance from a mentor, provided by the HEI, an MBA student was recruited to Company 1. This particular HEI promoted synergy between departments, securing dynamic research activity for commercialisation by actively seeking potential team members with commercial capabilities. The recruited entrepreneurial ownership team member in Company 1 commented that when he joined the firm there was an over-emphasis on the development of the product and perhaps not enough on the development of the market (Q1a, Table 5.5). This substantiates past research which has recognised that lead academic entrepreneurs may have difficulties identifying opportunities with commercial application (Lockett et al., 2003). The MBA team member brought valuable experience from the pharmaceutical sector, a network of contacts and a formalised approach to market research which was further assisted through the recruitment of another team member. Her strength came from her scientific knowledge of the workings of the product, a vital attribute when talking to potential customers who are scientists themselves. The combined human capital skills of the lead entrepreneur and the entrepreneurial ownership team members achieved a balance between commercial experience, scientific knowledge and marketing research skills. Their competitive advantage came from their specific human capital based in both the novelty of their product, their scientific expertise, their rudimentary knowledge of the market and their product's potential application in the market. The heterogeneity of human capital at the early stages of the venture has been viewed positively because it enhances survival chances of the firm (Zimmerman and Zeitz, 2002).

Company 2 was also made up of a diverse multi-disciplinary team, formed prior to firm formation, but their perceived main barrier to commercialisation was access to funding. To address this gap in knowledge the team turned to the TTO. The TTO prompted applications for government seed funding and for a sabbatical fellowship year of entrepreneurship training for the Post Doctoral student. The Industrial Fellow, identified as the lead entrepreneur, used his social capital to win contracts for the service side of the company and used his entrepreneurial-specific

Table 5.5: Human and Social Capital Related to the Recruitment of Team Members

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**Human Capital**: Knowledge of competitors' products/processes; Knowledge of industrial sector. **Social Capital**: Knowledge of potential customers; Ability to network with industrial players and to attract and recruit people with market knowledge and knowledge of the investment sector. **a)** *"To be honest the strategy in the company was not really set when I came along. There was a little too much focus on the finer points of research and not a lot on the big D, the development side and who is actually going to pay for it? Where is the money going to come from? Who is going to pay for the end product? Who is going to fund the development? Who is going to be interested in us? Is there a need in the market? All these questions are fundamental questions of whether or not it is worth while setting up a business"* (Entrepreneurial Ownership Team Member, MBA, Company 1).	**Human Capital**: Technical understanding of the potential product. **Social Capital**: Ability to develop networks and to attract and recruit people with market knowledge, to conduct contract work and to seek funding. **b)** *"Fantastic input on the market and how to get customers. Clearly they are at a level, massive company,.... the other thing about P and A was that they were not just selected because they were from X; they understood our technology, they know the science, they know the customer side so they really understood what we were trying to achieve. That was really important. There are not many people who know our area very well. Also, the history of the pharmacology and the science, it is a kind of dying trade these days""* (Lead Entrepreneur, Company 5).
Non-Academic Entrepreneur Q3	**Human Capital**: Ability to gather knowledge from scientific community about future laboratory needs using market research survey. **Social Capital**: Known networks in the investor sector based on past contact. **c)** *" was at that point in Scotland, and it is still fairly true, that there is a general recognition, and I think this is what* the engineers *had picked up on, was the appreciation that biology and life-sciences were moving in this post genomic era into more miniaturisation and automation. My earliest recollection was getting together with the four of us,* the engineers and academics *and having brainstorming type meetings. ..It was really about, well you tell us what you can do, from an engineering point of view...*and *... what the scope of post genomic biology was ...and I remember a couple of brain storming sessions.."* (Team Member, Academic, Company 8).	**Human Capital**: Ability to gather knowledge about pharmaceutical sector. **Social Capital**: Known contacts in sector from prior work experience. **e)** *"These are things which I perceived and then when I joined the company I found out they were not like that. The first thing which was most harmful was it has taken a lot longer to raise the funding, and it has put the company in jeopardy in the meantime. The second was the first product, which I thought was ready just to be manufactured and sold, was not that close to being market ready and the third thing I would say is that I anticipated that once we had this product ready that we held a list of potential customers who were committed to buying the product once it was available, that we could just go with the new product once we had it, demonstrate it and show it did do what we said and we would start to see purchase orders fairly quickly. That has not happened either.* (Team member, Company 6).

human capital, drawn from his prior industrial managerial experiences, to manage the company. This particular team exhibited close social contact and relationships and exhibited high levels of trust and affinity towards each other, an observation supported by research on social capital from an organisational perspective (Leana and Van Buren, 1999). The functional backgrounds of the members were complementary and displayed heterogeneity of human capital for the process of opportunity identification and opportunity evaluation.

Motivation for forming Company 3 was prompted by the lack of available funding from traditional sources (e.g. government and charity sectors) for basic research. With the co-operation of the TTO and business development agency the lead entrepreneurs were able to recruit a consultant who had substantial experience in nurturing spinout firms from other HEIs. His contacts and expertise were instrumental in preparing the company for eventual floatation on the AIM market. This 'surrogate entrepreneur' who had specific entrepreneurial experience and contacts within the investment sector was not initially taken on as an entrepreneurial ownership team member but as part of the management team. Although both academic entrepreneurs (Company 3) criticised the two support organisations, the TTO and the local business development agency, it was through them that the introduction was made to the consultant who eventually became the company's chairman. The creation of the Company 4 was also in response to the lack of funding from traditional sources, an experience similar to that of the clinicians in Company 3. The lead entrepreneur learned more about the investment sector by recruiting an experienced engineer who had substantial commercial experience. Exploiting the experience and social network contacts of the recruited engineer and the presentation skills and reputation of the lead academic entrepreneur and his two colleagues, access to first round funding proved unproblematic. Although the lead academic entrepreneurs effectively build ties with providers of business advice they were less effective in building direct ties with equity providers (Mosey and Wright, 2007). This they did with assistance from surrogate entrepreneurs.

However, companies 3 and 4 were both forced to London for their first round funding because the investment sector in Scotland was unwilling or unprepared to support the research and development of medical and dental devices. This may reflect

a lack of maturity in the life-science sector in Scotland, an overzealous conservative approach to investment by venture capitalists in Scotland or indicate a lack of knowledge and understanding on behalf of the venture capitalists in Scotland serving life-science ventures. On several occasions lead entrepreneurs commented that finding funding would have been easier if they had been based in Cambridge (UK) (or in more extreme comments) America. These observations led to the following proposition:

Proposition 7: Lead academic entrepreneurs developing medical or dental devises on sponsored environments are more likely than other lead academic entrepreneurs on sponsored environments to seek investment outside Scotland.

The strengths of Company 4 lay in product development, internal financial controls and medical knowledge. Their greatest liability was lack of managerial expertise. As part of the opportunity evaluation process the investors appointed a part-time CEO. The CEO came from a blue chip medical company. The needs of the new company and entrepreneurial team were not met by the experiences brought by the manager. There was a mismatch of resource synergy (e.g. between the needs of the firm and the abilities of the appointed CEO). This proved to have a long-term detrimental effect on the regulatory procedure for certifying the new product. Over zealous venture capitalists forced inappropriate managerial team members upon the lead academic entrepreneurs giving rise to the following proposition:

Proposition 8: Lead academic entrepreneurs are more likely than lead non-academic entrepreneurs to experience a mismatch of resource synergy between their perceived needs and the ability of their investors to provide team members with matching skills.

In addition, an observation from the lead entrepreneur in Company 4 indicated that there was a general lack of understanding about the medical device sector from the investors themselves. The regulatory procedure proved tougher in terms of device safety and the level of investment, post-prototype testing. No one in the entrepreneurial ownership team, or the investors foresaw this outcome.

5.5.2 Lead Academic Entrepreneurs and Team Membership on Non-Sponsored Environments

Prior to the formation of the second version of Company 5 the lead entrepreneur assigned his intellectual property (IP) to his new university and in return

agreed to an exclusive licence for the use of the IP. Assigning the IP to the HEI was an astute strategy. The lead academic entrepreneur attracted government funding for Proof of Concept prior to the formation of the company. Access to such funding came from the TTO and was made available to the HEI not the entrepreneur or their company. Proof of Concept funding allowed lead academic entrepreneurs to better develop their ideas, as a laboratory concept, prior to a commercial launch. This was an example of the government providing resources to allow entrepreneurs' skills in research and development to be used towards establishing concept viability. Subsequently, what the entrepreneurs offered potential investors was a proven opportunity. Non-academic entrepreneurs offered less developed concepts to their investors. These two observations about IP ownership and Proof of Concept suggest the following proposition:

Proposition 9: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to better develop their scientific concepts as commercial opportunities because of Proof of Concept funding.

With regard to Company 5 the lead academic entrepreneur's indecisiveness revolved around management and organisational issues. For information about funding and firm formation he required further support from the TTO. To compensate for lack of business acumen, the lead entrepreneur recruited a colleague as an entrepreneurial ownership team member who displayed good organisational ability. He was offered a place on an entrepreneurship fellowship course by the TTO. The lead entrepreneur, on the other hand, used his time networking with people in the life-science sector in Scotland. Two members from a large pharmaceutical company were convinced to sit on their board to advise the entrepreneurs. Having this level of expertise to hone in on was important to the entrepreneurs who recognised their limitations in knowledge about how to access their desired markets and how and where to apply for future funding. The two board members brought status to the company because of their specific industrial human capital and established reputation (Q2b, Table 5.5). In addition, a member of a business development agency authorised and commissioned a market research feasibility study by an independent company for Company 5. The survey indicated a positive response their potential product. This was important information for the lead entrepreneur who assigned much importance to

the outcome of the study. The marketing survey instilled in the lead entrepreneur, a greater sense of purpose towards the development of the instrument.

A speculative difference between the academic entrepreneurs on sponsored and non-sponsored environments may be that academic entrepreneurs viewed outside resource providers, from industry, as potential competitors whereas those on non-sponsored environments saw them as potential co-operators or customers. Clearly, the creation of a market is dependent on accessing resources held by outside stakeholders. There is a risk that the lead academic entrepreneurs, on sponsored environments, put constraints on the development of their concepts because of their suspicion. In addition, the majority of academic entrepreneurs remained in full time employment as professors which challenged their resources and time allocated to firm formation. There was a conflict between their traditional objectives of education and basic research and the process of commercialisation.

5.5.3 Lead Non-Academic Entrepreneurs and Team Membership on Sponsored Environments

The two engineers leading Company 8 had a high capacity to process information. They were able to use their specific entrepreneurial human and social capital to assess, access and leverage resources to conduct a survey of life-science firms and to gauge reaction to their consultancy firm offering advice on automation and miniaturisation of industrial processes. Further, they were able to present their concepts to the academics within a medical research laboratory and third, in conjunction with the academics, to leverage social, financial, physical and organisational resources necessary to identify an opportunity for commercialisation and to thereafter incubate the idea (Q3c, Table 5.5).

The stimuli for starting a business grew from the lead entrepreneurs' combined skills as engineers, their sales and marketing competencies and past entrepreneurial experience, all spurred by the threat of redundancy. They possessed both general managerial human capital and specific entrepreneurial human capital. The combination of the skill strengths each member brought to the team in the form of both general and specific human capital was recognised to be a major strength by suppliers of funding and potential customers. The combination of academic, technical

and commercial experience worked in their favour when applying for funding. When making presentations to business angels the combined team brought an array of success experiences from past commercial ventures and a well-grounded reputation so much so that the chairman from the business angels' company, investing in the company, volunteered to chair Company 8. Being offered a chairman from the investors brought to Company 8 more entrepreneurial specific human capital. The division of labour between the founding members was well defined.

5.5.4 Lead Non-Academic Entrepreneurs and Team Membership on Non-Sponsored Environments

The lead entrepreneur forming Company 6 was a scientist with substantial working experience in the defence industry and also prior experience of starting and running his own company. After liquidating a previous company in Wales, this serial entrepreneur re-located to Scotland to an area with a cluster of bio-tech and life-science firms. His knowledge of the availability of government grants and commercial loans was substantial. Human capital was entrepreneurial specific and specific to the life-science sector but, he was liable to over-exaggeration (Q4e, Table 5.5). He recruited board members and shareholders from his previously liquidated company. Generally, like lead academic entrepreneurs, lead non-academic entrepreneurs located on non-sponsored environments also tended to recruit entrepreneurial team members who were known to them through previous employment or business ownership exposures.

The non-academic entrepreneurs leading Companies 7 and 9 had no previous start up experience and little exposure to the challenges of commercialisation. Although the lead entrepreneurs in Company 7 had ample scientific and technical human capital there was nothing in their backgrounds to indicate specific human capital representing experience in commercialisation. Their understanding of the market place and future strategies of larger pharmaceutical firms came from their industrial specific human capital gained from their past employment experiences. However, for the practicalities of the process of start-up, including how to write business plans, they had to seek advice from the business development agency. The lead entrepreneur in Company 9 was an architect with equally little exposure to the process of commercialisation. Devoid of commercial specific human capital, the

architect's accountant suggested that they contact the local business development agency for advice. The lead entrepreneurs were then advised by the local business development agency to seek the assistance of another company versed in the promotion of early start-up companies.

5.6 Cross-Case Comparison of Resource Profiles Brought by Team Members

The following section explores and compares the resource profiles of entrepreneurial team members at opportunity identification. Entrepreneurs seeking to develop their opportunities leveraged their entrepreneurial ownership team members with similar or diverse human capital. Consistently, academic entrepreneurs located on sponsored environments made comment about the need to recruit team members with appropriate business acumen to compensate for their lack of understanding to allow access to resources, especially financial and social networks. Lack of entrepreneurial specific human capital has been exposed as a potential barrier to commercialisation for scientists (Radosevich, 1995). Inevitably, they were seeking to compensate for their lack of commercial understanding. However, with the exception of Company 1, lead academic entrepreneurs recruited previously known team members from their current or former HEI (Clarysse and Moray, 2004). Lead academic entrepreneurs with no previous business ownership experience, therefore, sought entrepreneurial ownership teams that were associated with human capital homogeneity. Their teams had diverse knowledge relating to technology and science rather than products or markets. The small entrepreneurial ownership teams (e.g. 2 to 4 equity holders) were constrained by the amount of human capital at their disposal and this was not always overcome by recruiting appropriately qualified additional team members. This was a barrier and could be overcome with a call for interdisciplinary teams with links to resources other than those associated with science. These observations suggest the following proposition:

Proposition 10: Lead academic entrepreneurs are more likely than lead non-academic entrepreneurs to focus on team homogeneity during the opportunity identification phase.

Lead non-academic entrepreneurs had acquired diverse technical capabilities relating to several industry settings and not solely related to life-science research. This experience was crucial in identifying a potential opportunity, in forming a

business concept and developing networks with actors for external resources. Moreover, lead non-academic entrepreneurs, reporting prior business ownership experience, sought entrepreneurial team members with diverse human capital profiles.

Financial resources were required to support product development and the protection of IP as well as the recruitment of appropriate management team members and other employees to develop the business idea. Through the guise of TTOs, on sponsored environments, and business agencies, on non-sponsored environments, seed funding, offered through government initiatives, was crucial for opportunity identification progressing to evaluation. Non-equity team members such as TTOs were vital because they guided entrepreneurs through the governmental funding application process and acted as representatives or custodians of the equity stake belonging to the HEI. Typically, non-academic entrepreneurs used early stage, or seed funding, in a proactive way to support applications for future funding rather than more research focused lead academic entrepreneurs. The lead academic entrepreneur relating to Company 4, for example, used the early seed funding to build a prototype whilst the lead non-academic entrepreneurs relating to Company 8 used finance to develop a business plan. One speculative reason for the emphasis some lead non-academic entrepreneurs put on funding expertise may be linked to their decision to locate on non-sponsored environments. Lead entrepreneurs relating to Companies 6, 7 and 9 were unable to leverage the support of a TTO from a HEI. Interestingly, the lead non-academic entrepreneurs relating to Company 8 located on a sponsored environment but did not use the services of the TTO. Lead academic entrepreneurs located on sponsored environments were eligible for public funding awarded through their HEIs, prior to the formation of their ventures. This support was not available to lead non-academic entrepreneurs. Academic entrepreneurs located on sponsored environments also benefited from lower cost bases due to reduced rents, access to HEI infrastructure and other cost saving privileges. An entrepreneur's location selection therefore, impacted on the focus of resources available to create and identify opportunities.

With regard to Companies 1, 2, 3, and 5 the lead entrepreneurs recruited and sought the assistance of non-equity holding team members, through the guise of the TTO or business development agencies. These agents did not have detailed

knowledge of the life-science sector and directed the entrepreneur toward more appropriate sources of professional advice and funding. External agents encouraged the academic entrepreneur to utilize the network resources of surrogate entrepreneurs (Vanaelst et al., 2006). These networks were used when finance was formally sought from venture capitalists and business angels. Surrogate entrepreneurs with prior investment experience were able to address funding barriers to business development for lead entrepreneurs (Franklin et al., 2001). Independent and external surrogate entrepreneurs, however, did not acquire from the outset an equity stake in the supported ventures. A surrogate entrepreneur was attracted to Company 3 when the lead entrepreneur failed to secure government and charity funding but was, initially, recruited as a business consultant. This individual subsequently became an entrepreneurial ownership team member and the chairman. When the diversity of human capital within a team was limited at the opportunity identification phase, non-equity holding members compensated for a lack of skills.

The lead entrepreneurs in Companies 6 and 7 brought with them different experiences and skills to their firms. The former brought entrepreneurial experience from previous business ownership whilst the latter brought scientific knowledge, knowledge of the industrial sector but little business acumen. Entrepreneurial ownership team membership associated with Company 6 was precarious because of the geographical spread of team members associated with their previous company and their inability to relocate close to the new. Data indicate that the lead entrepreneur shouldered most of the decision making and did not accurately share information well with the other team members. Company 7 relied on the scientific knowledge and contacts of the two lead scientists and advice from the business development community, which they both found wanting. Generally, it was reported that the business development agencies lacked experience in dealing with life-science projects.

The lead non-academic entrepreneur in Company 9 had little knowledge of business or the regulatory process of certifying a new chemical. Rather than learning from previous experience or bringing prior knowledge, the lead entrepreneur and team learned ‘by doing’ which extended the time frame of opportunity identification and evaluation. Although non-academic entrepreneurs had equal access to business development agencies, it was observed that they were less successful in being awarded

access to surrogate entrepreneurs. It is unclear whether this observation was a result of a reluctance of business development agencies to introduce non-academic entrepreneurs to surrogate entrepreneurs or whether surrogate entrepreneurs had a preference for working with academic entrepreneurs. This evidence suggests the following proposition:

Proposition 11: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to gain access to 'surrogate entrepreneurs'.

5.7 Summary

This chapter has presented the findings, from a qualitative analysis, of interviews with respondents from nine sets of entrepreneurial ownership teams exploring 'why', 'how' and 'when' teams were formed. Lead academic entrepreneurs on sponsored environments expressed and manifest a preference for attracting and recruiting team members from within the HEI in which they worked. In all cases, except one, (Company 1), entrepreneurial ownership team members were known to the lead entrepreneurs prior to the formation of a company. Additionally, team formation preceded company formation making opportunity identification a 'team effort'. There was a greater danger of homogeneity of human capital within the academic entrepreneur led teams because prior human capital was overly represented by technological knowledge and little business acumen. However, as Burt (1997) argued "while human capital is surely necessary to success, it is useless without the social capital of opportunities in which to apply it" (Burt, 1997, p339). Entrepreneurial ownership team members with industry-specific human capital or commercial experience were introduced to the lead entrepreneurs by the TTOs. The TTOs in turn were well connected to the local business development agencies where other 'surrogate entrepreneur' recommendations were made. Although a general criticism of the TTOs and the business development agencies was that they had little experience in the life-science sector, they did offer information and access to advice, funding and experienced entrepreneurs. Their social capital allowed them access to higher returns on their human capital, suggesting and interactive effect between social and human capital (Burt, 1997). This was particularly beneficial to the academic entrepreneurs during the entrepreneurial commitment phase. Many of the other people that the TTO was associated with were resource providers connected to governmental

funding and advisory bodies, whose cooperation, coordination and support was needed (Granovetter, 1973). However, over time, the TTO and their expertise became redundant and was replaced by expertise from other sources (e.g. surrogate entrepreneurs and investors). This would indicate 'depreciation' in social capital (Lester et al., 2008). The effect was not restricted to social capital. TTO's knowledge about key issues and the working of local authorities and funding for HEI commercial concerns was only relevant for short time. It seems that the resources TTOs accumulate and bring to office are most valuable during the discovery and evaluation phases of the entrepreneurial process (Vohora et al., 2004) but during the process their social and human capital deteriorates. Thereafter, 'specialised' entrepreneurial team members were used to exploit their commercial specific human capital. Specific human capital related to prior knowledge and experience with venture capitalist and business angel investors.

Lead academic entrepreneurs' perceptions of opportunities were rooted in their academic research and knowledge of the market extracted from industrial players met through the academic and technical conference circuit or through contact with customers and end users if they had a dual entrepreneur / clinical role. Although academic entrepreneurs were generally proficient at identifying opportunities for commercialisation, they recognised a need to develop capabilities to evaluate and exploit the idea as a commercial opportunity. Important was the availability of people to fill the role of commercial evaluation. Lacking in social capital and contacts with entrepreneurs who held experience in the life-science sector, the academic entrepreneurs had to rely on the contacts offered by outside team members such as business development agencies or TTOs. Outside team members, who were not equity holders, held relevance during the opportunity identification phase and were usually appreciated for their knowledge and expertise in applying for government funding (e.g. Proof of Concept, SPUR and SMART awards).

Recruited surrogate entrepreneurs were responsible for matching the entrepreneurs with appropriate sources and providers of investment. With the availability of appropriately skilled and experienced surrogate entrepreneurs a key issue, the local business development agencies contacts with appropriate entrepreneurs was especially valuable. Although the lead academic entrepreneurs' capabilities were

vital for opportunity identification, especially on a technical level, establishing market viability in the form of regulatory certification (for medical devices), for instance, was lacking and there was evidence to suggest that the TTOs and the entrepreneurs themselves needed to develop their capabilities in the management of such issues. This recommendation can also be extended to the venture capital company who funded the medical device company. The nature of the commercial idea and the role of human resources, in particular, seemed to be a persuasive influence on investors' opinion about the new companies. Again and again the need to have a well-developed and diversely qualified team was emphasised. Both the quality and quantity of human capital held within the team determined further access to internal and external resources.

Lead non-academic entrepreneurs on non-sponsored environments also preferred team members who were previously known to them either through work connections or from previous entrepreneurial ventures. Working with previously known colleagues had the limitation of not expanding available human capital to the existing entrepreneurial ownership team because generally colleagues came from similar backgrounds. One lead non-academic entrepreneur provided evidence of bad practice being imported from prior entrepreneurial experience (e.g. over optimism). Prior business ownership can provide both positive and negative experiences. Similar to academic led enterprises, non-academic entrepreneurs on sponsored environments had access to the services and advice of local business development agencies. This allowed access to government funding in the form of SMART and SPUR awards. However, there was an observed variation in the degrees of success between academic and non-academic entrepreneurs in their ability to win government funding. It is difficult to gauge whether this is a reflection on the quality of advice from business development agencies compared to TTOs or a reflection on the ability of the non-academic entrepreneurs to apply for funding.

Lead non-academic entrepreneurs on sponsored environments displayed least prior personal connections with team members and had to go through a search process to find potential members. Relying on past contact with business agencies lead non-academic entrepreneurs could reply on their social capital referring to "the sum of actual and potential resources embedded within, available through, and derived from,

the network of relationships possessed by that individual" (Nahapiet and Ghoshal, 1998, p 243) to get higher returns on their own specific human capital (Burt, 1997). In one case this led to a synergy of heterogeneous human capital providing a commercial solution to a cumbersome laboratory process (e.g. opportunity identification). The challenge was offered by academics and the solution provided by engineers. The diversity of experience and skills in the team proved to be attractive to business angels who released their own Chairman to lead and manage the project during the entrepreneurial commitment phase. He added substantial understanding of product development and general management.

Chapter 6: Case Analysis:

The Entrepreneurial Process

6.1 Introduction

Chapter 6 explores the entrepreneurial process. The process acknowledges the resources associated with Information Search leading to Opportunity Identification (e.g. discovery); Resource Accumulation, Leverage and Management (e.g. evaluation) for eventual Firm Creation (e.g. exploitation) (Alvarez and Busenitz, 2001). These components of the entrepreneurial process are outlined in the conceptual model guiding this study presented in Chapter 3 (Theme 3). Past literature has inferred the importance of the role of social networks (Hills et al., 1997; Mosey et al., 2006), and the effect of prior knowledge and experience (Shane, 1999) on an individual's ability to identify, evaluate and exploit opportunities for commercialisation. In this study it is speculated that the ability to do so may be a joint function of the nature of the opportunity in conjunction with the human and social capital characteristics of the entrepreneur(s). During the study, opportunities rarely existed independently of the individuals involved or the specific context in which they operated. There was a gradual maturation by the entrepreneurs to see a connection between their technology and a market need (or indeed vice-a-versa). In this chapter the following research questions presented in Chapter 1 will be explored:

Research Question 5: 'How' do lead academic and lead non-academic entrepreneurs identify and exploit opportunities for creating a firm?

Research Question 6: 'What' types of opportunities do lead academic and non-academic entrepreneurs identify?

Research Question 7: To what extent are opportunity identification and exploitation activities related to the actual and perceived human capital characteristics of the entrepreneur / entrepreneurial team?

Research Question 8: To what extent are opportunity identification and exploitation activities related to the actual and perceived social capital characteristics of the entrepreneur / entrepreneurial team?

The structure of the chapter is as follows. Data from case studies are compared (e.g. lead academic and non-academic entrepreneurs on sponsored and non-sponsored external environments) and are presented in the series of 'quote quadrants', allowing

between case and across case comparisons. The entrepreneurial process is viewed in three phases to include data concerning information search and opportunity identification (e.g. discovery) (Section 6.2); data from entrepreneurs covering resource accumulation, leverage and management (e.g. evaluation) (Section 6.3) and finally a review of 'how' decisions were taken to form firms (exploitation) (Section 6.4). In section 6.5 a summary is presented.

6.2. Discovery: The Context (Theme 3)

Entrepreneurs identified opportunities by being alert to and noticing opportunities that the market presented (Kirzner, 1979). The entrepreneur from this perspective was alert to the value of the information they gleaned from their environment but did not discover the opportunity from searching. They were alert. The entrepreneur's ability to identify these opportunities was influenced by prior knowledge and experience (e.g. general and specific human capital). Prior information disseminated from work experience, education or other means, therefore, influenced the potential entrepreneur's ability to understand, interpret and apply the new information in ways that others, lacking in the knowledge could not. Differences between lead entrepreneurs' ability to recognise, discover or create an opportunity relied, in part, on their alertness related to prior knowledge associated with knowledge of their subject area; knowledge of markets; knowledge of ways to serve the market and knowledge of customer problems (Sarasvathy et al., 2003; Shane, 2004).

The human capital relating to the entrepreneur was critical in determining the extent to which the entrepreneur could know where an invention or intervention needed to be made. The less prepared and experienced the entrepreneur, the more extensive their search for information. Some entrepreneurs identified opportunities because they had superior abilities to process information and to scan and search their environment for opportunities (Shane, 2000). They had better access to information about the existence of an opportunity because of the environment they inhabited (Shane, 2003) indicating superior social capital. This breadth of human and social capital refers not only to the skills but also the social networks (connections and relationship) they possessed (Lester et al., 2008). The ability to recognise, discover or create an opportunity may depend, therefore, on the individual's unique knowledge set

with respect to technologies and markets (Chandler et al., 2002) and social networks to information providers. The human capital of the entrepreneur may be critical in determining the extent to which the entrepreneur can 'know' where an invention or intervention needs to be made. However, the development of a technology often occurred before a commercial opportunity was perceived or identified. In practical terms this translated into scientific research being conducted prior to a commercial application being identified from the research (e.g. technology was created prior to a known market application). It could be argued that we might expect opportunity identification of a technology with commercial possibilities to precede development of the technology (i.e. as in opportunity discovery where demand exists but supply does not). This study often found the contrary. Development of the technological creation preceded the identification of the commercial opportunity or the discovery of a market. This was especially true for academic entrepreneurs potentially indicating a deficiency in social capital. In the case of academic entrepreneurs, skills associated with R&D were directed primarily at academic basic research. These skills were only laterally transferred to the development of a commercial product when a commercial opportunity was identified.

6.2.1 Information Search and Opportunity Identification: Academic Entrepreneurs on Sponsored Environments

Academic entrepreneurs identified opportunities for commercialisation because they were immersed in research and in all cases the technological source of their opportunity was rooted in their academic scientific exploratory work. More often than not, the lead academic entrepreneurs were involved in scientific experimentation prior to identifying a market niche. However, sometimes the market dictated what type of product or process was required (e.g. a recognised opportunity where there already existed a demand for the supply of a new product). This could involve improvement of a product already available within the market (Company 1), the introduction of a novel product or approach to solving an already existing problem (Company 3) or the invention of a new medical device or instrument, combining different technologies (Company 4). On the other hand, the delivery of a new chemical process (Company 2) could be seen as an opportunity discovered since demand definitely existed but the supply of the new product of process had yet to be developed.

The lead academic entrepreneur (Company 1) did not indicate that he was searching for a business opportunity prior to his alertness of what was happening in the market or what products were available for toxicity testing. This would suggest that the entrepreneur did not discover the entrepreneurial opportunity through search but through a process of recognition. He recognised the value of his new information that he received through a combination of information (e.g. results from his PhD research; permission to use a licence to enhance his product and assessment of similar products on the market). His own technological knowledge was used to evaluate his competitors' products, an issue associated with absorptive capacity (Cohen and Leventhal, 1990). Awareness of the market opportunity was related to the information he already possessed, which he had accumulated through his education and exposure to other academics. Originally, he intended to offer a toxicity testing service to the chemical and biotechnology industry. However, feedback from the industry indicated that need was for actual test-kits not a service. This process of opportunity recognition proved to be iterative and not linear because prior knowledge leading to opportunity identification and an approach to evaluation and exploitation was overtaken by feedback from customers. His access to the social network of customers came from prior knowledge of the pharmaceutical industry from one of his team member, recruited after firm formation, indicating that specific human capital was important for the recognition of the value of the technology but that market knowledge was influenced by strong ties to the pharmaceutical industry (e.g. social capital).

Similarly, the lead academic entrepreneur, motivating the entrepreneurial ownership team in Company 2, not only understood the science and technology behind the proposed process of changing chemical compounds because he was a scientist, he also had 20 years industrial experience in the bio-science sector. His experience allowed insight into the market, into what customers required and exposed him to the weaknesses of the scientific approaches of potential competitors trying to solve similar scientific challenges. Prior specialist knowledge of the sector gave the lead academic entrepreneur competitive advantage. The lead academic entrepreneur's own ability to discover an opportunity in the new process was enhanced by prior understanding about 'how' the new process could be used to create a new product for the pharmaceutical industry. The solution to the scientific challenge was identified as the possible commercial opportunity. In Companies 1 and 2 opportunities unfolded from

prior technical knowledge of potential products or processes. In addition, the entrepreneurial ownership team in Company 2 knew the value of the new process because they had prior information about their potential main customer's needs (Q1a, Table 6.1) an issue identified as creating value in previous literature (Shane, 2000). Prior knowledge of this need (e.g. demand) influenced the lead entrepreneur's ability to identify an opportunity and was supported by his technical ability to potentially develop the new process (e.g. a solution to a problem). Prior knowledge thus bridged the relationship between the technology (development of a new enzyme) and the discovery of the entrepreneurial opportunity (e.g. demand definitely existed but the supply of the new product of process had yet to be discovered) (Sarasvathy et al., 2003).

The foundation of opportunity identification for Company 3 was technologically led. Consequently, research was conducted towards the goal of patenting and protecting knowledge. The variety of roles that the two, high-profile academics played covering, clinical, administrative, advisory, research, academic and entrepreneurial, exposed them to a diversity of people. For example, at academic and technical conferences they had contact with both industrial representatives from the oral hygiene sector and other academics involved in similar research. Contact allowed a search for information on market fashions and needs. In their clinical capacity, they had direct contact with patients. Those experiences allowed them to gauge patient and practitioners' need for better dental decay detection systems. The literature indicates that people are more likely to receive new information that will provide a missing piece in recognising an opportunity if they have variation in their experiences (Shane, 2003). Having contact with a diversity of people allowed the lead entrepreneurs to recognise the demand in the market place for advancement in dental decay detection (e.g. for a supply of a new approach).

The lead academic entrepreneur in Company 4 described the technology behind his artificial implantable graft as a platform technology (e.g. a recognised opportunity based on the supply of a new medical device). Fluid flow technology was applicable to areas other than medical devices and was observed and detected prior to the identification of the commercial opportunity. Movement of the fluid within the confines of vessels was the scientific discovery. The new information was used to

Table 6.1: Information Search and Opportunity Identification

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**Human Capital**: Technological specific human capital to evaluate competitors' products; Iterative information searches for market/customer requirements; Access to competitors' products. **a)** *"S was the first person to push me to say that there was a commercial opportunity here because what we do is very similar to what the companies did that we worked for in the past. So we saw the way that the company was doing things meeting a commercial opportunity and saw some of the shortcomings of the way they carried out the technology. That was the first piece, when we knew there was an opportunity here, if we could get the right technology to do it with the right people and the right laboratory. That was the first initiative…* (Lead Entrepreneur, Industrial Fellow, Company 2). **b)** *"As a vascular surgeon I know that the current bypass grafts perform very poorly in certain situations. So there was a huge need for a bypass graft that does not stop working if it goes over a certain length. If this works it will answer that problem. There was a huge problem. A new understanding would have a potential impact on the problem"* (Lead Entrepreneur, Surgeon, Company 4).	**Human Capital:** Technological specific human capital to evaluate competitors' products; Access to competitors' products. **c)** *"Well research starts when research starts, it wasn't started to form a company or even to make a product. It was basic research and it wasn't even taking place in a formal manner."* (Lead Entrepreneur, Company 5). **d)** *"Basically, in terms of the technology,* Company 5 *remember has a dual business model, we have got a service side and an instrument side. The services …. for the testing of new pharmaceuticals. The instrument side is developing instrumentation that allows…people to do their testing themselves in house."* (Lead Entrepreneur, Company 5) **e)** *"Well they know already because they would be end users of the product themselves to start with. They already understand what the product can be used for and they know what the competing technologies are out there because they use them in their own research. They have got contacts with companies and other university researchers elsewhere, they are up with the state of the art in the field so they will know if such a piece of equipment became available it would be useful to other people"* (TTO, Company 5).
Non-Academic Entrepreneur Q3	**Human Capital:** Access to technological specific human capital (scientific and engineering) **f)** *"..there was a little bit of serendipity here because I went to a seminar organised by ..Connect, the name suggests what they do, they connect people across all types of industry. Speaking at that seminar was XX and his topic was about innovations in the life-sciences to take tests methods to micro scale. The key word was "lab on a chip". …I immediately spotted the synergy ….He immediately latched on to the fact that we had automation skills, we were desperate to get into his world so there was a complete match of needs there. The outcome of that was that two engineers got together with two scientists and I guess just by a brain storming process within two months we came up with the idea which we have patented "* (Lead Entrepreneur, Engineer, Company 8).	**Human Capital:** Iterative information searches for market/customer requirements. **g)** *"As a company we have developed that expertise over the last 15 years and I saw a tremendous market opportunity to take our knowledge of opto-electronics, the sense of themselves and match them to what a customer's needs are and turn that into a package which is a mix of hardware and software and knowledge from the company."* (Lead Entrepreneur, Entrepreneur, Company 6). **h)** *"The opportunity was not seen as a market opportunity it was seen very much as how can we stop people getting killed by organophosphate. The market opportunity was very much secondary to doing things"* (Lead Entrepreneur, Architect, Company 9).

develop a prototype for a new medical device because the lead academic entrepreneur was a surgeon who used graft implants as part of his work. He was aware of the deficiencies of products on the market. Similar to the dental device in Company 3, this prior information and knowledge about blood flow enabled him to recognise an opportunity in which to enter a known market (Q1b, Table 6.1).

6.2.2 Information Search and Opportunity Identification: Academic Entrepreneurs on Non-Sponsored Environments

Research and development for drug testing instrumentation was introduced to run parallel to the service side of the company (Company 5). After moving from a non-sponsored environment to a sponsored environment, the TTO, attached to the HEI, stated that because the lead entrepreneur and team member were potential end users of the instrument under development, they were well aware of what the market had to offer and the limitations of available instruments. Additionally both members were well networked into the academic sector to listen to feed back from the practitioners testing the instruments. The two academics were close to the functioning market of instrumentation for testing pharmaceuticals. Searching for and access to market information was part of their academic routine (Q2c,d,e Table 6.1). Like Companies 1 and 2, Company 5 processed prior knowledge about competitors' products and demonstrated technological acumen through the (potential) discovery of a new supply of instrument.

6.2.3 Information Search and Opportunity Identification; Non-Academic Entrepreneurs on Sponsored Environments

A synergy of ideas, talents and opportunities emerged whilst one of the academics, a prospective team member, was presenting information at a business networking function attended by one of the engineers (lead entrepreneur). He immediately recognised the link between the aspirations of the academic, for future miniaturisation and automation of laboratory processes, and his own skills. Once an opportunity was identified by looking for links between the modern needs of a post genomic laboratory and the skills of electronic engineers (e.g. a reliance on general human capital), the next step was to form a company. The synergy of the recognised knowledge held by both the engineers and the academics drove the processes of technical innovation and market discovery (Kirzner, 1979). No new knowledge was created but the process to be automated was only known to the scientists, whilst the

engineers held the solution (Q3f, Table 6.1) (e.g. there was both a demand and a supply) (Sarasvathy, et al., 2003). It was not only diversity of knowledge which allowed the team to discover opportunities but synergy of knowledge, prior knowledge, education, work experience, social connections and prior entrepreneurial experiences (Venkataraman, 1997). One of the academics reported that the formation of the firm was almost formulaic because he had already been through the same process involving another spinout firm headed by a different surrogate entrepreneur (e.g. exploitation of specific human capital).

6.2.4 Information Search and Opportunity Identification; Non-Academic Entrepreneurs on Non-Sponsored Environments

The benefits of past experience and exposure to commercial pressures, the experience of prior business ownership and ability to progress an idea to become a commercial concept manifest itself in a diversity of approaches for Companies 6, 7 and 9. The lead entrepreneur in Company 6 was a 'serial entrepreneur.' Using his scientific knowledge, his past employment experiences and contact with previous customers linked to his former company, he was able to identify a need for an analytical instrument for the bio-pharmaceutical industry. In his previous start up he very deliberately created a company involved in the distribution of current technologies establishing market intelligence (Q4g, Table 6.1). The literature indicates that people in marketing jobs are often the first to receive information for opportunity identification because they hear customer preferences (e.g. issues such as shortage of supplies, problems with existing products or services or the need for new products or services) (Klepper and Sleeper, 2005). In the case of Company 6, the need for a new product, and therefore a business opportunity, was identified prior to the formation of the company. There was a search for market information prior to the development of the new analytical instrument. Unlike academic entrepreneurs who centred their work around laboratory based research, this non-academic entrepreneur used his customer base to research the needs of the market place, prior to discovering the opportunity (e.g. the demand existed but the supply had yet to be discovered) (Sarasvathy, et al., 2003).

The two lead entrepreneurs in Company 7 formed a company for the research and development of new cell-lines but also supplemented their research with contract

service work in bio-pharmaceuticals. They identified a market need for the development of special cell-lines because there was a move away from diagnostic to therapeutic science in the pharmaceutical sector at large. According to recent research, individuals with exposure to prior industry-specific human capital are in ideal positions to seize upon openings for business opportunities and to decide upon effective strategic decisions for new firm formation (Colombo and Grilli, 2005). Therefore, Company 7's exposure to the pharmaceutical industry offered them opportunity. In this particular case, what the two lead entrepreneurs knew and understood was related to what they learned in the organisation in which they were formerly employed (Cooper and Bruno, 1977). Their new business opportunity was both practically and strategically directly related not only to their scientific specific human capital but also to their knowledge of the pharmaceutical sector. Their opportunity was discovered because there existed a demand for the supply of their yet undeveloped cell-lines (Sarasvathy, et al., 2003).

Unlike the entrepreneurial ownership team founding Company 8, which consisted of the academics who presented a problem and the engineers who offered a solution, the members of Company 9 could only identify the problem (e.g. the ill effects associated with chemicals in sheep dip). No one in the entrepreneurial ownership team had sufficient scientific knowledge to find a solution and neither was the regulatory process for certifying new chemicals understood. In addition there was a fundamental lack of entrepreneurial experience. The opportunity was not presented as a commercial one but rather a socially responsible reaction to the ill effects of chemicals (Q4h, Table 6.1). As the idea of forming a company progressed the attitude towards finding a product with potential market utility became more of a necessity.

6.2.5 Cross-Case Comparison at Discovery

Lead entrepreneurs in Companies 1, 3, 4 and 8 reported a scientific discovery process which led to its incorporation into a product (e.g. for Company 4: novel information about fluid flow technology incorporated into a product which transported blood). These entrepreneurs had developed particular knowledge through their exposure to education and experience in academia (or contact with academia in Company 8) and were therefore more likely to recognise entrepreneurial opportunities, within their realm of expertise, which involved and required a response to new

technological / scientific discovery. Table 6.2, outlining the relationship between the entrepreneurial process and human capital, lists the companies numbered 1 to 9 and reflects the location status of the individual companies at the time of the electronic survey in 2004. The human capital associated with discovery, evaluation and exploitation is presented by reviewing the past work, educational and market experiences of the lead entrepreneurs and their entrepreneurial ownership team members.

Opportunities were often reactions to finding solutions for specific problems expressed in terms of dissatisfaction with the performance of products and activities in the market, or the absence of such products in the market (Q1b, Table 6.1) (Chandler et al., 2002). Whilst lead academic entrepreneurs entered markets in response to recognised weaknesses in competitors' products, non-academic entrepreneurs were more likely to investigate a market prior to the discovery or invention of a new product. Those involved in the discovery of an opportunity were also more likely to be involved in contract work (e.g. Companies 2, 5 and 7). Presented empirical data and theoretical insights suggest the following proposition:

Proposition 12: Lead academic entrepreneurs are more likely to identify an opportunity through a process of recognition conducting scientific exploration (e.g. supplying products for which there is a known market) than lead non-academic entrepreneurs who identify an opportunity through a process of discovery (e.g. identifying a demand with the supply of a product not yet fully developed).

The lead academic entrepreneurs in Companies 2 and 5 searched for a new product or process for a specific customer problem. However, they were still operating within their own sphere of knowledge and expertise. They searched for appropriate information prior to meeting customer / product problems as part of the opportunity identification process. A market opportunity was discovered first rather than an identified product that had potential market application. Pharmaceutical testing instrumentation was the discovered market opportunity for Company 5 and in Company 2 the need for intermediary chemicals for the pharmaceutical industry was the discovered opportunity (Q1a, Table 6.1). The process of opportunity identification came from a customer need and market opportunity. All companies in Quadrant 1

Table 6 2: Relationship Between Human Capital (HK) and the Entrepreneurial Process

Company	*Market*	*HK related to Discovery*	*Product / process to serve Market*	*HK related to Evaluation*	*Future Market Solutions*	*HK related to Exploitation*
Company 1: Lead academic entrepreneur(s) located on sponsored environments	Test kits and instrumentation for testing for toxicity	Education, research experience and work experience in pharmaceutical sector, business classes	Development of a novel way to test for toxicity. Supplementing research with distribution of products for another company	Novel knowledge of fungi as a test medium for toxicity understood from PhD research. Strong ties to TTO	Fungi inserted with glow-in-the dark genes is a stable medium for a test kit which is self contained and does not rely on any source of external power	Work with competitors' test kits showed weaknesses in design. PhD research showed the value of fungi. Manufacture of kits is contracted out. Strong ties to investor
Company 2: Lead academic entrepreneur(s) located on sponsored environments	Biochemical processes/ pharmaceutical	Education, research and industrial work experience in pharmaceutical sector and present ownership of chemical company	Development of 'intermediary' enzyme. Supplementing research with contract research	Work experience with drug companies, extensive drug research at HEI, present business ownership in relevant sector, industrial contacts from conferences. Entrepreneurship fellowship course. Strong ties to TTO	Further research to discover the intermediary enzyme sought by pharmaceutical companies and to take the laboratory scale process up to industrial scale	Research experiences indicate discovering intermediary drugs possible. Industrial experience indicates customer need for intermediary drug. Surrogate entrepreneur has industrial experience and potential contacts
Company 3: Lead academic entrepreneur(s) on sponsored environments	Diagnostic test kits for dental decay	Clinical, academic, research experience and contact with industrial sector	Development of an instrument for early detection of tooth decay	Clinical experience from working as dentists; extensive research experience at HEI and industrial contacts from conferences. Strong ties to TTO	Increased detection of decay leading to preventative programmes arresting further decay through the manufacture of a diagnostic test kit	Clinical and work experience showed that there was a need for early detection. Strong ties with investors through recruited surrogate entrepreneur
Company 4: Lead academic entrepreneur(s) on sponsored environments	Medical device for implantation	Clinical, research experience and knowledge of present products	Development of a graft for implantation	Clinical experience from working as surgeons (amputations); extensive research experience and known graft manufacturer. Lack of commercial experience	Manufacture of a graft prototype for human implantation for further testing for regulatory approval	Knowledge of blood flow exposed design flaws in present day grafts based on a false interpretation of 'how' blood flows. Strong ties with investors through surrogate entrepreneur

Company 5: Lead ent(s) non-academic located on sponsored environment	Instrumentation for drug testing/ pharmaceutical	Education, research and past entrepreneurial experience	Development of an instrument to test drugs. Supplementing research with contract research	Work experience with prototypes of different test kits. Former business ownership. Knowledge of sector from contract work. Entrepreneurship fellowship course. TTO support	Ethical use of donated human tissue for testing drugs gives a better indication of effect of drug prior to introducing it to humans	Knowledge from both biology and opto-electronics showed how drugs could be tested on human tissue prior to testing on humans
Company 6: Lead non-academic ent(s) on sponsored environment	Instrumentation for drug testing/ pharmaceutical	Education, knowledge of customer needs and past entrepreneurial experience	Development of instrument for testing drugs	Knowledge of instrument design from past work experience. Resource networks from local authorities	Development and manufacture of an instrument to test drugs	Knowledge from scientific background and understanding of what the market/future customers required
Company 7: Lead non-academic ent(s) located on sponsored environment	Biotechnology/ pharmaceutical/ cell-line production	Education, research and work experience in pharmaceutical industry	Development of new cell lines. Supplementing research with contract research	Education and work experience in pharmaceuticals. No knowledge of commercialisation	Research and production of special cell line	Prior working research experience in same sector; prior knowledge of future international strategy of pharmaceutical industry; education in science and cell line development
Company 8: Lead non-academic ent(s) located on sponsored environment	Instrumentation/ miniaturisation and automation for high-through-put information in laboratory processes	Education, work and past entrepreneurial experience. Commercial savvy	Development of a tape for testing and separating DNA.	Knowledge of miniaturisation design and manufacture from work experience. Academic understanding of laboratory processes. Access to investors	Manufacture of prototype tape	Prior working experience in automation and miniaturisation in electronics sector. Education and research work provided the laboratory problems to be solved.
Company 9: Lead non-academic entrepreneur(s) located on	Pesticides	Education but little relevant commercial experience	Original concept was to develop a 'safer' sheep dip but latterly development of pesticides for head lice and mosquitoes	No knowledge of industrial sector or certification process for new chemicals	Discovery of an effective head lice eradication formula which also kills mosquitoes	No prior knowledge. The chemical was discovered serendipitously when the original chemical computation for sheep dip was being tested

were involved in the creation of new scientific discovery whereas lead non-academic entrepreneurs came from less stable backgrounds e.g. prior business failure (Company 6), redundancy (Companies 7 and 8) and involvement in completely unrelated professions (Company 9). Lead academic entrepreneurs held functional scientific knowledge which could be used to enhance existing products or create new products whilst non-academic entrepreneurs reacted to observed customer needs. It could be argued that a more diverse and varied background led to the need to search for an opportunity rather than one presenting itself (Q4g, Table 6.1).

Lead non-academic entrepreneurs were, therefore, more proactive in their search for an opportunity (Companies 6, 7, 8 and 9) than lead academic entrepreneurs. The non-academic entrepreneurs on sponsored environments displayed a process of recognition related to their past work and business ownership experiences. This manifested itself in an extensive gauging of customers needs in Company 6 where the original lead entrepreneur surveyed the environment for ideas from customers. Opportunity was led by customer need in Company 6. In Company 7, the two lead entrepreneurs expressed the desire not to compete with the main players in their field and deliberately chose to research and develop cell-lines which would not be of interest to the large players. Knowledge of the market allowed the entrepreneurs to avoid competition. The entrepreneurs leading Company 9 could not rely on any past entrepreneurial experience and learned as they progressed. The process was time consuming and there was and still is no definitive final product. These observations led to the following proposition:

Proposition 13: Lead academic entrepreneurs' general human capital (relating to education) allows for an opportunity identification approach reliant on scientific discovery whilst lead non-academic entrepreneurs' specific human capital (relating to prior working experience) allows for an opportunity identification approach reliant on recognising market demands.

6.3 Evaluation: The Context (Theme 3)

Having ascertained that the nature and extent of human capital endowed in lead entrepreneurs influences opportunity identification, human capital may also be a function in accumulating, leveraging and managing other resources (Shane and Venkataraman, 2000) (e.g. social, financial, physical and organisational) for the evaluation of the opportunity. The small entrepreneurial teams (e.g. 1 to 4 members),

attached to each company, were constrained at evaluation by the amount of human capital at their disposal and this was overcome by recruiting additional team members (Table 6.2). Entrepreneurs reported leveraging access to resources through networks of other actors known within their external environment and whose experience bridged the technical to the commercial.

6.3.1 Resource Accumulation, Leverage and Management: Academic Entrepreneurs on Sponsored Environments

The accumulation of resources necessary to evaluate projects was often centred on proof of concept and development of prototypes, all of which had to be funded. In Company 1, the lead academic entrepreneur, having attended business seminars offered and run by the HEI, was guided by the TTO towards applying for government funding, which allowed further research and development and greater in-depth market research. In Company 2, the intention of the entrepreneurial ownership team was to fund their research from contract work. A difference between Company 1 and 2 was that the entrepreneurial ownership team in Company 2 was in place prior to the formation of the firm. Their reliance on contract research, to fund their own research, was criticised by the TTO who felt that they should have attracted more money to the company at the launch stage instead of simply relying on government awards. Past research indicates firms undercapitalised at founding are less likely to invoke positive perceptions from future external stakeholders (Baum and Silverman, 2004), less likely to survive (Bates, 1990) and less likely to grow compared to those that obtained capital from external sources at early phases (Westhead, 1995). However, in the case of Company 2, the entrepreneurial ownership team did not wish to relinquish equity other than that given over to the HEI in return for the use of IP.

Having no entrepreneurial experience, the two academics leading Company 3 approached their resident TTO for advice. Access to government funding allowed the launch of their company but detailed business plans and contact to business angels and venture capitalists came from a recruited surrogate entrepreneur who had a proven track record in spinning out companies from other HEIs. His previous dealings with and social ties to venture capital investors reduced considerable risk for the resource providers because his prior successful contact had initiated a trusting relationship, an issue explored in the past literature (Aldrich and Fiol, 1994). The combination of the

business acumen from the surrogate entrepreneur and the technical knowledge and reputation of the two academic clinicians, contributed to the leverage and management of financial, regulatory and organisational resources for Company 3.

Initially, there was a miscalculation of the gap between the skills and knowledge of the lead academic entrepreneur in Company 4 and what the company required for start-up. Using his reputation and the skills of an engineer with previous business ownership experience, the lead entrepreneur was able to attract substantial venture capital funding. Less emphasis, however, was placed on the management of time, the management of testing the product and the management of the certification process. There was lack of understanding and a very weak tie to people who had that specific knowledge. This deficit in human (and social) capital proved disastrous because investor's milestones were missed (Q1a, Table 6.3). The testing and certification process, for example, involving animals, had to be conducted outside of the UK increasing costs substantially. Company 4 were constantly trying to recover from these earlier episodes and could not access people with certification experience. The process for moving from opportunity identification to evaluation was not uniform and linear. Initial opportunities were revised over time. Company 1 began with the concept of a service business model but revisited it once market intelligence had been accumulated to offer an individual test kit. Team structure and function developed after firm formation and went through several iterations. The reshaping of business models also perturbed Company 2. The technology associated with Company 2 was understood and practiced prior to formation as contract work. Their identified opportunity was market driven and their recognised options on future discovery were to manufacture the specific chemical or to consider selling / licensing the technique of production. Academic contacts and industrial knowledge were embodied in the individuals in the team. Investors gained early access to Company 4 by insisting on the introduction of a CEO from a blue chip company, who was not qualified to run a small start up. Several changes of personnel disrupted research and development and proved costly.

6.3.2 Resource Accumulation, Leverage and Management: Academic Entrepreneurs on Non-Sponsored Environments

After relocating to a new HEI, the lead academic entrepreneur in Company 5 relied on government awards for proving the ethicacy of his product and for the early stages of start-up. The lead academic entrepreneur also recruited the services of another academic who demonstrated entrepreneurial rigour in his work. In addition, there was assistance from the national business development agency that sponsored market research and Proof of Concept (Q2b, Table 6.3). Similar to the companies in Quadrant 1, there was a strong reliance on team members with managerial specific human capital and government agencies providing business advice.

6.3.3 Resource Accumulation, Leverage and Management: Non-Academic Entrepreneurs on Sponsored Environments

The entrepreneurial team in Company 8 offered venture capitalists and business angels an idea for miniaturising a laboratory process with proof of market and proof of prior commercial management. Out of all the case studies, this entrepreneurial ownership team interviewed as if they had scrutinised the identified opportunity, had considered how best to exploit the potential commercial value of the technology and had identified each individual team member's talents and skills to speculate on the advancement of the product. The unique combination of the diverse and individual skills of the lead non-academic entrepreneur and team members favoured competitive advantage (Q3c, Table 6.3). The academics had technical specific capital with an established reputation within the science sector both in the UK and the USA. The engineers also brought technical specific capital from an electronics engineering background with specific skills in manufacturing and sales. One member from each side of the divide had previous start-up experience. They therefore started with higher-level organisational capabilities and imported a greater level of tacit knowledge that leveraged access to other human capital (e.g. ability to manage the process and relationships with capital providers). Their investors offered their own chairman to sit on the board of Company 8. Consistently this team met milestones set by government agencies awarding grants and targets set by investors. The engineers took the process a step further by experimenting with the manufacture of the actual production of their product.

Table 6.3: Resource accumulation, leverage and management (Evaluation)

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**Human Capital gained from:** Social networks to allow access to potential team members with commercial experience; Networks to allow access to investment providers **a)** *"..we are looking for necessary funding to make sure we can finish the clinical trial. We are ready to go and protocols are in place; the products made but we have to guarantee funding that the clinical trial will end and that is when the problems of the biotechnology companies start. Trying to get enough money to make progress because the way the funding is given means that progress is difficult and more expensive than it needs to be. It is just ridiculous. We could have got far further and far quicker far cheaper if someone had just said here is all the money you have used up till now, go and do what you are supposed to do, as opposed to getting it in dribs and drabs"* (Lead Entrepreneur, Surgeon, Company 4).	**Human Capital gained from:** Social networks to allow access to potential team members with commercial experience; Networks to allow access to investment providers **b)** *"Scottish Executive had just brought in Smart Successful Scotland which was Wendy Alexander, the enterprise minister at the time. She launched it and there was whole lot of little schemes tied up in this Smart Successful Scotland and we tied up with them. The first one was called the Proof of Concept award which specifically allowed people to develop IP within the university setting for the purposes of commercialisation. We applied for that and we were successful. We had a bit of jiggery pokery to be done because the IP was held by my colleague's company down in England. We had to get that assigned. In order to take up a Proof of Concept award, which was held within a university, the university has to own the IP. So we had to assign it at that point to the university. This is very unusual. Usually IP is developed within a university. We gave it to the university in order to get this big chunk of funding to help us develop it"* (Lead Entrepreneur, Biologist, Company 5).
Q3 Non-Academic Entrepreneur	**Human Capital gained from:** Social networks to allow access to potential team members with technical specific human capital; Networks to allow access to investment providers **c)** *"I think that we were all looking for opportunities I guess. What was key and what I realise now is key is getting the right team. When you hear this it is not something that you understand yourself until you start working through this process but you hear it from the funding agencies, you hear it across the board that it is not even so much about the product but it is about the team. If the people in the team are not right then…."* (Board Member, Company 8).	**Human Capital gained from:** Social networks to allow access to potential team members with commercial experience; Networks to allow access to investment providers **d)** *"In our previous job we had been looking at a number of new areas for the company to diversify in and one was the development of therapeutic antibodies and how to treat infectious diseases. So our knowledge about the need for those sorts of products came from the work we had been doing and their market research and just looking out there for what was available to treat those diseases that led us to believe that there was a definite need there"* (Lead Entrepreneur, Scientist, Company 7). **e)** *"We will look for opportunities amongst the government schemes similar to SMART of which there are a number and there are also one or two other sources. There are things like the Bill Gates Foundation which might come in for us at one point. He is putting a lot of money into the disease area where we are involved in. That's about it at this stage. We have a SMART award and we have to get on … The other thing is to continually look for new contract work"* (Lead Entrepreneur, Scientist, Company 7).

6.3.4 Resource Accumulation, Leverage and Management: Non-Academic Entrepreneurs on Non-Sponsored Environments

In Company 6, the lead entrepreneur relied on his own specific prior entrepreneurial experiences to accumulate resources. He brought with him technical capability drawn from his education in science, his working experiences in the Ministry of Defence as well as his prior start-up exposure. He demonstrated a wide knowledge of the industry in which he hoped to function both in the USA and in the UK and was in the process of building a reputation amongst technical colleagues and representative in the venture capital community. As a non-academic entrepreneur he was keen to extend his network of influence within academia and had made contact with a local HEI. He built on his technical and social network resources to gain access to private equity, allowing him to develop the company infrastructure and to relocate to a sponsored environment.

The founders in Company 7 possessed enough financial capital from their redundancy package, prior knowledge of the market (Q4d, Table 6.3) and sufficient specific human capital from past education and scientific work to offer themselves to the pharmaceutical world as a company seeking contract work. Similar to companies lead by academic entrepreneurs, Company 7 offered a dual business model. Along with a contract service they wished to develop their own cell-lines. The starting endowments with which the two scientists began Company 7 rested extensively on their own human resources relating primarily to their skills claimed through education and past employment. Recognising that they lacked business skills, they approached the business development agency and slowly built up their knowledge of sources of available funding (Q4e, Table 6.3). The scientists did not manage to build on their technical and social ties to gain financial resources and were observed to have a limited social network. They found it difficult to network. Unlike academic entrepreneurs their access to business advice was poor possibly because they lacked access to a gatekeeper, a role played for academic entrepreneurs on sponsored environments by the TTOs.

Company 9 offered an example of a lead entrepreneur who developed insufficient resources and network ties and presented with inappropriate human capital to move from the early stages of opportunity identification to the next. The idea for

the opportunity was not well defined and the team members ill qualified. The resource building process was ambiguous. Business acumen was bought as a resource from the market place and thereafter the company holding responsibility had full responsibility for fundraising not only for the management of the company but also for the chemical testing and regulatory process. All laboratory work was sub-contracted out to different research institutions. Due to lack of diligence on the part of the management company a patent was filed on behalf of the company for a chemical for which a patent had already been filed. This halted the entrepreneurial process and as a result Company 9 remained at the opportunity identification stage throughout the study.

6.3.5 Cross-Case Comparison at Evaluation

All lead entrepreneurs reported that attracting resources for evaluation was a challenge. This phase required the entrepreneurs to not only identify future resources but also to learn how to access and manage them. For those with little or no commercial experience, with a lack of understanding about their target market and with few contacts with finance providers and business advisers, this proved difficult. However, lead entrepreneurs, who had or were gathering an entrepreneurial team with diverse human capital, were able to develop and build on existing social networks. Table 6.4 outlines the relationship between the entrepreneurial process and social capital associated with discovery, evaluation and exploitation. Data indicates weak and strong tie connections which are related and influenced by human capital at similar junctures (Table 6.2). Weak ties with resource providers were evident in Companies 1, 3 and 5 in relation to fundraising. The lead academic entrepreneurs provided the technical-specific human capital and market knowledge whilst recruited surrogate entrepreneurs, team members or TTOs, exploited their social capital to network with resource providers to attract funding (Mosey et al., 2006). Social ties between TTOs and the local business development agencies were especially valuable, but sometimes not always appreciated (Franklin et al., 2001). TTOs acted as ‘gatekeepers’ to other resource providers (Johannisson, et al., 1994). The lead academic entrepreneurs often committed considerable portions of their precious time (considering that they still were full time employees of the HEIs) to gain the commitment of these key team members.

For Company 1, headway was made through a personal introduction to an angel syndicate by a relative of the lead entrepreneur (e.g. a direct social tie). Companies 3 and 4 were forced to London to seek funding. In both cases prior knowledge and specific human capital relating to venture capital provision came from surrogate entrepreneurs. Other sources of early seed funding for opportunity identification included winnings from a business plan competition (Company 1), university equity (Companies 2 and 3), redundancy packages (Company 7), market research commissions from the governmental business development agency (Companies 5 and 8) and private equity (Companies 2, 6 and 9). At the evaluation phase general human capital pertaining to technical knowledge was less valuable than social capital in relation to networks and ties with resource providers. Such networks provided access to specific human capital relating to sources of general management skills, the development of prototypes, securing proof of concept and industrial contacts. Human capital thus varies in advantageous value at different points during the entrepreneurial process and access to strong ties more important at the evaluation phase. These observations give rise to the following proposition:

Proposition 14: Lead academic entrepreneurs on sponsored environments who are involved in the research and development of medical and dental devices are more likely than other lead entrepreneurs to have or to be offered direct ties with surrogate entrepreneurs by resources providers.

Proposition 15: Lead academic entrepreneurs on sponsored environments who recruit surrogate entrepreneurs are more likely than non-academic entrepreneurs on non-sponsored environments to receive capital investment from external investment providers.

Companies 7 and 9, non-academic entrepreneurs on non-sponsored environments, displayed a distinct lack of sufficient entrepreneurial experience and had limited access to experienced advisors to guide them appropriately. Future effects of early stage mismanagement can only be speculated, but for Company 9 their first product had to be discarded. The effect of poor advice for the entrepreneurs in Company 7 meant that their own research had to be put on hold whilst the contract side of the operation took prevalence. In addition, the failed merger with another company and the rejected application for funds from financial providers substantially weakened their already precarious organisation. The two entrepreneurs

Table 6 4: Relationship Between Social Capital (SK) and the Entrepreneurial Process

Company	*Market*	*SK related to Discovery*	*Product / process to serve Market*	*SK related to Evaluation*	*Future Market Solutions*	*SK related to Exploitation*
Company 1: Lead academic entrepreneur(s) located on sponsored environments	Test kits and instrumentation for testing for toxicity	Family connections to investment sector. Pro-active HEI mentors. Academic network of scientists	Development of a novel way to test for toxicity. Supplementing research with distribution of products for another company	Assistance from one company in USA to use their technology. Team member's prior exposure to pharmaceutical sector and business connections	Fungi inserted with glow-in-the dark genes is a stable medium for a test kit which is self contained and does not rely on any source of external power	Networked with other providers of test kits at trade shows. Strengthened understanding of market needs through market research through observation, research and development. Exposing concept to the academic community
Company 2: Lead academic entrepreneur(s) located on sponsored environments	Biochemical processes/ pharmaceutical	Academic network giving access to technical expertise. Industrial network for potential clients	Development of 'intermediary' enzyme. Supplementing research with contract research	HEI / industrial collaborative research for enzyme. Access to HEI technical personnel. Access to TTO. Access to surrogate entrepreneur with business connections	Further research to discover the intermediary enzyme sought by pharmaceutical companies and to take the laboratory scale process up to industrial scale	Direct relationship with major industrial chemical company requiring the enzyme. Network of prior industrial connections for contract work
Company 3: Lead academic entrepreneur(s) on sponsored environments	Diagnostic test kits for dental decay	Co-operation with other HEI to conduct research. Clinical network	Development of an instrument for early detection of tooth decay	Skilled research team. Access to TTO. Access to surrogate entrepreneur. Access to VC. Access to business development agency	Increased detection of decay leading to preventative programmes arresting further decay through the manufacture of a diagnostic test kit	Clinical work giving access to patients. Research network. Technical conference network. Governance responsibility as a national dental health advisor
Company 4: Lead academic entrepreneur(s) on sponsored environments	Medical device for implantation	Clinical network. Access to specialist engineer	Development of a graft for implantation	Skilled clinicians. Access to business development agency. Access to surrogate entrepreneur. Access to VC	Manufacture of a graft prototype for human implantation for further testing for regulatory approval	Access to clinical and surgical hospital network. Access to patients. Access to international research facilities

Company	*Market*	*SK related to Discovery*	*Product / process to serve Market*	*SK related to Evaluation*	*Future Market Solutions*	*SK related to Exploitation*
Company 5: Lead ent(s) academic on located sponsored environment non-	Instrumentation for drug testing/ pharmaceutical	Access to multi-disciplinary team. Access to business development agency	Development of an instrument to test drugs. Supplementing research with contract research	Access to TTO. Access to colleagues. Access to business development agency	Ethical use of donated human tissue for testing drugs gives a better indication of effect of drug prior to introducing it to humans	Access to academic community as end users of the product. Access to board members of an established chemical company
Company 6: Lead non- academic ent(s) on sponsored	Instrumentation for drug testing/ pharmaceutical	Access to business development agency	Development of instrument for testing drugs	Access to business development agency and known HEI contacts	Development and manufacture of an instrument to test drugs	Access to previous customers from prior start-up
Company 7: Lead non- academic ent(s) on located	Biotechnology/ pharmaceutical/ cell-line production	Limited access to business development agency	Development of new cell lines. Supplementing research with contract research	Access to industrial players in the pharmaceutical industry	Research and production of special cell line	Access to industrial players in the pharmaceutical industry for contract work
Company 8: non- Lead academic ent(s) on located sponsored	Instrumentation/ miniaturisation and automation for high-through-put information in laboratory processes	Access to business development agency. Access to academic sector	Development of a tape for testing and separating DNA.	Access to academic sector. Access to business angels	Manufacture of prototype tape	Access to competitors and competitors products. Access to academic conference circuit for company promotion. Access to academic network
Company 9: Lead non- academic entrepreneur(s) on located	Pesticides	Access to farming community	Original concept was to develop a 'safer' sheep dip but latterly development of pesticides for head lice and mosquitoes	Weak ties with business and scientific sectors	Discovery of an effective head lice eradication formula which also kills mosquitoes	None. Market need identified from internet research

found themselves continually reassessing their situation. This was especially necessary for realigning applications for funding from private, governmental and charitable sources.

Lead entrepreneurs with the most education reported more access to venture capitalists and were the more successful in raising funds (e.g. those who were full professors). Generally, these lead entrepreneurs were also responsible for the creation of unique IP associated with their product. Past literature substantiates this observation that better educated entrepreneurs have more success gaining finance from venture capitalists (Shane, 2003). This lies contrary to Westhead and Storey (1995) who found that firms which were reliant on intangible assets, such as education levels, had greater problems than other firms in obtaining capital. Full professors added value to their applications because they were recognised leaders in their field of research. Their findings were published in recognised peer reviewed journals. Within their own HEIs they displayed managerial and administrative acumen by conducting extensive research programs. Their applications for basic research funding to governmental and charitable bodies and their presentation skills helped with the application process for funding to potential investors. Not only was their approach professional, they carried with them considerable individual reputation and the reputation from their respective HEIs. Knowledge of the market and application of potential products did not pose a major challenge for most lead entrepreneurs. Lead academic entrepreneurs' perceptions of opportunities were rooted in their academic research and knowledge of the market extracted from industrial players met through the conference circuit or through contact with end users who had dual academic / clinical roles. The effect of further education and academic reputation prompted the following proposition:

Proposition 16: Lead academic entrepreneurs who are full professors based on sponsored environments are more likely to attract venture capital funding than lead non-academic entrepreneurs on non-sponsored environments.

6.4 Exploitation: The Context (Theme 3)

The possession of idiosyncratic information or beliefs leading to the discovery of an entrepreneurial opportunity (Kirzner, 1973) is not sufficient to attract resources.

As with the prior two phases in the entrepreneurial process, it may be anticipated that entrepreneurs with relevant experience, skills and connections will be better situated to exploit the opportunity than those without. Those without must have the capabilities to access, choose and recruit those with. Learning from other team members may allow the entrepreneurs to move towards firm formation (Kor and Mahoney, 2000). The entrepreneur must also have the capacity to persuade resource providers to release resources (e.g. financial, social, physical and organisational) and to convince them that their ability to combine these resources, will lead to a profitable outcome. All lead entrepreneurs in this study exploited their opportunity by creating independent firms.

6.4.1 Firm Creation Decision: Academic Entrepreneurs on Sponsored Environments

During the exploitation phase of the opportunity identification process involving the decision to create a firm academic entrepreneurs relied on the advice of the TTO. Lead academic entrepreneurs were all forerunners in their field of academic research but were less comfortable with their entrepreneur roles. The human capital resources that were lacking revolved around finance, organisational issues including a time commitment to the process, certification regulations, accommodation, the market and access to trained people. These observations are substantiated by past research which highlights that inexperienced entrepreneurs may lack access, in the form of social network content (Hoang and Antoncic, 2003), to seed funding, industry knowledge or access to investment finance (Mosey et al., 2006). It was anticipated that academic entrepreneurs would have difficulty building or identifying new weak ties to spot new opportunities (Burt, 1992; Üçbaşaran et al., 2003a) or set up strong ties with team members to access resources, distinct capabilities or social capital (Vohora et al., 2004). Facing these barriers the human capital of academic entrepreneurs may effect the development of their social capital.

The lead entrepreneur in Company 1 realised value from his PhD during the write up phase. Winning a business plan competition forced him to form a company. The lead academic entrepreneur accepted space within the HEI incubator unit but had reservations about forming the company so quickly. He relinquished equity to the providers of the prize money and accepted assistance from two mentors who guided him through the process of applying for government funding. Applying for

government funding was an action consistent throughout the firm formation process and was available to both academic and non-academic entrepreneurs on sponsored and non-sponsored environments (Q1b, Table 6.5; Q2c, Table 6.5; Q3d, Table 6.5). Application to business angels came after firm formation and with the assistance of a team member who had prior experience with the pharmaceutical sector. Applying for venture capital or funding from business angels was sought after firm formation and those who were successful accessed people who had prior dealings with the providers.

Company 2 was the only firm which did not rely on venture funding. This firm supported itself through contract work. The lead academic entrepreneur who was the Industrial Fellow had been inspired to question the possibilities of forming a firm within the HEI institution for a number of reasons. Much of the 'push' came from a surrogate entrepreneur operating in the USA who suggested co-operation between the HEI and his company. In addition, the lead entrepreneur desired to exploit his previous industrial experience and the HEI offered accommodation and use of IP. The literature indicates that prior business experience encourages opportunity exploitation by providing the necessary skills, information and trust (Larsson and Starr, 1993), to encourage resource flows through known social networks, in this case provided by the surrogate entrepreneur and the lead entrepreneur. The surrogate entrepreneur provided knowledge of the market and contact with clients who required contract research. The lead academic entrepreneur's first line of enquiry concerning firm formation was through the TTO who assisted with the applications for appropriate government funding and approved an Entrepreneurship Fellowship course for the Post Doctoral student. As with Company 1 the academics changed their roles from academia to commerce after firm formation. Only the full professor in the entrepreneurial ownership team remained a full time academic and acted as their science advisor. He acted as a bridge between the world of commerce and the world of basic research whilst at the same time maintaining and increasing his academic reputation.

Company 3 was formed and incubated within the HEI Technology Transfer Offices prior to moving to a technology park. The lead academic entrepreneurs' frustration at not being awarded further government or charity funding to develop their technology spurred them to form a firm primarily to attract funding. Their lack of social networks led the TTO to search for and recruit an experienced mentor (with the

Table 6.5: Firm creation decision (Exploitation)

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**Human Capital gained from**: Social networks to mentors and surrogate entrepreneurs for access to governmental and VC funding; Ability to access scientific advice; Ability to access potential contract customers **a)** *"...exploratory work was undertaken to consider the viability of setting up a company and independent market research was undertaken and corroborated the market opportunity and some independent findings which lent weight to the proposition that was manifesting itself in the early days. We attracted a couple of mentors to the project one of which became the chairman of the company and this company was incorporated in Oct. 2001."* (TTO Representative, Company 3). **b)** *"So I suppose, I came up with the idea, J came in then G and we founded the company. We founded the company for two reasons. One is to negotiate with the trust over the IP and the second was to make us accessible to government grants. Specifically the SMART award. So that gave us 45,000 pounds to do a Proof of Concept."*(Lead Entrepreneur, Surgeon, Company 4).	**Human Capital gained from**: Ability to access government funding application process; Access to scientific advice; Access to facilities (e.g. laboratories) **c)** *"I mean we were up beside Cyclacel and Ardana, companies who had massive amounts of funding and we were the only ones with no funding. It was nuts, we were in* (a place in Glasgow) *and we were listed in the top ten Scottish spinouts, potential spinouts and I think that the link with* (a large chemical company) *helped that a lot. To keep the company surviving you have always got this branding thing. You are always trying to brand the company, it is potential; l you have got to keep developing the public perception of it. We were really good at that. We were really good at giving the right perception of* (Company 5) *when ever we were outward facing" (Lead Entrepreneur, Biologist, Company 5).*
Non-Academic Entrepreneur Q3	**Human Capital gained from**: Ability to access government funding application process; Access to scientific advice **d)** *"The next step was that we applied for the SMART award. We reckoned that that was a fairly rapid way to get external funding. SMART at that time was worth 45,000 pounds which was 75% of the project costs……There was a lot more red tape involved in getting that simple SMART award than the last round of funding when we raised a million pounds but we persevered and we secured that in Jan 2002 and then we got our first private funding in Sept 2002…….. We had some deliverables, which were expected of the SMART process, which was all about Proof of Concept right. "* (Lead Entrepreneur, Engineer, Company 8).	**Human Capital gained from**: Ability to access government funding application process; Access to scientific advice; Access to facilities (e.g. laboratories) **e)** *"The only thing that we could have done differently was when we actually moved into our first lab to start the contract work I think that at that point we should have got down to our own research work more seriously than we did at the time. We did kind of hold off on that because we were dithering over funding and things like that. Several other things came up like a merger with another Scottish company. We allowed ourselves to be side tracked by this"* (Lead Entrepreneur, Scientist, Company 7).

assistance of the local business development agency). Mosey et al., (2007) recognised that TTOs designed bridges to span structural holes between research and industry networks. Access to funding, which led to the eventual launching of the company on the Alternative Investment Market (AIM) was found due to the expertise and prior knowledge of the recruited mentor (Q1a, Table 6.5). A deal was also struck with the HEI over the IP. It was agreed that if the company reached a certain value or was floated on the AIM then the university would assign the IP to the new company. The academics in Company 3 remained full time HEI employees throughout the process. Although they exhibited a lack of business acumen the leading academics were exposed to the logistics of conducting and managing international research projects (e.g. identification of research subject, applying for funding, writing proposals, managing funds and organisational skills). Through these general experiences they were exposed to several aspects of business, not least, time management, as they juggled with their academic, advisory, clinical and commercial roles.

The entrepreneurs leading Company 4, like the academic entrepreneurs in Company 3, formed a company as a reaction against the lack of funding from traditional sources for basic research (Q1b, Table 6.5). Their HEI showed no interest in assisting with research either financially or practically, by offering laboratory space, or by giving easy access to their IP. However, their private equity venture capitalists (3i), sought through a surrogate entrepreneur, failed to fully appreciate the full potential and value of the opportunity and did not adequately manage their investment. Important milestones were missed putting these potential high ability and value entrepreneurs and their high quality opportunity at risk. Three of the team members remained in full time employment as medical personnel. Academic entrepreneurs were loyal to their academic commitments. In all the cases, the focus of the entrepreneurs changed from targeting support from the HEI to focusing on external resources important for business development once legitimacy and internal support within the HEI was established. With reference to companies 3 and 4, the lead entrepreneurs experienced a ‘push’ away from their HEIs from the TTOs to encourage independence.

6.4.2 Firm Creation Decision: Academic Entrepreneurs on Non-Sponsored Environments

The lead entrepreneur in Company 5 had prior start up experience and learned commercialisation skills from his practical hands on experience (e.g. learning by doing) (Jovanovic, 1982). Brief commercial exposure complemented what he had learned formally through education and exposure to market needs. Assistance in building a business profile, attractive for government funding, was supplied by the TTO. Their application for funding was considered timely because there were several schemes in the offing for entrepreneurs wishing to commercialise HEI knowledge. Through a process of extensive networking the lead entrepreneur extended his weak social ties, directly and indirectly, and successfully invited two members of a large pharmaceutical company onto the board of directors. Davidsson and Honig (2003) recognise that human capital profiles of academic entrepreneurs may be enhanced by developing weak ties with industry actors. Their recruitment attracted considerable positive press thus raising the profile of the company and added weight to their funding applications to governmental and private bodies (Q2c, Table 6.5). The decision to form a company came after the success of Proof of Concept and whilst the lead entrepreneurs were still employees of the HEI. They continued to successfully apply for government funding to further develop their research and development of the instrument and supplemented their income with contract work. Unlike the academics leading Companies 3 and 4, once non-governmental funding was secured both academics in Company 5 resigned from their academic positions.

6.4.3 Firm Creation Decision: Non-Academic Entrepreneurs on Sponsored Environments

Company 8 offers an interesting insight into the process of forming a company. The non-academic lead entrepreneurs had previously formed another company offering consultancy and advice on automation and miniaturisation to the life-science sector. Through this venture they met with two academics who became part of the entrepreneurial ownership team. After an opportunity had been identified which they considered to have sufficient future value, they decided to experiment with the manufacture of a prototype product to ensure that there was sufficient evidence of proof of concept. This they did by forming a company, which the engineers considered to be a spinout from their original consultancy company. Since two representatives in the entrepreneurial team were potential end-users of the product

they had enough knowledge of the market, the future requirements of the market and access to competitors' products to have an initial understanding that there was sufficient promise in the market place for their application. This particular team demonstrated they possessed relevant prior knowledge and specific capabilities to successfully develop opportunities, create value and generate potential returns. The team also used their successful application for SMART and SPUR awards to further their search for future funding (Q3d, Table 6.5). Crucial to the formation of the company was the observable division of labour. The engineers devoted all their time to the formation of the company by setting out a strategy for fund raising, searching for suitable accommodation and for product development. The scientists' skills were relied upon as a form of advice and to give weight to presentations to investors and other members of the academic community.

6.4.4 Firm Creation Decision: Non-Academic Entrepreneurs on Non-Sponsored Environments

The lead entrepreneur in Company 6 explained that his relocation to Scotland from Wales was encouraged by the local business development agency and by the local HEI who donated residential premises. His access to investment came from applications made through the business development agency, bank and private investors sourced by a newly appointed non-executive board member. Unlike lead academic entrepreneurs, access to people came from his own direct and indirect strong social ties (Granovetter, 1973) established during the formation and liquidation of his previous business. The services of TTOs were inaccessible to non-academic entrepreneurs on non-sponsored environments.

The inexperience of the two scientists leading Company 7 made one of the lead entrepreneurs say that if he had to go through the experience of setting up a company again, he would be more focused on his own research rather than on the requests of the venture capitalists (Q4e, Table 6.5). He felt that the research and development of their novel cell-lines to be more important than their contract work. The financial benefits, he calculated, from such a strategy would be greater than relying on the services and potential support of investors. The decision to form their own company was compounded by redundancy and the need to find an alternative to paid employment. The two lead entrepreneurs used their redundancy money to write business plans and

apply for funding from government and charity bodies. However, knowledge of what and where to apply for funding both from the private and governmental sector was lacking and they were ill advised by local business advisory services. In relation to resource providers their observable network structures were weak, their network content poorly defined and network governance, non-existent (Hoang and Antoncic, 2003). Exploiting their known industrial contacts they successfully tendered for contract work from the pharmaceutical sector relying on their own network and knowledge from their previous employment in the sector. As soon as they won their first contract they moved from residential to a sponsored environment.

Company 9 was formed because, following advice from his accountant, the lead non-academic entrepreneur sought guidance from the business development agency. The lead entrepreneur stated that the formation of the company was a process that happened in stages. At each stage he learned more about the process of forming a firm, about the process of regulatory practice, about patenting and about the need to find qualified people to carry the firm forward. The dynamic entrepreneurial process was a learning-by-doing experience for him. It did, however, rely on raising private equity and took considerable time to evolve (e.g. the initial idea for the formation started in 1996).

6.4.5 Cross-Case Comparison at Exploitation

The decision to form a company led by academic entrepreneurs relied on input from TTOs. Apart from the lead entrepreneur in Company 4 all the entrepreneurs sought support and advice about the process of commercialisation, funding and the legal nuances of forming a firm from the TTOs, prior to and at formation. During this phase the business proposal was examined and the technology scrutinised. All academic entrepreneurs offered evidence that they had scrutinised the market and were able to gauge market needs. This was often supported by formally funded market research. The links gained through contact with the TTOs developed the personal capabilities, networks and experience of the lead academic entrepreneurs. However, after firm formation, academics who were full professors were reluctant to give up their commitment as academics and tended to remain loyal to and in full time employment within the HEI and divided their time between academic and entrepreneurial demands. Their specific research remained an academic priority.

There was some evidence of a firm-HEI linkage observed through an exchange of personnel (Pfeffer and Salanick, 1978).

All the academic entrepreneurs on sponsored and non-sponsored environments had gained access to industrial or commercial players connected to their field of research. Contact was established through a number of avenues. The lead entrepreneur in Company 1 established what competition was available for toxicity detection through attendance at trade fairs and conferences. An industrial player commissioned the HEI housing Company 2 to conduct experiments to unravel a specific chemical process. The industrial player released their IP to Company 2 in anticipation that they would discover the process. Evidence of market need had already been demonstrated when a dental hygiene company approached the academics in Company 3 for a licensing option on their system for early detection of dental decay. Industrial players also made contact with academics in Companies 2 and 3 at conferences. The lead entrepreneurs forming Company 4 showed the least amount of understanding about how to maximise returns from their potential product. These structural holes appeared to exist between their scientific network and the industrial network (Mosey and Wright, 2007). They displayed the most inexperience in framing a decisive route to market and were exposed to inappropriate management supplied by their investors which did not bridge the structural hole. The academic entrepreneurs in Company 5 appreciated the advice from the TTO prior to the formation of their company for access to funding but also had direct ties with the pharmaceutical sector and had formal market research commissioned by a division of the business advisory service. The lead academic entrepreneur remained incentivised to included industrial members on his board (Üçbaşaran et al., 2003).

For academic entrepreneurs on sponsored sites their well-developed technologies were often supported by a government led initiative (Proof of Concept). The fund, awarded to the HEI, allowed the potential entrepreneurs time to devote to the development of their concepts prior to exploitation. Lead academic entrepreneurs, with narrow resource profiles, remained on more resource munificent environments to gain access to additional resources throughout the identification, evaluation and exploitation process (Pfeffer and Salanick, 1978). This compensated their lack of commercial expertise. In addition, TTOs and/or business development agencies

partnered academic entrepreneurs with surrogate entrepreneurs or with more experienced entrepreneurial ownership team members (Vanaelst et al., 2006). Few of the academic entrepreneurs brought with them commercial experience. The entrepreneurs relied on the social networks of their advisors and mentors to gain access to people with relevant expertise. The lead academic entrepreneurs, therefore, selected a sponsored environment to reduce uncertainty, to gain access to resources and increase their commercial legitimacy with regard to customers, suppliers, financiers, competitors and government agencies. These observations led to the following proposition:

Proposition 17: Lead academic entrepreneurs on sponsored environments are more likely to have weaker ties to resource providers outside of their sponsored environment than non-academic entrepreneurs on non-sponsored environments.

The non-academic entrepreneurs on the sponsored environment had an array of capabilities in the form of prior entrepreneurial experience, a well balanced and heterogeneous mixture of human capital within the team, technical and commercial experience and a well researched market plan. Through contact with business advisers they successfully won awards from government agencies, reaching desired targets in timely fashion and within budget. More expertise was recruited when business angels offered their chairman to chair Company 8's board. The entrepreneur / investor relationship offered network benefits that were strongly positive and additive rather than simply overlapping (Mosey et al., 2006). Such was the synergy of talents that the engineers experimented with the production and manufacture of products. They were able to network with resource providers using their own social capital and contacts because both the engineers and the academics had prior start-up businesses experience and were known to and trusted by the investment community as reliable candidates. They, therefore, leveraged their reputation and track record to raise external finance and access to business support and advice.

The non-academic entrepreneurs on non-sponsored environments, on the other hand, were more market led and the resource more often lacking was scientific or technical expertise. Their resource profiles often, but not always, included prior business experience with prior customer, market and finance knowledge. These

experiences were gained from prior exposure. In addition, several non-academic entrepreneurs reported experiences that prompted a reaction to threats such as liquidation or redundancy.

Advisors and mentors from the business development community and private consultants were inexperienced in the life-science sector and offered inappropriate advice. This was particularly true for the lead entrepreneurs in Companies 4, 7 and 9 who had the least commercial experience. Company 7, for example, was advised to apply for SPUR funding when the application process should have been made for SMART funding. Both the inadequate levels of entrepreneurial experience and the inappropriate level of advice given by support agencies to guide and shape early business development affected the later developments of the companies. To date, Company 9 has not surpassed the opportunity identification stage and the company has changed management and product on at least three occasions.

6.5 Summary

This chapter covered three components of the entrepreneurial process as outlined in the conceptual framework guiding this study and presented in Chapter 3. Summarised as Theme 3, the components covered exploration, evaluation and exploitation. Analysis of the interview data from nine sets of lead entrepreneurs and their entrepreneurial ownership team members allowed for insights to be made about human capital and network factors that influenced the opportunity identification process. Different forms of human capital were more or less useful during different parts of the opportunity identification process (Davidsson and Honig, 2003). Specific human capital affected the discovery or identification of opportunities but (commercial) exploitation of opportunities was governed by general human capital (Dimov and Shepherd, 2005). Although this observation simply adds to the confusion over the importance of specific and general human capital at different phases of the entrepreneurial process (Corbett, 2007) from a RBV of the firm theoretical basis the unique bundle of resources associated with an advanced education suggests a unique source for value creation. The results of the current study are perhaps applicable to clinicians who are specialists in contemporary medical and dental fields where specific human capital was insufficient to identify a potential opportunity. Opportunities

involved new knowledge challenging the frontiers of extant medical and dental understanding. In the life-science sector, when initially identifying an opportunity, general scientific human capital is not only important but a prerequisite. What lead entrepreneurs had to learn was when to involve or recruit other team members with specific entrepreneurial human capital applicable to the evaluation and exploitation of their idea. The interaction between the different human capital shows that it is not just 'what' the entrepreneurs knows (e.g. general human capital) which is important but also 'who' the entrepreneurs know (e.g. social capital for access to people with specific human capital). This observation is more applicable to lead academic entrepreneurs than non-academic entrepreneurs because the later were less likely to develop novel IP. Both social and human capital appears to change value over time or 'deteriorate' over time (Lester et al., 2008). Past experiences and interpersonal networks of lead entrepreneurs affect their current actions and access to people, influence their ability to create new networks to gather new information, and to influence others.

Finding people with the appropriate human capital to successfully attract funding was a recognised barrier to commercialisation. Other identified barriers to commercialisation extended to building managerial capabilities, discovering a route to market, evaluating what product to take to market and knowing the regulatory process of certification for medical devices and chemicals. Initial stages of opportunity identification were pre-ceded by a phase which included interaction between potentially interested members. The formative steps of evaluating an idea for commercialisation was biased towards the technical side and less towards identifying commercial value from skills and knowledge. Entrepreneurs reported leveraging access to resources through networks of other actors known within their external environment and whose experience bridged the technical to the commercial. The conference circuit (both technical and academic) frequented by academic and industrial payers offered an arena for searching for information related to opportunities; to meet industrial payers and to promote new companies.

The findings of the qualitative analysis lent support to research results from previous studies, primarily in respect to the role of human capital and capabilities impacting on the entrepreneurs' ability to identify an opportunity, ability to

accumulate resources and the support, both real and potential, to form a firm. Lacking in social capital and contacts with people who held experience in the life-science sector, lead academic entrepreneurs had to rely on contacts offered by outside team members (or privileged witnesses) such as government agencies and investment providers for legal and financial assistance (Vanlaest, et al., 2006). TTOs and the business development agencies were instrumental in providing information and access to government awards but were less 'directly' involved in assisting entrepreneurs seek contact with venture capitalists and business angels. Expertise in finding funding from investors was accomplished through the use of surrogate entrepreneurs who had proven track records and had established network ties with finance providers. With regard to Companies 3 and 4, venture assistance was sought from investors in London because of insufficient interest and / or experience in the local investment markets which may be a reflection that the life-science cluster in Scotland is still in its infancy.

In this study the extent that social and human capital of the lead entrepreneurs and team members influenced the entrepreneurial process varied over time and phase. The social and human capital embodied in each lead entrepreneur and team members was an important determinant of attractiveness to potential surrogate entrepreneurs, investors and potential customers. Data suggests that academic reputation and level of education (e.g. full professorship) are strongly associated with likelihood of positive opportunity identification and exploitation. Rather than treating all the academic entrepreneurs and all the non-academic entrepreneurs as homogenous, data suggests that their human and social capital was quite unique and heterogeneous, and that heterogeneity was reflected in their access to and provision of outside resource providers. Although the HEI and the act of commercialisation are meant to be separate entities and concepts, in reality they are highly connected. Resource dependence theory has identified this to be the case (Pfeffer and Salanick, 1978). Lead academic entrepreneurs were often able to exploit HEI resources even after they had officially left the HEI location.

Chapter 7: Case Analysis: Location

7.1 Introduction

During the process of data collection lead entrepreneurs changed geographical location moving between sponsored environments and from sponsored to non-sponsored environments. In this chapter, data relating to 'why' movement occurred is discussed. 'How' entrepreneurs discover opportunities, gain access to critical resources and deal with barriers to commercialisation may be shaped by their external environmental conditions. The concept of the incubator organisation (or property based initiative) offering network services and support (i.e., a science park) is well documented (e.g. Westhead and Batstone, 1998). Movement between different environments may occur because the perceived benefits gained from a one environment may be limited to a certain phase of the entrepreneurial process. Data relating to the effectiveness of social networks outside of a supportive environment is missing from current research and research recording changes in external environment undetected in the literature. This study provides fresh insights relating to the neglected theme of the movement of entrepreneurs and their firms between different environmental contexts.

The structure of the chapter is as follows. Section 7.2 reviews the impact different external environments have on access to resources relating to three critical junctures (Vohora et al., 2004) (e.g. opportunity identification; entrepreneurial commitment; venture credibility) (Theme 4 in Chapter 3). Movement is mapped between sponsored and non-sponsored environments during these critical junctures in the entrepreneurial process. Exploring external environmental conditions and the influence it has on access to critical resources helps answer the following research question:

Research Question 8: 'How' does the external environment impact on the entrepreneur's / entrepreneurial ownership team's access to resources?

Section 7.3 offers a cross-case comparison of access to resources in sponsored and non-sponsored environments at the opportunity identification phase. Section 7.4 explores resource accumulation from different external environments at the entrepreneurial commitment phase. The critical juncture called venture credibility is

covered in Section 7.5. In some cases, entrepreneurs and their firms changed environment but remained at the same phase of development, or regressed, unable to source required resources because of deficient social capital or inadequate entrepreneurial capabilities. The critical juncture 'venture credibility' is broken down into 1st and 2nd phase because within this phase there was an increase in movement between environments (Figure 7.1). The first phase of venture credibility generally reflected the maturation of the firm formation process manifest by a movement away from an HEI for academic entrepreneurs or a movement towards sponsored environments for non-academic entrepreneurs. The second phase associated with venture credibility was linked with the winning of a contract, normally for a provided service, or the award of further investor funding (e.g. business angel of venture capital). More movement of non-academic entrepreneurs between environments was recorded than academic entrepreneurs. Propositions are offered and a summary presented in Section 7.6.

7.2 External Environment: The Context (Theme 4)

In this comparative longitudinal study, three development phases, or critical junctures, were identified (Vohora et al., 2004) (Figure 7.1). 'Where' and at 'what' juncture the entrepreneurs were 'at' was identified, initially, from an electronic survey (2004) and latterly from interviews with the lead entrepreneurs (2005). Location within the typology was recorded at these three critical junctures (Figure 7.1). The first critical phase was opportunity identification (e.g. when the entrepreneur recognised a potential in a new discovery). The second was entrepreneurial commitment (e.g. when the lead entrepreneur showed commitment to progressing the opportunity). The third phase was venture credibility which tested the credibility of the entrepreneur's ability to exploit resources. A fourth critical juncture was also identified; the threshold of sustainability, but none of the lead entrepreneurs in this study reached this phase. According to the critical junctures model the lead entrepreneur guides the firm through growth phases by overcoming the challenges and resource restrictions of each critical juncture (Vohora et al., 2004).

Figure 7.1: External Environmental Location at Critical Junctures

	OPPORTUNITY IDENTIFICATION			ENTREPRENEURIAL COMMITMENT			VENTURE CREDIBILITY (1st phase)			VENTURE CREDIBILITY (2nd phase)	
	Sponsored environment	Non-sponsored environment		Sponsored environment	Non-sponsored environment		Sponsored environment	Non-sponsored environment		Sponsored environment	Non-sponsored environment
Academic entrepreneur(s)	Company 1 2 3 4	Company 5		Company 1 2 3 4 5	Company		Company 1 2 3 4	Company 5		Company 1 2 3 4 5	Company
Non Academic entrepreneur(s)	Company 8	Company 6 7 9		Company 8 9	Company 6 7		Company 7	Company 6 8 9		Company 6 7	Company 8 9
Information collection dates	Information on location gathered retrospectively during face-to-face interviews in 2005			Information on location gathered retrospectively during face-to-face interviews in 2005			**Information on location gathered during electronic survey 2004 (point of entry to the study)**			Information on location gathered during face-to-face interviews in early 2005 **(Transcript checks allowed one more point of contact in mid 2005)**	

7.2.1 Critical Junctures: Academic Entrepreneurs on Sponsored Environments

7.2.1.1 Opportunity Identification

Figure 7.1 shows that the academic entrepreneurs leading Companies 1, 2, 3 and 4 remained on sponsored environments, although not their original sponsored environments, throughout the investigation. Companies 1 and 2 stayed within the walls of their 'parent' HEI environments moving only from laboratory space to an incubator unit (Company 1) and from a science department to rented HEI redundant laboratory space (Company 2) (Figure 7.2). Opportunities for commercialisation generally grew from their research, conducted within their respective HEIs where they had substantial access to both physical and tacit resources (Lockett et al., 2003). Two of the four lead academic entrepreneurs were practicing clinicians. If the lead entrepreneurs had a clinical role, they were generally able to substantiate market need through observation of patients and feedback from other clinicians. Access to the human capital associated with specific technical ability and scientific knowledge, held within the academic and student community, provided the lead entrepreneurs with a convenient way to share and test their ideas. The bond between the entrepreneurs and their colleagues and students was strong and, as stated already, this social capital had both a positive and a negative effect on overcoming barriers at this opportunity identification juncture (Nahapiet and Ghoshal, 1998). A positive bonus was accessibility to specialised human capital in the form of

Figure: 7.2: Location at opportunity identification phase

	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** Company 1 (HEI) Company 2 (HEI) Company 3 (HEI to Technology Park) Company 4 (HEI to Technology Park)	**B** Company 5
NON-ACADEMIC ENTREPRENEUR	**C** Company 8	**D** Company 6 Company 7 Company 9

scientific knowledge but a downside was the exposure to negative attitudes from colleagues concerning the commercialisation of publically funded research. The

ethics of commercialising public knowledge has been identified as a barrier in the past literature (KLöfsten and Jones-Evans, 2000). Initially, the challenge of discovering new knowledge and finding solutions to life-science problems or conducting industrially financed contract work was the primary motivation for pursuing basis research. Market application and commercialisation was a later consideration facilitated by high levels of social capital centred outside the HEI science research environment (e.g. industrial contacts met on the conference circuit). The prompt to establish a firm, for some academic entrepreneurs, was the cessation of funding for basic research from traditional sources, which was normally awarded to their HEI or department (e.g. Companies 3, and 4).

Non-equity team members, such as TTOs or representatives from the business development agencies, were vital for giving advice about the logistics of starting a company and knowledge and experience of winning governmental grants and awards available for life-science start ups. Initially, to compensate for a lack of specific entrepreneurial human capital, the lead academic entrepreneurs relied on the TTO to offer access to alternative sources of public funding and access to the people with investment knowledge (Q1a, Table 7.1). However, in all cases, the relationship between the lead entrepreneur and the HEI changed during the entrepreneurial process. Relationships altered when first round funding from the private sector (e.g. business angels and venture capitalists) was required. TTOs did not possess the necessary networks to introduce lead academic entrepreneurs directly to potential investors. Attention was diverted away from HEI support systems to local business development agents who were linked with experienced surrogate entrepreneurs and specialist investors (Franklin et al., 2001). The research phase prior to opportunity identification appeared to be long, complex and publicly or industrially funded in all cases.

Additional benefits gained from the HEI environment were expressed by both the lead entrepreneur and entrepreneurial ownership team members. Some broadened their managerial capabilities by attending business classes and entrepreneurial fellowship classes offered by the HEI. Proximity to fellow academics, who were potential end users of proposed future technologies and products, was considered an advantage, as was access to students, who were potential employees.

Table 7.1: Opportunity Identification Phase		
	Q1 Sponsored Environment	**Q2 Non–Sponsored Environment**
Academic Entrepreneur	**Access to:** Physical and organisational infrastructure of the HEI; Business and grant advice from TTO; Proximity to scientific expertise and business/management expertise from business school. **a)** *"He* (the TTO) *advised us on actual nuts and bolts of running a company like you have to write a business plan, what kind of accounts and budgets you have to do. He also advised us on what kind of funding to try to apply for and he helped us apply for a SMART award for example. Pointed us in the direction of other networking opportunities and the information about the Royal Society of Edinburgh Enterprise Fellowship (RSE) came from him."* (Entrepreneurial Ownership Team Member, Post Doc, Company 2).	**Access to:** Physical address; Business development agencies for grants and business advice. **b)** *"We constructed some very simple ideas for experiments in our heads and me and my colleague went off and did it in his garage. Very much your standard inventor type stuff. It then became a bit more formal in as much as we started to get successful results and we started to figure out some key experiments. And that was it. We were quite commercially grounded at that point so we realised that we didn't want to do this in any particular university or any particular institution. We were just doing it in our own time. Virtually in a garage"* (Lead Entrepreneur, Biologist, Company 5).
Q3 Non-Academic Entrepreneur	**Access to:** Physical and organisational infrastructure of the HEI; Proximity to scientific expertise; Business development agency. **c)** *"So at the very initial stage we had* the two engineers there and *permission from the university and the appropriate people at the vet college. They gave* the two engineers *the use of some vacated labs some old redundant lab space in which they could set up and do their market research and consultancy work that they were doing but also used it as a base which we could use and formulate and work with them to develop business plans, have meetings, think about future directions etc."* (Board Member, Academic, Company 8). **d)** *"The biggest help we got there was from Connect ..... They were very active in connecting us with potential funders, with potential collaborators, and we also got help from Scottish Enterprise. They spotted fairly early that we had some potential and they assigned us a business manager and that allowed us to tap into their network"* (Lead Entrepreneur, Engineer, Company 8).	**Access to:** Physical address; Limited access to business development agencies. **e)** *"We came to Dundee from North Wales. We started the company with some office accommodation that XX University lent to us. We were talking to XX and SET about trying to re-locate here and SET were very proactive in trying encourage us to start up again. They gave us access to lawyers and accountants and things like that.* The HEI *I already had links with and we did a deal with their commercialisation guys where by they would provide us with free accommodation when we got going in exchange for a small shareholding."* (Team Member, Company 6). **f)** *"First, the company was located with the* managerial consultancy company *who ran it badly from their office* outside Edinburgh. *All the meetings were there, their staff manned it they did everything. We paid a contract of so many thousand per month to provide all services, telephone, management, board meetings and to run it completely."*(Lead Entrepreneur, Scientist, Company 9).

Close physical proximity to potential team members allowed in-depth discussion about commercialisation, exploration of division of labour and roles within potential companies and identification of gaps in knowledge, prior to actual firm formation (Ensley et al., 1999; Bergmann Lichenstein and Brush, 2001; Ensley et al., 2002). Specific scientific knowledge held by the academics was considered to be paramount because the commercialisation process was enhanced by their impeccable, high profile academic reputations. The close proximity of the incubator environment to HEIs also allowed academics to continue their academic work in parallel with entrepreneurial commitments.

If the opportunity was identified within the HEI and the HEI offered incubation space, lead academic entrepreneurs commented on the ease of transition from being 'an idea' to forming a firm. There was no inconvenience of seeking 'new' accommodation. The physical capital and organisational infrastructure offered by the HEI was advantageous because of the recognition of market prices for the same facilities outside of the HEI. Being associated with and sharing the same address as an HEI, with an internationally renowned reputation, boosted the image and reputation of the potential companies, compensating for newness and smallness. Access to on-line scientific journals, access to laboratory space and an already existing infrastructure was also considered a bonus. Entrepreneurs viewed the HEIs in a positive light in relation to the flexible allocation of rentable space. Proximity to organisational facilities, other staff members and business advice eased the transition from opportunity identification to committing to entrepreneurial activity. Network benefits for firms located on and off sponsored environments have been confirm by previous research (Lindelöf and Löfsten, 2002; Storey and Westhead, 1995). During the entrepreneurial commitment phase one lead academic entrepreneur chose to relocate from a non-sponsored environment to a sponsored environment (e.g. Company 5) (Figure 7.3).

7.2.1.2 Entrepreneurial Commitment

Entrepreneurial commitment came early to the lead academic entrepreneur in Company 1 because winning a business plan competition necessitated immediate firm formation. The lead academic entrepreneur was coached in business plan

development by an MBA student who later became an entrepreneurial ownership team member. The sponsored environment allowed the possible merging of two sets of complementary human capital resources (scientific and business expertise) held within two different HEI departments (e.g. the network ties providing access to resources) (Nahapiet and Ghoshal, 1998). A pro-active manager of the incubator unit acted as the network gatekeeper, introducing potential science candidates to business colleagues (Johannisson, 1998). Commercial specific human capital held by the MBA student and networks known to the mentors allowed the lead entrepreneur in Company 1 to better understand market needs and to upgrade business plans.

Figure: 7.3: Location at entrepreneurial commitment phase

	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** Company 1 Company 2 Company 3 Company 4 Company 5	**B** No Companies in this quadrant
NON-ACADEMIC ENTREPRENEUR	**C** Company 8 Company 9	**D** Company 6 Company 7

Advantages of the sponsored environment for the lead academic entrepreneur and entrepreneurial ownership team members in Company 2 revolved around the fact that the IP they used had been created within their HEI department (Q1a, Table 7.2). They were familiar with the facilities, the people and the equipment. Being located within the department allowed the professor to continue his academic career and serve on the entrepreneurial ownership team as a science advisor. The external environment acted as the galvanising influence, supported initially by the TTO who guided the team towards sources of government funding and entrepreneurship training.

A desire to create a separate identity from the HEI prompted Company 3 to move from one sponsored environment, the HEI, to another, a technology park. In response to asking why the entrepreneurs moved to the technology park a representative from the TTO office suggested that it transmitted a message to the investment community that the entrepreneurs were committed to commercialisation.

Table 7.2: Entrepreneurial Commitment Phase

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**Access to:** Physical infrastructure; Business advice from TTOs; Proximity to potential team members and trained employees. **a)** *"Because we were here to start with. We saw there was an opportunity for us to get some facilities here and it has numerous advantages to being here e.g. proximity to equipment and the people we are already familiar with. It is cheap compared to going out of the university..... Our overheads allows us to operate the business and we have proximity to Professor X and the procurement stores, services, access to broadband, library facilities, on line journals. I think initially the big thing was the facilities."* (Entrepreneurial Ownership Team Member, Post Doc, Company 2). **b)** *"You* (the lead entrepreneur) *had the idea for commercialisation and a few other lecturers also had similar ideas on the service side and the group in the department met to discuss it and what came out of that was that most of the academics were not that committed to commercialisation. They saw it as a way to easy additional income for the department in our own research. They then did not have the commitment to achieving this because if you are half hearted ..."* (Entrepreneurial Ownership Team Member, Company 5).	No companies in this quadrant at Entrepreneurial Commitment phase
Non-Academic Entrepreneur Q3	**Access to:** Physical infrastructure; Proximity to technical human capital. **c)** *"The location was being driven by our science partner at the university. They provided us with a free office for several months. So the location we are at now we have been here since pretty early on, it is near the university, we are in the middle of a biotech cluster. There is a good resource pool in this part of the country and this particular location is affordable as opposed to the crazy stuff at a science park, so we consciously did not go to a science park. We were appalled by their cost and I think culturally, the industrial feel here is, just it is ,more in tune with 'lets get stuff done here attitude'..... We were the first tenants here, it was a new building. We have an office and a shed and we are expanding into another office and an even bigger shed. And that will do us for 18 months two years for sure."* (Lead Entrepreneur, Company 8).	**Access to:** Physical infrastructure; Proximity to other life-science firms; Business development agency. **d)** *"The other advantage of sub-letting at the time was that we could work on a 3 month rolling contract so we were not locked into, what other groups get locked into, a five year lease. For a company that is just starting out you do not know if you are going to be there 2-5 years later and take on that burden of risk. The other big advantage was that the lab was already kitted out. We just needed to bring our equipment but all the benching was there all the cabinet and sinks and all these kind of mundane items were installed."* (Lead Entrepreneur, Scientist, Company 7).

The change of environment by Company 3 illustrates an example of a 'push' from the HEI authorities. The TTO representative indicated that there had been an over-reliance on the support facilities within the HEI and after four years a decision was taken to recommend a move from the sponsored environment of the HEI to an alternative supportive external environment.

Company 4 also remained within a sponsored environment, the shift occurring from hospital laboratories to a technology park (Figure 7.3). Exploiting his medical reputation, the lead academic entrepreneur reported few organisational difficulties in attracting government funding and local business enterprise finance to support the transition from the hospital to a technology park. Company 4 experienced a 'push' from the hospital environment to progress research and development activities because no facilities were offered within hospital premises. The hospital environment was hostile towards the concept of commercialisation. Access to a refurbished laboratory was provided by the business development agency which was also a stakeholder in the technology park.

7.2.1.3 Venture Credibility

Further changes in the external environment at the venture credibility critical juncture were considered with reference to two phases. First phase of venture credibility relates to the synergy of social capital exploits and human capital relating to education and academic reputation in an endeavour to attract public funding to establish the firm (Figure 7.4a). Phase 2 focuses upon the effect of additional funding or the winning of contact work and subsequent changes in external environment (Figure 7.4b). Company 1 did not change location and treasured access to the infrastructure that the HEI offered (Figure 7.4a). Financial resources needed to overcome the venture credibility critical juncture were won through the combined efforts of the lead academic entrepreneur using a network of contacts known to his family and the recruited entrepreneurial ownership team member. Social capital in Company 1 was important for the creation of the firm. The lead academic had strong ties with resource providers outside of the HEI environment because of family connections (Granovetter, 1973). With access to funding they employed one scientist from their HEI to promote market research, funded attendance at trade shows, extended their research and

development by employing another scientist and sponsored students in PhD research. The latter could be viewed as a reciprocal advantage to the HEI because not only did Company 1 fund PhD research, the lead entrepreneur also accepted a lecturer's position to promote his area of speciality.

Figure: 7.4a: Location at venture credibility (1st Phase)		
	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** Company 1 Company 2 Company 3 Company 4	**B** Company 5
NON-ACADEMIC ENTREPRENEUR	**C** Company 7	**D** Company 6 Company 8 Company 9

Relying solely on equity holding individuals and the HEI, the lead entrepreneur in Company 2 felt that to attract venture capitalists would be paramount to "giving the firm away". After being awarded government funding for the initial start-up, they relied solely on income from contract research. Remaining in the same sponsored HEI environment with security of future, released pressures of calculating future overheads and costs (Figure 7.4a). The value of the services of the TTO to the lead academic entrepreneur in Company 3 were appreciated at the start of a long four year incubation period (Figure 7.4a) but were reported as frustrating towards the end

Figure: 7.4b: Location at venture credibility (2nd Phase)		
	SPONSORED ENVIRONMENT	**NON-SPONSORED ENVIRONMENT**
ACADEMIC ENTREPRENEUR	**A** Company 1 Company 2 Company 3 Company 4 Company 5	**B** No companies in this quadrant
NON-ACADEMIC ENTREPRENEUR	**C** Company 6 Company 7	**D** Company 8 Company 9

of the relationship (Q1a, Table 7.3a). This would suggest that lead entrepreneur's access to resources was influenced by their human capital (e.g. reputation and education) which was in turn extended into new areas (e.g. commercialisation) through their contacts within their social networks (e.g. TTOs). However, the value of the resources provided by the TTOs was restricted to the opportunity identification and entrepreneurial commitment critical junctures. Thereafter entrepreneurs were guided to new sources of direction from other resources providers (e.g. surrogate entrepreneurs and business development agencies). This would indicate that there is deterioration in some social capital (Lester et al., 2008) and that, not unlike human capital, social capital has a different value at different critical junctures.

As resources, both social and human capital can be extended and enhanced. In this study access to specific human capital (e.g. that related to business) was enhanced through extending social network circles (e.g. access to surrogate entrepreneurs). Inexperience and criticism apart, it was through the TTO social network that the entrepreneurs were able to network with the business development sector. These academics only had weak ties with actors located on the outside of their department who had specialist information about investment (Granovetter, 1973). The entrepreneurs did not possess this social capital themselves. Access to specific human capital relating to business acumen was guided by the TTO, who was part of business development agency network. Through this network lead academic entrepreneurs made contact with surrogate, serial entrepreneurs who were able to introduce people in the investment sector. Generally, lead academic entrepreneur's social network did not extend to surrogate entrepreneurs. A 'surrogate entrepreneur' was recruited as a business consultant once Company 3 had moved to the technology park. He had previously held equity stakes in several HEI spinout firms and had established contacts with corporate financiers. This individual subsequently became an entrepreneurial ownership team member and the chairman of Company 3. His knowledge gained from prior HEI 'spinout' experience allowed greater understanding of how best to integrate resources to create value.

Table 7.3a: Venture credibility (1st Phase)

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**Access to:** Business development agency and social networking for surrogate entrepreneurs. **a)** *"The* TTO *office has been very helpful for the duration and it has been a long haul, four years. So they have been, at the same time, the greatest help towards trying to facilitate the process but at the same time, towards the end of the process, became the greatest frustration because they have not done this before. Meaning that they have not taken a company from start to spinout in this way and onto the AIM market. So the people who were giving us advice didn't know what they were meant to be giving us advice on. And they had limited finance and could offer limited support."* (Lead Entrepreneur, Dentist, Company 3).	**Access to:** Business development agency and social networking for introduction to industrial players in the life-science sector. **b) "***What I know they did was they sought other members of the board who had industry experience. They brought in someone with financial experience, they brought in someone who had been involved with Dolly the Sheep from the Roslin Institute and took advice from them about what they needed to be doing. They used a whole host of Scottish Enterprise people to bounce ideas off. At the end of the day I would have said that someone like* the lead entrepreneur *who does a lot of that kind of thing was known to almost everyone in Scotland if you mentioned spinout companies. He was extensively networked. He spoke to everyone. In terms of the advice and if there was anyone to speak to he would go and speak to them and that was very important to him to make sure he understood what all the angles in terms of what you could do and what you could not do"* (TTO, Company 5).
Non-Academic Entrepreneur Q3	**Access to:** Business development agency and proximity to other life-science companies. **c)** *"There is plenty of space. We have areas where we can create the lab areas that we want. A chemical lab, a dark room area. So we have that capability. This is also the centre of life-science companies in the region. There are quite a few other key participants in the life-sciences that are on the tech park so it sort of puts us in among companies that could be potential customers or suppliers or whatever. Those are the advantages. We also have that network too. We are all in the same industry. It is people who can be useful as contacts."* (Team Member, Company 6). d) *"For a brand new company which has no commercial assets and no start-up funding that was just an impossibility. When we signed our very first contract we needed lab premises to do that work. There was a company down at the XX building called Yyy Ltd and they had had to downsize and they had one large lab that they were not using at all. We sublet that lab from them."* (Lead Entrepreneur, Scientist, Company7).	**Access to:** Business development agency and social networking for introduction to investors specialising in life-sciences. **d)** *Also the group called Connect were very good initially. They are like a dating agency for investors and entrepreneurs and they were very helpful in introducing us to investors, one in particular was a group called XY in London and they made our contact there. We actually moved forward with XY but they did not end up investing but we spent a long time talking to them.* Angels *ended up investing. That was quite frustrating and hard work. It was hard work getting the SMART in Jan 2002 and then rather than getting on with developing* the product *with the grant we spent all that time working towards getting funding* (Lead Entrepreneur, Engineer, Company 8). ***e)*** **"***No advantages. It is supposed to be an incubator but the all other companies were doing electronic or mechanical devices so there was no synergy between the firms, either commercial or intellectual advantage to being associated with them."* (Lead Entrepreneur, Architect, Company 9).

Although Company 3 enjoyed the benefits of the technology park, the lead entrepreneur indicated that the relationship with his HEI would be used to further the research aims of his company (Q1a, Table 7.3b). Whilst the business development agency provided laboratory infrastructure and early access to government funding, the lead entrepreneur and team members maintained their links with their HEI. It could be speculated that the technical infrastructure of the HEI was superior to that of the sponsored environment of the technology park. This finding highlighted a new and unrecorded relationship. Some lead academic entrepreneurs, who did not resign from their academic positions, were able to mange their companies in sponsored environments external to the HEI and to manage research and development for their companies using the facilities within their sponsored HEIs (e.g. they contracted work to the university).

Company 4, which experienced a hostile HEI, appreciated their accommodation on a sponsored technology park. As a result of the lack of necessary human entrepreneurial human capital and social capital associated with commercial awareness and prior business exposure the lead entrepreneur relied on the business enterprise company to construct laboratory space to allow for the development of a prototype model of their medical device. A summary of all movements at critical junctures is presented in Appendix 8.

Table 7.3b: Venture credibility (2nd Phase)		
	Q1 Sponsored Environment	**Q2 Non–Sponsored Environment**
Academic Entrepreneur	**Access to:** Business development agency and social networking for surrogate entrepreneurs. **a) "…***what we are about to do is that there is a new post where the company is going to fund somebody at the university innovation centre to pursue some of the research projects that the company needs. So there is a symbiotic ongoing relationship where the company is free to choose where the company funds research and development but can use the university and in many cases will choose the university."*(Lead Entrepreneur, Dentist, Company 3). **b)** *"They went to* an industrial site *somewhere in XX …which was relatively cheap. They had not received their investment funding. Subsequently they moved to a new HEI. Initially they were using their SMART award to develop their technology. That is what they were doing at XX. At that point they had formed a company. We had agreed* (the original HEI) *that we were going to license the technology to them. It was up to them how they went about their business. It is easier for them to stay here* (the original HEI) *but we simply do not have the space".* (TTO, Team Member, Company 5).	No companies found in this quadrant during venture credibility (Phase 2)
Non-Academic Entrepreneur **Q3**	**Access to:** Business development agency and proximity to other life-science companies. **c) "***it is still a multi use building and the science park centre is about make to the building into a multi use building which is what precipitated the move. Multi occupancy. So this is going to be like an incubator building. So multiple companies will be in this building. In fact multiple companies are in this building already. Most of them are office space however. There is only one other lab based company here at the moment. They are all life science companies. Some are consultants. So there are possibilities of synergies, yes".* (Lead Entrepreneur, Scientist, Company 7).	**Access to:** Business development agency and social networking for introduction to investors specialising in life-sciences. **d)** *"The key thing we had difficulty with in the early days was getting incubator space that would take two or three people. We found a real gap there in the infrastructure for incubator space that is cost effective. We were the first tenants here, it was a new building. We have an office and a shed and we are expanding into another office and an even bigger shed."* (Lead Entrepreneur, Engineer, Company 8). **e)** *"But we moved to the* city centre *when an experienced scientist invested in us. After 2/3 years the company changed its name to* Company 9 *and a dedicated management team were found and appointed and* Company 9 *left that engineering group and moved to offices in the middle of the city centre."* (Entrepreneurial Ownership Team Member, Company 9).

7.2.2 Critical Junctures: Academic Entrepreneurs on Non-Sponsored Environments

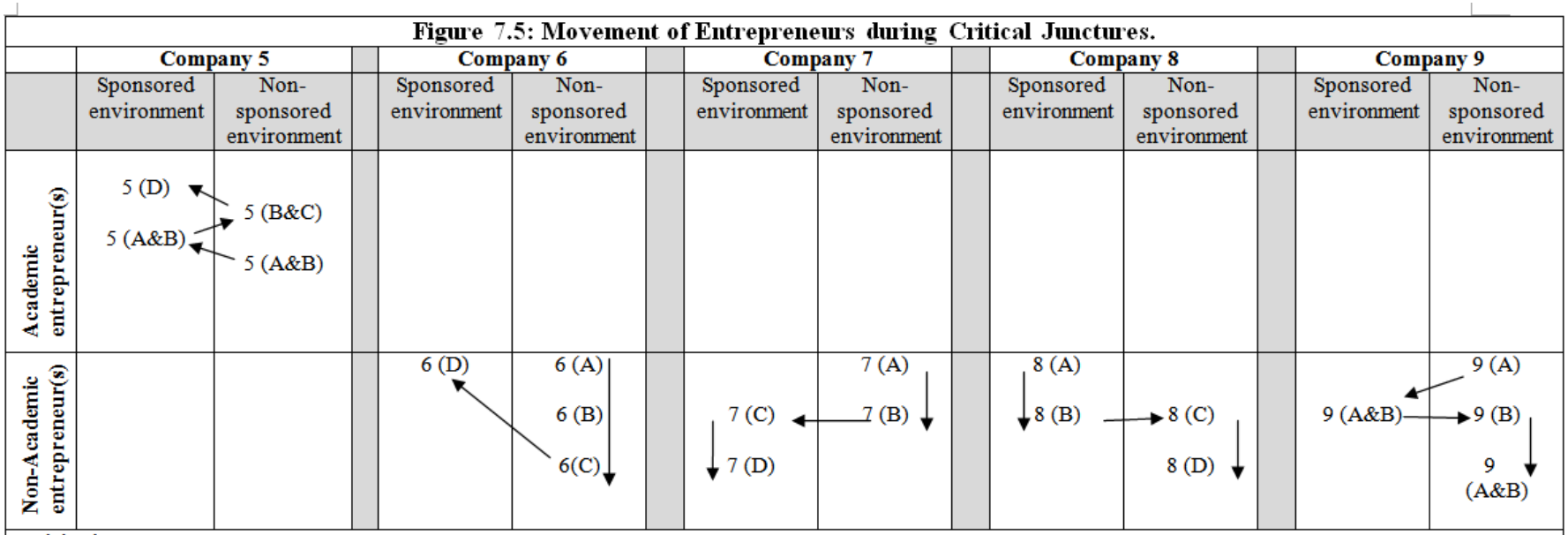
7.2.2.1 Opportunity Identification

Circumstances surrounding the opportunity identification process for the lead academic entrepreneur in Company 5 located on a non-sponsored environment were quite unique. Combining their two areas of scientific expertise, two academics designed preliminary experiments for a device to test pharmaceutical drugs which were conducted in a make-shift laboratory (e.g. a non-sponsored environment) (Q2b, Table 7.1). The lead academic entrepreneur assigned the IP to his new HEI (e.g. a sponsored environment) where he was offered employment. Changing external environments did not immediately indicate that the lead academic entrepreneur had bridged the opportunity identification critical juncture to the next phase (e.g. to entrepreneurial commitment) (Figure 7.5). He remained at the opportunity identification phase, relying on advice from the TTO and attracting government funding to test his idea's practical application and measure market need (Appendix 8). During this period of Proof of Concept, prior to firm formation, the lead academic entrepreneur recruited the assistance of another academic colleague from within his own department where they eventually incubated their company. Specific technical capital was sought from other members of staff and students who were employed to conduct contract work.

7.2.2.2 Entrepreneurial Commitment

Although the laboratory facilities of their sponsored environment allowed them to develop their technology there was a conflict of interest. Challenges which hampered the academic entrepreneur were conflicts with other members of staff and university organisations relating to the use of HEI facilities, the use of academic time and resources, ownership of intellectual property and rewards and violation of academic norms (Nelson, 2004) (Q1b, Table 7.2). Conflicts of opinion between the lead academic entrepreneur and academic staff 'pushed' Company 5 out of the HEI to an industrial site. By doing so they were able to demonstrate entrepreneurial commitment. However, there were enormous disadvantages associated with the non-sponsored industrial site. They were some distance from their HEI where they both had academic responsibilities, far from their source of ethically donated human tissue, which they needed for their experiments and the laboratory facilities were basic.

Figure 7.5: Movement of Entrepreneurs during Critical Junctures.



Critical Junctures Key:

Opportunity identification (A)

Entrepreneurial commitment (B)

Venture credibility 1st phase (C)

Venture credibility 2nd phase (D)

The fortuitous recruitment of two very experienced board members from a large chemical company was due to individual effort, not a benefit from the non-sponsored environment. This action increased the credibility of their company (Q2b, Table 7.3a).

7.2.2.3 Venture Credibility

It could be argued that Company 5 had to rely on their own human capital reserves and individual networking skills to compensate for the lack of resources at the non-sponsored industrial site. The move was seen as a temporary measure. Once seed funding was committed they resigned from their academic posts and dedicated their time to the development of both contract research and their drug-testing instrument moving to a sponsored environment within a new HEI with purpose built laboratories and easy access to their source of ethically donated human tissue (Q1b, Table 7.3b).

7.2.3 Critical Junctures: Non-Academic Entrepreneurs on Sponsored Environments

7.2.3.1 Opportunity Identification

The opportunity identification phase for Company 8 commenced in donated laboratory space located within an HEI (Figure 7.5). Not only were the physical components of the laboratory used to assist in the development of the product, the actual functioning of the laboratory was studied by the non-academic entrepreneurs. It allowed close proximity to the specific human capital held by the HEI academics, access to physical laboratory space and strengthened their relations with business development agencies for introductions to potential investors (Q3c and d, Table 7.1). One of the academics also observed that having the engineers in the laboratory was a good public relations exercise because visitors were introduced to the concept of commercialisation within the HEI environment (Appendix 8).

7.2.3.2 Entrepreneurial Commitment

In addition, they had good relations with a national networking agency who put them in contact with potential funders interested in the life science sector (Q4d, Table 7.3a). Close proximity between the academics and the engineers, allowed for a speedy development of a business plan and the subsequent application for funding from government sources. During the initial entrepreneurial commitment critical juncture

Company 8 remained within the confines of the sponsored environment of an HEI laboratory (Figure 7.5).

7.2.3.3 Venture Credibility

Moving to an industrial site was considered to be cost effective and offered access to workshops for the production of a prototype. The rent on the industrial site compared favourably to rental prices of units on neighbouring science parks, which meant that the company was close to a cluster of life-science firms. In addition, they were within a reasonable distance from the new purpose built HEI research institute where the academic team members worked (Q3c, Table 7.2). Finding incubator space for a small start-up was considered to a major barrier for commercialisation (Q3d, Table 7.3b).

7.2.4 Critical Junctures: Non-Academic Entrepreneurs on Non-Sponsored Environments

7.2.4.1 Opportunity Identification

After liquidating his previous company and during the time of relocation, an HEI donated two residential premises to the lead entrepreneur of Company 6 to incubate his new firm (Q4e, Table 7.1). The residential premises offered no other resources or advantages other than a physical address. The lead non-academic entrepreneur in Company 6 moved from non-sponsored environments (e.g. residential properties) owned by the local HEI during incubation to a sponsored environment (e.g. technology park) (Figure 7.5).

The opportunity identification phase relating to Company 7 occurred whilst the two lead entrepreneurs were employees of a pharmaceutical firm (Figure 7.5). The threat of redundancy spurred them to consider setting up their own firm. They predicted market trends within the pharmaceutical sector from management directives at their company's headquarters and were able to ascertain what services they should offer as an independent company (Appendix 8). Strategically, they identified which cell-lines to produce so as not to compete with major players within the same sector. Once redundant, further development through the opportunity identification phase was

conducted from their residencies as they prepared business plans and solicited business for contract work.

The lead entrepreneur and entrepreneurial ownership team members relinquished responsibility for the day to day management of Company 9 from their farm premises when, after advice from their accountant, they sought counsel from a company which specialised in early start-ups (Q4f, Table 7.1). This was considered to be a fully sponsored site because the company had specific knowledge about funding proposals, organisational expertise but had no experience of the regulations governing the testing of new chemicals. All testing of chemicals was outsourced to different HEIs. In this case, the external environmental context provided access to practical managerial tools and physical resources for the management of the company (Figure 5). The lead entrepreneur, however, was sceptical about the advantages to such a business model (Q4e, Table, 7.3a).

7.2.4.2 Entrepreneurial Commitment

Both the local HEI and business development agency were supportive of the lead entrepreneur's (Company 6) efforts to relocate and offered future collaborations and advice about funding and facilities on the local technology park (Q3c, Table 7.3a). Rather than the external environment being an influence on access to resources, the entrepreneurial human capital and social capital networks of the lead non-academic entrepreneur gained from previous business ownership experiences, guided the company through a process of applying for grant awards. He also created network bridges within the science community through exposure of his research to the academic community and accumulated a broader legitimacy for commercialisation by "getting to know" a company in the Sates with whom he developed a reciprocal and mutually beneficial relationship (Delmar and Shane, 2004).

The lead non-academic entrepreneurs in Company 7 formed their company and moved to a sponsored site only after they had won their first contract (Figure 7.5). They self financed the entire project. A lack of social networks to develop business acumen led to a degree of frustration for the two lead entrepreneurs. They had

difficulty in accessing reliable business development advice specifically for inexperienced, nascent entrepreneurs in the life-science sector.

Claiming the management company to be incompetent, the lead non-academic entrepreneur in Company 9 recruited assistance from a new investor who represented the shareholders of the original company, dismissed the management company and re-located the firm to office premises in the city centre (Figure 7.5). The re-location not only indicated a change of external environment but also a reversal in the entrepreneurial process because a new product was brought on line for development (e.g. they reverted from entrepreneurial commitment to opportunity identification). The small city centre office offered few advantages other than providing a base and postal address. The firm could not pass through the entrepreneurial commitment critical juncture because of a lack of resources and returned to the opportunity identification phase (Q4e, Table 7.3b). Company 9 displayed an inability to conceptualise how a technological discovery could be applied to satisfy a real customer need and achieve proof of market.

7.2.4.3 Venture Credibility

There were obvious, necessary and important physical resources available through the sponsored environment for new life-science firms, which the two scientists in Company 7 appreciated. Although they reported that the cost of renting space was expensive, the advantages of having custom build laboratories and access to supplies and purchases co-ordinated by the science park administration was considered practical. For a small company with no credit record the advantage of having a science park purchasing department supplying their specialist needs eased administrative pressures. Another advantage of sub-letting laboratory space was the flexibility of the lease (Q4d, Table 7.2). Two weeks prior to the actual physical interview, the lead entrepreneur moved Company 7 from the sub let space to a dedicated laboratory and office space within the same science park which was to function as an incubator unit (Q3d, Table 7.3a; Q3c, Table 7.3b).

7.3 Cross-Case Comparisons: Opportunity Identification Phase

The data indicate that lead academic entrepreneurs chose to remain within the environment in which their research was conducted to frame the opportunity further. For these inexperienced and nascent entrepreneurs on sponsored environments there was access to resources both physical and human from the tangible facilities of the environment and through the provision of tacit advice from the TTO. Using their technical human capital, lead academic entrepreneurs were able to capitalise on their HEI social networks and familiarity with their surroundings, facilities and access to support services whilst their lack of business acumen was compensated for by the support offered by the TTOs. Within the sponsored environment the relationship between human and social capital was mutually symbiotic (e.g. human capital had an effect on social capital and vice-a-versa). Social capital facilitated the development of human capital by affecting conditions for exchange and development. Human capital, within the same environment, was used or seen by resource providers as a status or measure to allow greater (or lesser) access to other social networks, unfamiliar to academic entrepreneurs. The status, reputation or 'credibility', as perceived by Anderson et al., (2007), acted as a "symbolic entrance requirement for entry" to social networks and "as a mechanism for maintaining goodwill" within the network (Anderson et al., 2007, p262). In agreement with past research this study found that 'strong norms' and 'mutual identification' within the academic community of an HEI exerted a powerful force influencing and promoting lead academic's research programs towards commercialisation (Nahapiet and Ghoshal, 1998; Mosey and Wright, 2007). However, it was the bridging social capital linked to weaker ties to the resource community for specific commercial knowledge which was more important than the bonding social capital within a close network of strong ties within the academic community (Davidsson and Honig, 2003). In only one case (Company 5) was there evidence that 'an academic mindset' restricted acceptance of the commercialisation of publically funded research. This self imposed restriction purposively blocked access to general human capital. The discussion about level of support at opporuntiyt idneitifcation suggests the following proposition:

Proposition 18: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to submit more developed concepts to venture investors because of their superior access to physical resources (e.g. laboratories), technical human capital (e.g.

scientists) social network capital (e.g. business advisers) and public funding (e.g. Proof of Concept).

Lead academic entrepreneurs or entrepreneurial ownership team members rarely 'fully' resigned from their academic posts and close proximity to or within their HEI eased the time demands of their dual roles (e.g. academic and entrepreneurial). During the framing of the opportunity it was more likely for lead academic entrepreneurs on sponsored environments (e.g. HEIs) than lead non-academic entrepreneurs on non-sponsored environments to resist a change to their external environment. Lead academic entrepreneurs were employees on the sponsored environment. Their proximity benefited both parties. The HEI provided premises and TTO assistance, whilst the lead academic entrepreneurs provided academic services to the HEI, funded PhD student research and raised the profile of the HEI (Q1a, Table 7.3b). These observations give rise to the following proposition:

Proposition 19: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to have a reciprocal relationship with their resources providers at the opportunity identification phase.

The lead non-academic entrepreneurs on non-sponsored environments were at a disadvantage because their access to advice and resources was often determined and limited to business development agencies. Lead academic entrepreneurs on sponsored environments had access to both. Differences in access to, and acquisition of, business expertise also mirrored differences in access to the physical resources offered by the sponsored and non-sponsored environments. Sponsored environments were better geared towards the needs of a life-science start-up (e.g. provision of laboratory space, supplies, specialist scientific equipment, expertise, electronic journals and biological waste disposal). In respect of physical resources, all lead academic entrepreneurs located on a sponsored environment reported that they had access to laboratory facilities. During incubation non-academic entrepreneurs on non-sponsored environments reported that there was inadequate provision of laboratory space and consistently reported that funding from local business development agencies had to be used to refurbish premises to set up basic laboratory facilities (Q4d, Table 7.3b). Immediate access to personnel offering commercial advice and a physical infrastructure also allowed lead academic entrepreneurs choosing a dual business

model (e.g. development of their own product / process and their contract work) to pursue both activities. Non-academic entrepreneurs on non-sponsored sites had to devote time to setting up laboratories and give priority to their contract work.

7.4 Cross-Case Comparisons: Entrepreneurial Commitment

During the entrepreneurial commitment critical juncture all, bar one, lead academic entrepreneur were allocated space within the HEI to further develop their technology and progress applications for funding. Company 1 was housed in a dedicated HEI incubator unit. Company 2 rented redundant laboratory space within an HEI department and Company 3 used HEI laboratory space for research and the TTO office prior to moving to a technology park within the same city location. Company 4 had to move away from the hospital as soon as the incubation process started and rented laboratory space from the local business development agency on the local technology park. Shared HEI laboratory space was organised for Company 5 prior to their move to a non-sponsored environment. However, all academic entrepreneurs were aware of two issues surrounding their choice of sponsored location. First, there was a time limit to their presence in HEI accommodation because there was concern about over reliance on HEI resources. Second, there was their reaction to a change in culture. Lead academic entrepreneurs experienced a transfer from one culture, where everything is prescribed and rule based (e.g. the HEI environment), to another one, where everything is open (e.g. the commercial environment). Here their creativity was subjected to severe scrutiny from a business perspective. The 'cleverness' of their concept had little worth. The success of their transition may be related to how they developed in terms of their ability to understand the external dialogue about their IP and creations once they were beyond the HEI environment and into the commercial world. They constantly had to be aware of developing existing resources and developing new ones through the commitment of key individuals who would supply initial capital and knowledge to enable the lead entrepreneurs to progress their opportunities. For this they relied on the leverage of social capital either from their own networks (Companies 1, 2 and 5) or through the networks of their investors (Companies 3 and 4).

Another issue emerged from the data relating to association with a location. The lead academic entrepreneurs in Companies 3 and 5 were aware of the shortfalls of an over identification with an HEI albeit for different reasons. HEIs have a reputation amongst investors for being bureaucratic and difficult to work, especially in terms of negotiating rights to IP. This was the reason offered by the lead academic entrepreneur of Company 3 for wishing to distance himself from the HEI. He wished to establish independence (Q1a and b, Table 7.4). In Company 5 the reason for the separation was associated with the negative mentality of fellow academic colleagues towards commercialisation opportunities (Q2c, Table 7.4). The lead non-academic entrepreneur in Company 8 stressed the importance of the combination of academic and industrial skills in his team which was appreciated by their investors. However, he made claim over the IP from the HEI because he was not an HEI employee (Q3d and e, Table 7.4). The non-academic entrepreneurs leading firms on non-sponsored environments all made reference to the difference between academic entrepreneurs and themselves and claimed that the former often commercialised for the wrong reasons (Q4f, g and h, Table 7.4). In general lead academic entrepreneurs left sponsored environments for negative reasons whilst non-academic lead entrepreneurs sought sponsored environments for positive ones. These observations lead to the following proposition:

Proposition 20: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to be 'pushed' away from their environments to promote independence during the entrepreneurial commitment critical juncture.

Access to redundant HEI laboratory space was utilised by the non-academic entrepreneur leading Company 8. The lead non-academic entrepreneur in Company 6 did not have access to a laboratory until after the entrepreneurial commitment critical juncture when he moved to a sponsored environment. Company 7 only sublet a laboratory on a sponsored environment once a contract had been won and found the lack of provision of suitable laboratory premises a barrier to company formation. The managerial consultancy company responsible for Company 9 out-sourced all their scientific work to different HEIs. Generally, all lead non-academic entrepreneurs commented that there was a general lack of adequate laboratory space for early development. This discussion led to the following proposition:

Table 7.4: Location Influences

	Q1 Sponsored Environment	Q2 Non–Sponsored Environment
Academic Entrepreneur	**a)** *"Because we needed space and we needed offices and we needed to demonstrate that we were separate from the university. To be run as a separate commercial enterprise."* (Entrepreneurial Ownership Team Member, Dentist, Company 3). **b)** *"An essential step both in public relations and in reality. In order to be successful we had to get free of the university way of doing things."* (Lead Entrepreneur, Dentist, Company 3).	**c)** *"We also felt, and I know this sounds terrible and arrogant, but we both felt we were better. Better is the wrong word but we certainly had the capabilities of being more successful than the peer group that we were in. We respected them and we had great camaraderie with our colleagues, but we always felt that they were missing opportunities and it was so frustrating. It was a frustrating environment to be in for both of us I think. We both had the same mentality that if we pushed ourselves out of our comfort zone…."* (Lead Academic Entrepreneur, Biologist, Company 5).
Q3 Non-Academic Entrepreneur	**d)** *"One of the things they* (investors) *liked about the founding team is that as well as combining engineering and science, there was a bit of commercial savvy as well. There was good industrial management skills. We were all tagged as techies but we all knew how to manage what we were doing and I think historically a lot of this stuff has spun out of universities and a lot of interesting ventures have floundered because the founding team does not have the breadth of exposure to managing projects"* (Lead Entrepreneur, Engineer, Company 8). **e)** *"…the other thing we did, and we did this to clarify and to help the investors, was to have the university assign any rights and IP to* Company 8. *We did not really have to do that because the concept came from* us the engineers. *But because* the academics *had been involved and presented the problem and we had come up with a solution we wanted to keep it clean for the investors. So that was a fair way to do it"* (Entrepreneurial Ownership Team Member, Engineer, Company 8).	**f)** *"I have never understood this vogue for taking academics who have got this wonderful idea for a new technology, spinning them out into a company and then expecting a market to want what they have produced. It has always seemed to me to be a risky thing and as with most entrepreneurs that I am aware of, what we are actually trying to do is something in the lowest risk way possible"* (Lead Non-academic entrepreneur, Company 6) **g)** *"Unlike a lot of university spinouts where they have been working on some research usually around some technology and someone says well that's patentable let's go and get a patent on it and then someone says well let's go and commercialise this. ….The advantage we have over university spinouts is that we have actually been working in a commercial industry already. Academic research is very different to industrial research. A lot of university spinouts do not recognise that for some time"* (Lead Non-academic Entrepreneur, Scientist, Company 7). **h)** *"I think having worked in the contract side of things as well previously is a good training for being able to have a clear route through a piece of work, to see the end clearly and as cheaply as possible. A lot of scientists come from academic backgrounds and are off on tangents and things so to be able to be disciplined in your approach is a good thing"* (Lead Non-academic Entrepreneur, Scientist, Company 7).

Proposition 21: Lead non-academic entrepreneurs located on non-sponsored environments are more likely than lead academic entrepreneurs on sponsored environments to change location because they need to access laboratory space at the entrepreneurial commitment critical juncture.

7.5 Cross-Case Comparisons: Venture Credibility (1st and 2nd phase)

On HEI sponsored environments, the TTOs were instrumental in introducing lead entrepreneurs to potential investors and surrogate entrepreneurs. Investors have been traditionally very sceptical about new life-science start-ups and only participate when they feel there is a fully functioning balanced (business/technical) professional team in situ (Roure and Keeley, 1990; Cyr et al., 2000). As a result, lead academic entrepreneurs relied on the greater entrepreneurial human capital and social networks of TTOs to access surrogate entrepreneurs and acquire resource endowments including seed funding, laboratory space and other human resources. Lead academic entrepreneurs also had to recruit appropriately qualified personnel to convince investment providers that they had in place a responsible management team. However, they consistently displayed a lack of network capital allowing access to such people. The TTO, often through cooperation with the business development agency, was responsible for introducing surrogate entrepreneurs to the lead academic entrepreneur. The surrogate entrepreneurs had previous experience of HEI spinouts and brought strong networks of knowledge about the investment community. In some cases surrogate entrepreneurs became entrepreneurial ownership team members and in one case, chairman (e.g. in Company 3). The combination of these experiences and connections allowed for the integration of these resources to create value. In addition, lead academic entrepreneurs who did not resign from their academic positions continued to mange their companies in sponsored environments external to the HEI and to conduct and finance contract industrial research for their companies using the facilities within their sponsored HEIs. This revelation about exploiting two environments at one time leads to following proposition:

Proposition 22: Lead academic entrepreneurs located on sponsored environments (external to their HEI) are more likely than lead non-academic entrepreneurs on non-sponsored environments to exploit two locations at one time.

Non-academic entrepreneurs benefited from the services and network facilities on sponsored environments and were able to utilise the networks of the business

development agencies who were generally stakeholders in the sponsored environment. The sponsored environment, such as the technology or science park, offered companies space to set up a laboratory, a prestigious address and proximity to other life-science companies. Company 7, once removed from their non-sponsored residential environment and situated on a sponsored environment, benefited from the services offered by a science park infrastructure dealing with other life-science companies.

Contact with business angels for the lead non-academic entrepreneurs in Company 8, situated on a non-sponsored environment, was guided and strengthened by their prior business acumen not their external environment. Funding for Company 9 was sourced through the perseverance of the lead entrepreneur. The change to a sponsored environment meant that he and his entrepreneurial ownership team members paid for the services of another company to manage their affairs. However, Company 9 did not transcend the entrepreneurial commitment phase and by the end of the study had returned to the opportunity identification phase with a new manager, a new business model and a new product.

7.6 Movement between Sponsored and Non-Sponsored Environments

The recorded movement between sponsored and non-sponsored environments is perhaps the main contribution of this thesis and one which has not been documented before. From a resource dependency perspective academic entrepreneurs were at an advantage during the pre-opportunity identification process because of their privileged access to an educational infrastructure with scientific research and facilities at its core (Pfeffer and Salancik, 1978). Equipment and logistics were unmatched in non-sponsored environments. In all nine cases access to laboratories was necessary. Lead entrepreneurs commented on the lack of suitable and affordable laboratory space outside of HEIs. At the venture credibility phase it was observed that lead academic entrepreneurs often funded research within their own HEIs (e.g. contract research) in support of their own companies situated on other sponsored environments external to the HEI.

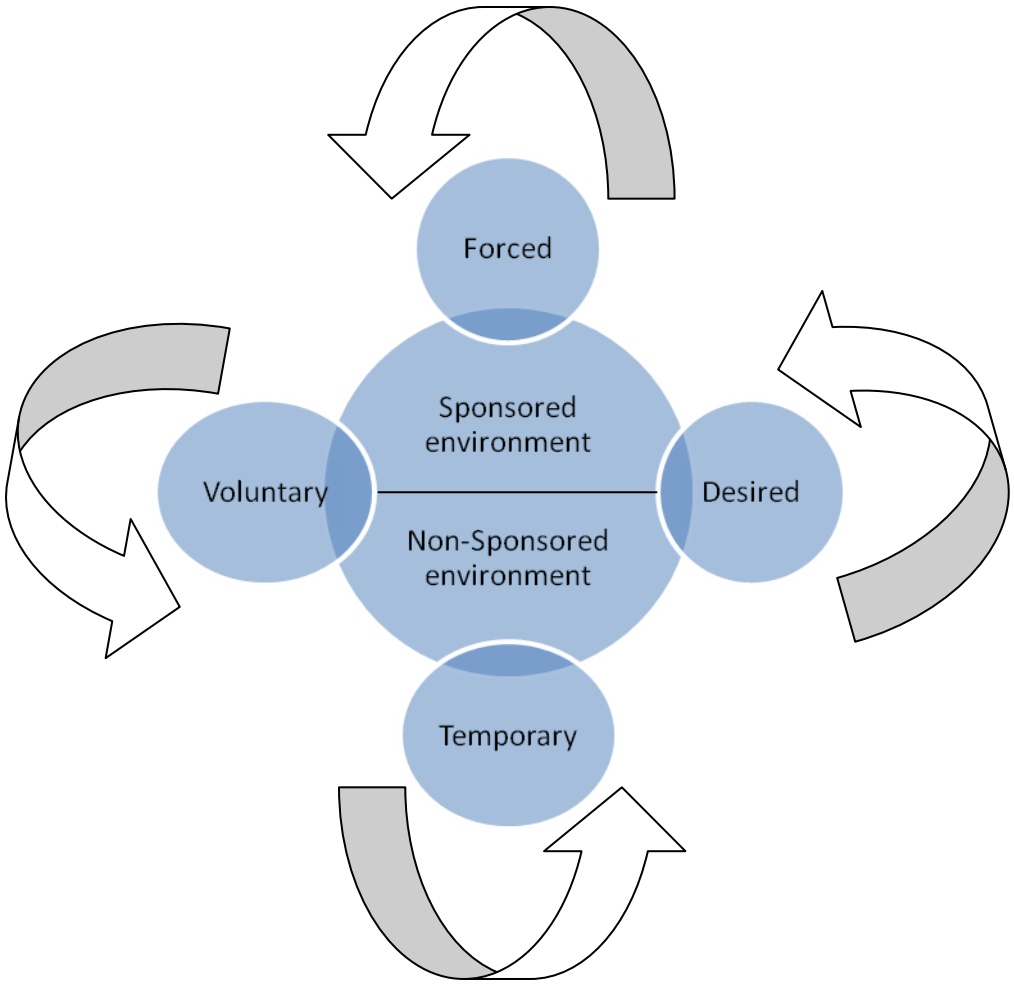
Sponsored environments provided entrepreneurs with an infrastructure that could be leveraged to access physical and human resources, which by definition were not available to entrepreneurs who selected non-sponsored environments. It was at the venture credibility phase that lead academic entrepreneurs were encouraged (by HEI authorities) to leave their sponsored sites, not necessarily because they needed access to further resources but because the HEI wished to renounce their own incubator status and support. Lead academic entrepreneurs viewed their 'forced' move (sponsored environment to sponsored environment) as a demonstration of independence from HEI resource reliance (e.g. a forced transition). Figure 7.6 offers a graphical representation of the relational movements between external environments.

During the same phase, however, lead non-academic entrepreneurs were attracted to sponsored sites (non-sponsored to sponsored) to access physical laboratory space (e.g. a desired transition) (Figure 7.6). Both lead academic and non-academic entrepreneurs selected sponsored environments where the local business development agency was a major stakeholder and where both reported a lack of laboratory facilities, a condition rectified by the business development agency itself. A 'voluntary' move out of an HEI environment was recorded rarely, indicating that the internal HEI sponsored environment offers lead entrepreneurs access to a familiar and established scientific infrastructure in terms of physical resources and specialist scientific human capital. This specialist infrastructure remained consistently important to the lead entrepreneurs during all phases of the opportunity identification process and beyond.

The instances where lead academic entrepreneurs moved voluntarily from a sponsored to a non-sponsored environment accounted for, in one case, the desire to own IP (e.g. a voluntary transition) (Figure 7.6). The move was confounded by negative attitudes of other academics with strong views against the commercialisation of publicly funded research. In general, however, there was resistance from academics to move away from the HEI sponsored environment to new sponsored environments. The case for non-academic entrepreneurs was different. They desired to move to sponsored environments. The one exception here was the company who experimented with a manufacturing process (Company 8) and required heavy industrial machinery rather than access to laboratory facilities. I perceived that the move out of the HEI

was considered negative by academic entrepreneurs but the move to sponsored environments as positive by non-academic entrepreneurs.

Figure 7.6: Relational Movements between Sponsored and Non-Sponsored Environments



7.7 Summary

The study at hand explored how the external environment influenced access to resources (physical, social, financial, technological and human capital) for enterprises created by entrepreneurs within sponsored environments compared to those created in a non-sponsored environment. A novel conceptual typology mapping dynamic external environmental changes over time recorded location choices made by lead entrepreneurs during the entrepreneurial process (Figure 7.1). Three critical junctures, in the iterative entrepreneurial process, were identified e.g. opportunity identification,

entrepreneurial commitment and venture credibility (Vohora et al., 2004). Critical junctures have been identified in past empirical studies but the accompanying change in environment has not been subject to investigation or adequately reported. This was a novel finding. Appendix 8 illustrates how lead entrepreneurs encountered the three critical junctures and identifies where they were located during the three junctures. Data revealed that during a critical juncture entrepreneurs could straddle the two forms of external environment. A change in location did not immediately communicate progress in the entrepreneurial process. At times advancement was reported and at others entrepreneurs and their firms regressed to a past phase (Figure 7.5).

To compensate for human capital resource profiles lacking in business acumen, four academic entrepreneurs selected a sponsored environment from the outset of the opportunity identification process. This enabled lead academic entrepreneurs to leverage the resources, knowledge, reputation and contacts of the physical surrounds of the HEIs and their respective TTOs. During the opportunity identification juncture, lead academic entrepreneurs on sponsored environments set up dependent relationships with TTOs who were instrumental in providing business knowledge and contacts. The TTOs had considerable control over access to resources, human, financial and social. Academic entrepreneurs appreciated access to the specific human capital associated with business knowledge, access to sponsored business advisors, support in applying for government sponsored awards and the laboratory infrastructure offered by the HEI environments. This close proximity to a nest of resources suited the lead academic entrepreneurs because they did not resign from their academic responsibilities during this early phase. Their relationship with their respective HEIs was often reciprocal. Although they exploited the scientific infrastructure they returned to the HEI teaching programs and provided funding for PhD projects. These projects often had a direct bearing on their commercial work.

Only one lead academic entrepreneur selected a non-sponsored environment. This entrepreneur asserted that the new technology required extensive preliminary testing, and during the process he wanted to maintain complete ownership of the IP which could have been more problematical if he worked in an HEI sponsored environment. Sponsored environments were beneficial for academic entrepreneurs at the opportunity identification phase because the physical environment and human

capital infrastructure of the HEI institutions allowed access to laboratory equipment and infrastructure and specialist knowledge about sources of public funding to formulate their ideas for commercialisation. However, once funding was required from a private source during the entrepreneurial commitment phase, the limited experience of the TTOs dictated that the lead entrepreneurs look for other sources of relevant human capital. This was normally provided by members of the business development agencies, outside of the sponsored environment, who were networked to surrogate entrepreneurs with experience from previous exposure to the life-science sector (Franklin et al., 2001). Surrogate entrepreneurs were very rarely invited to join a new firm when the firm was located within the confines of the HEI (exception was Company 2). Recruiting a surrogate entrepreneur also triggered a change to the external environment as well as gaining access to private equity funding through the social network of the newly recruited surrogate entrepreneur. This is in line with prior research highlighting the role of personal networks in the search for venture capital (Shane, 2004). The data indicate that resources available to lead academic entrepreneurs within a sponsored HEI environment have restricted applicability to the opportunity identification phase only. The knowledge and networks of TTOs was identified as limited and relevant to the phase of opportunity identification. However, academic entrepreneurs remained on sponsored environments throughout the study, exchanging the sponsored environments of their HEIs for the sponsored environments of science or technology parks.

Lead non-academic entrepreneurs generally strived to enter a sponsored environment and were aware that their academic counterparts had better access to equipment and facilities within their HEIs. Their move was prompted by access to funding or the winning of contract work which necessitated access to laboratory facilities. One lead non-academic entrepreneur selected a sponsored environment in order to gain access to resources relating to specific scientific human capital provided by academic team members but chose a non-sponsored environment for the venture credibility phase because his resource needs required access to manufacturing facilities (Company 8). Conversely, three lead non-academic entrepreneurs were in non-sponsored environments at opportunity identification. The opportunity identification phase occurred whilst these entrepreneurs were employed by other companies (Company7), whilst operating a previous company (Company 6) or whilst making

observations about environmental issues (Company 9). Three of the four lead non-academic entrepreneurs progressed their entrepreneurial commitment phase from residential premises. Their external environments offered little access to resources or networks. Lead non-academic entrepreneurs on non-sponsored environments relied on their own network of contacts to gain access to needed resources. These entrepreneurs were market-focused from the outset, and they could leverage their diverse resource profiles associated with prior business experience as well as prior market, customer and finance knowledge. However, at the venture credibility phase two moved to sponsored environments mainly for access to physical facilities such as laboratories, equipment and specialist services. A trend amongst non-academic entrepreneurs was to seek co-operation with actors and premises within sponsored environments (Rod, 2006). The data indicated that non-academic entrepreneurs are attracted to sponsored environments because of the superior provision of laboratory facilities, supporting infrastructure and closeness to other life science firms. Access to sponsored environments often came during the venture credibility phase only after they had won a contract to conduct research for a third party.

Chapter 8: Conclusion

8.1 Introduction

New business formation contributing to innovation is of central importance in entrepreneurship (Marvel and Lumpkin, 2007). The innovativeness of an opportunity is viewed as a measure of potential value (or wealth creating potential) (Shane, 2000). Innovative opportunities (i.e., new firm formation) can be shaped by the skills, experience, knowledge and resources of entrepreneurs and resource availability in the environments selected by entrepreneurs to identify, pursue and exploit opportunities (Reynolds et al., 1994; Westhead, 1995). An entrepreneurs (or entrepreneurial ownership teams) knowledge about markets and technology is believed to shape the identification and exploitation of innovative opportunities (Shane, 2000). Acquisition and processing of information and other resources by entrepreneurs is also perceived to shape opportunity identification, pursuit and exploitation (Alvarez and Busenitz, 2001). Despite a growing body of studies focusing upon human and social capital profiles of technology-based entrepreneurs (Marvel and Lumpkin, 2007; Mosey and Wright, 2007; Shrader and Siegel, 2007; Wright et al., 2007), the resource profiles of technology-based entrepreneurs are poorly understood (Brush et al., 2001). Studies have generally focused on academic entrepreneurs (Franklin et al., 2001; Zucker et al., 2002; Wright et al., 2004; Lockett et al., 2005). Most studies have failed to explore whether the resource profiles of academic entrepreneurs are narrower than non-academic entrepreneurs.

Another literature indicates that the formation of knowledge-based firms (which includes life-sciences) is more likely in resource rich environments with established mechanisms to provide firms with resources (Siegel et al., 2003). Resource dependence theorists suggest that entrepreneurs need to adapt and / or move to resource rich environments to ensure business formation and development (Pfeffer and Salancik, 1978) or survival (Westhead and Storey, 1995). An example of such a type of environment in this study was the science park or HEI incubator unit which can be described as supportive or sponsored. A sponsored environment provides a significantly higher and more stable level of resources for new firms (Mustar, 1997; Mustar et al., 2006). A supply-side perspective suggests that opportunity identification can be shaped by a lead entrepreneur's resource profile or of those

recruited to the entrepreneurial ownership team, whilst a demand-side perspective suggests resource availability in the external environment. This study has looked at the influence of both.

The structure of the chapter is as follows: Section 8.2 offers a general overview of the thesis and research methodology. Section 8.3 presents the key research findings and interpretations relating to Themes 1 and 2 (e.g. the lead entrepreneur and team members). Findings and conclusions are compared to extant literature where possible and used to build theory. A synthesis of findings relating to the entrepreneurial process (Theme 3) is offered in Section 8.4. Section 8.5 covers Theme 4 relating to the external environment and in the following section a synthesis of key findings is presented. Implications for HEIs, practitioners, advisors and academics are outlined in Section 8.7 Section 8.8 highlights strengths and weakness of the qualitative study and Section 8.9 makes recommendations for future research. Finally, a summary is offered in Section 8.10.

8.2 Thesis Overview

Four major gaps in the past literature were identified. The first involved the neglect of the use of the entrepreneur as the unit of analysis (Westhead and Wright, 1998) and the second revolved around an observation that the opportunity identification phase of the entrepreneurial process has been under investigated (Bruyat and Julien, 2001; Sarasvathy et al., 2003). The third was identified as an under representation of longitudinal, qualitative studies, anchored to opportunity identification, which followed entrepreneurs in real time (Gartner and Birely, 2002; Fletcher, 2006). Comparative studies between entrepreneurs emanating from HEIs and those from industry were few and identified as the fourth gap (Westhead, 1997; Colombo and Delmastro, 2002; Bower, 2003). Focusing on the lead entrepreneur this study avoided an over emphasis on, and presumption made by many previous studies about, the existence of the firm.

The purpose of the study was to understand ‘why’ and ‘how’ some individuals identify, create or discover (Sarasvathy et al., 2003) business opportunities (Venkataraman, 1997; Baron and Ensley, 2006). Guided by insights from three

theoretical perspectives (Human Capital theory, Social Capital theory and the RBV of the firm), a novel conceptual typology of life-science entrepreneurs was presented relating to the HEI or industrial context and the sponsored or non-sponsored external environmental context. Four types of entrepreneurs were conceptualized: academic entrepreneur located on a sponsored environment; academic entrepreneur not located on a sponsored environment; non-academic entrepreneur located on a sponsored environment; and non-academic entrepreneur not located on a sponsored environment. Differences and / or similarities were highlighted with regard to access to resources during the process of opportunity identification. Resources, their availability and value, did not remain consistent throughout the entrepreneurial process and neither was the process linear.

First, using human capital theory, specific and general experiences were identified as being beneficial to the entrepreneurs as they circumvented barriers to opportunity identification (Becker, 1993a). Second, resource deficiencies were compensated through recruitment of team members (Üçbaşaran et al., 2003a) or from resources leveraged from the external environment surrounds (Mustar et al., 2006). Team members were either recruited from within the confines of the external sponsored environment or found in the wider society through the network auspices of mentors or advisors (Shane and Stuart, 2002). Non-equity holding team members such as mentors and advisors were instrumental in finding qualified and experienced personnel, with knowledge of the life-science sector, to work with the lead entrepreneurs. Advisors (e.g. TTOs) were often representatives of the HEI in which lead academic entrepreneurs were employed. These mentors or 'gatekeepers' bridged the gap between academia and industry by representing the interests of the HEI, which often required an equity stake in the potential companies, whilst offering business advice to business naïve academic entrepreneurs. Access to such a resource offered lead academic entrepreneurs competitive value added advantage at the opportunity identification phase. In addition to specific (relating to prior entrepreneurial experience) and general (relating to education) human capital experiences entrepreneurs also reaped specific physical resource benefits from their external environments. A critical junctures model conceptualised in the guiding framework (Figure 3.1) acted as a map to orienteer the entrepreneurial process (Vohora et al., 2004). In the longitudinal study critical junctures often, but not always, were

accompanied by a change in the external environment. A change in external environment did not always signal progress towards firm formation. Reported changes in environment have been rarely recorded before.

From a RBV of the firm perspective, value creation (rather than appropriation) was initially centred on the internal, embedded human capital resources of the lead entrepreneur prior to the bundling of other resources for firm formation (Barney, 1991) (e.g. ability to spot an opportunity, ability to work co-operatively, ability to source seed funding). In this study the construction of the new resources proceeded from personal resources (e.g. those centring on human and social capital 'inputs') towards becoming organisational resources (e.g. those centring on the firm's resources 'outputs') (Alvarez and Busenitz, 2001). Resources which were intangible and systemic (Miller and Shamie, 1996) (e.g. human and social capital) were much more influential during opportunity identification whilst tangible, discrete and property based resource (e.g. laboratory and financial resources) became more important as the commercial opportunity developed (Chandler and Hanks, 1998). At the opportunity identification phase of the entrepreneurial process the lead entrepreneurs became the hub resource "but not all…possess*(ed)* the requisite combination or level of skills to generate rents" (Barney et al., 2001b, p634). Lead entrepreneurs had to learn to combine tangible resources (e.g. access to technical personnel and physical scientific infrastructure) with intangible resources (e.g. knowledge, motivation, vision, drive) through a support network of contacts in academia and industry.

Human capital theorists suggest that individuals with broader pools of human capital resources consisting of achieved attributes and skills (e.g. years of formal education, years of work experience, prior business ownership) will be associated with increased levels of productivity (Becker, 1975). The behaviour of lead academic and non-academic entrepreneurs (and their firms) may, in part, be shaped by their human capital profiles. The human capital profiles of lead entrepreneurs (i.e., inputs) may shape their ability to address opportunity identification issues (i.e., outputs). An entrepreneur, for example, can compensate for his / her personal human capital deficiencies by attracting other individuals, through their social networks (Mosey and Wright, 2007), with more diverse human capital to join the entrepreneurial ownership team (Ucbasaran et al., 2003; Cooney, 2005). Enhanced human capital from prior

entrepreneurial experience may be interrelated with greater social capital associated with broader and deeper networks (Shane and Khurana, 2003). Erudition gained from previous experience can be embedded in tacit knowledge, explicit knowledge and social capital (Anderson and Jack, 2002). Entrepreneurs with past commercial experience may, therefore, have gained important resource-acquisition skills. Attracting additional equity partners into the entrepreneurial team can also enable a solo entrepreneur, particularly an academic entrepreneur with no prior business ownership experience, to accumulate specific human capital relating to managerial, technical and entrepreneurial capabilities required to identify, pursue and exploit an innovative opportunity (Matlay and Westhead, 2005; Ucbasaran et al., 2006). Entrepreneurs can also leverage their human capital to gain access to a predictable uninterrupted supply of critical resources (such as financial and social capital) (Cooper et al., 1994; Greene, 2000). Entrepreneurial experience can add to human capital through enhanced reputation and increased networks and better understanding of, for example, the requirements of finance institutions. Such entrepreneurs may have improved access through social networks to financial institutions such as banks, venture capitalists and informal investors, and obtain funds on better terms (Wright et al., 2007). Entrepreneurs may, therefore, leverage their human capital to influence their social capital.

In addition, entrepreneurial behaviour is exhibited in numerous external environmental contexts (Reynolds et al., 1994; Ucbasaran et al., 2001). External environmental resource availability can promote new firm formation. Relatively few demand-side studies have explicitly explored the issues promoting (or retarding) the identification, pursuit and exploitation of technology-based firms particularly in sponsored and non-sponsored environments (Westhead and Batstone, 1999; Löfsten and Lindelöf, 2003). A sponsored environment fosters the formation and development of new firms (Flynn, 1993) and promotes formal and operational links between entrepreneurs and HEIs (Siegel et al., 2003). Science parks and incubators adjacent to HEIs are sponsored environments. They can reduce uncertainty for entrepreneurs, increase the legitimacy of inexperienced entrepreneurs, increase direct access to human, social and physical resources, as well as to facilitate access to other external sources of resources (Westhead and Storey, 1995, Westhead and Batstone, 1999; Mosey et al., 2006).

8.2.1 Research Methodology

A discovery orientated phenomenological methodology was used to explore the meaning of the actions of practicing lead entrepreneurs (Holstein and Gubrium, 2004). Specifically, a qualitative case study methodology was utilized. This inductive approach enabled rich and thick description (Yin, 1989) and permitted in-depth exploration of sensitive issues and processes (Strauss and Corbin, 1990). Case study data are frequently collected in order to present information relating to meanings and processes that have not previously been explored in any great depth (Van Maanen, 1983). Case studies can examine behaviour from the actors' (i.e., lead entrepreneurs) frames of reference, rather than imposing predetermined views of the researchers. Further, case studies enable causality to be explored and theory to be extended (Eisenhardt, 1989).

Prior to the interviews, theoretical constructs were identified ex ante from the literature reviewed. As intimated before, with reference to supply-side issues a distinction was made between lead entrepreneurs employed in HEI (i.e. academic entrepreneurs) rather than industry contexts (i.e. non-academic entrepreneurs). With reference to local demand-side issues, a distinction was made between lead entrepreneurs at the time of the interviews located on sponsored and non-sponsored environments. No list of academic and non-academic entrepreneurs located on sponsored and non-sponsored environments engaged in life-science was published. Primary information had to be collected to identify types of lead entrepreneurs. Data was gathered from lead entrepreneurs who operated firms in a life-science cluster. Names of firms located in the geographical triangle between Edinburgh, Glasgow and Dundee in Scotland (Forbes and Low, 2004) was provided by Scottish Enterprise. The sample frame related to a random sample of 100 firms in the trade directory (Scottish Enterprise, 2003) listed to be engaged in life-sciences. To ascertain the academic context of each lead entrepreneur and to confirm the main industrial activity and location of each firm a structured questionnaire survey was designed. In April 2004, the survey was e-mailed to individuals in 100 firms. Seventy people responded to the survey (i.e., 70% response rate). Respondents confirmed the identity of the lead entrepreneur in each firm. Survey evidence enabled lead entrepreneurs to be allocated into the academic and non-academic categories, as well as the sponsored and non-

sponsored categories. In addition, the respondents confirmed whether the new ventures at the time of the survey were at the opportunity identification phase. Theoretical sampling was employed to select cases with different academic and sponsorship location contexts. Nine lead entrepreneurs were identified. These lead entrepreneurs had confirmed their life-science firms were at the opportunity identification phase. Each lead entrepreneur was mapped on top of the conceptual typology of lead entrepreneurs.

To unravel the 'insiders view' (Denzin and Lincoln, 1998), semi-structured face-to-face interviews were conducted between January and April in 2005. Dyadic case studies were conducted in a structured reiterative approach to gather information from the lead entrepreneur and two further entrepreneurial team members in each firm. Each respondent typically provided a 45 to 60 minute interview. Transcriptions of the interviews allowed general observations and description to be made (Pettigrew, 1990). Triangulation of statements from the three respondents in each firm enabled the response from the lead entrepreneur to be validated (Fetterman, 1998). Analysis of the data from the case studies allowed the refinement of existing theoretical constructs in contrasting contexts (Wolcott, 1994), thus, extending theory relating to human and social capital accumulation in a variety of entrepreneur type contexts. "The movement from relatively superficial observations to more abstract theoretical categories *was* achieved by the constant interplay between data collection and analysis that constitutes the constant comparative method" (Suddaby, 2006, p636).

Extension to existing theory was evaluated primarily from the richness of the data and "the degree to which it provides a close fit to empirical data, and the degree to which it results in novel insights" (Colquitt and Zapata-Phelan, 2007, p1281). In the process of theory building some data from this study replicated results from previous studies. New and novel contributions, however, exposed themselves whilst the data was interrogated. For example, during the process of collecting the data an unexpected but observable movement of the lead entrepreneurs between different external environments was recorded and mapped. No mention of environmental exchange has been recorded in the literature exposing spinout firm formation. It

appeared that different environments became more or less valuable at different times of the opportunity identification process.

8.3 The Lead Entrepreneur and Team Members: Key Research Findings and Interpretation (Themes 1 and 2)

This section provides further analysis of the key findings and interpretations and links findings to the theoretical perspectives guiding this study. Some findings provide new knowledge and some confirm or contradict previous studies. The following presentation is guided by the three main areas identified in the conceptual framework: the lead entrepreneurs and team members involved in the entrepreneurial process focussing on resources as a differentiator and value creator of the firm (Themes 1 and 2); the entrepreneurial process examined at three critical junctures (Theme 3), and third, the influence of the external environment on access to resources (Theme 4). Propositions proposed in Chapter 5 are summarised in Table 8.1.

8.3.1 The Lead Entrepreneur(s) (Theme 1)

With reference to supply-side issues, owners of some life science firms faced liabilities associated with newness and smallness (Delmar and Shane, 2004). Academic entrepreneurs with considerable technical skills had narrower pools of human capital (Brush et al., 2001), particularly managerial and entrepreneurial capabilities and less connections to resource providers. Conversely, non-academic entrepreneurs with broader managerial and entrepreneurial capabilities were able to compensate for their more limited technical skills with wider networks (Westhead et al., 2005). Different starting configurations of resources (Westhead and Storey, 1995; Shane and Stuart, 2002) (e.g. human, technological, social, financial and physical) were identified. Drawing on the resource based view of the firm (RBV) different resource configurations (access to, leverage and management) of resources highlighted differences between academic and non-academic entrepreneurs (Heirman and Clarysse, 2004; Druilhe and Garnsey, 2004).

General human capital relating to scientific knowledge was paramount for the identification of an opportunity in the life-science sector confirming previous research findings (Bozeman and Mangematin, 2004). Neither the lead entrepreneur nor subsequent team members in Company 9 exhibited such human capital and as a result

Table 8.1: Summary of Propositions from Chapter 5: The Entrepreneur and Team Members

Proposition 1: Lead academic entrepreneurs are more likely to identify opportunities from their basic research and are technology focused whereas non-academic entrepreneurs are focused on opportunities identified from market needs and market knowledge.

Proposition 2: Lead academic entrepreneurs are more likely than non-academic entrepreneurs to be potential end users of their identified opportunities.

Proposition 3: Lead non-academic entrepreneurs are more likely to be known within business advisory networks from their prior start up experience whereas lead academic entrepreneurs with less start-up experience are forced to rely on the advice offered by the HEI.

Proposition 4: Lead academic entrepreneurs on sponsored environments have access to more physical, social, financial and business advisory resources than lead non-academic entrepreneurs on non-sponsored environments.

Proposition 5: Lead non-academic entrepreneurs wish to locate on sponsored environments to seek proximity to scientists during opportunity identification in order to identify and define their product whereas lead academic entrepreneurs wish to remain on sponsored environments because of the superior access to resources.

Proposition 6: Lead academic entrepreneurs' general human capital (i.e. reputation) has a greater influence on enhancing their social capital network than lead non-academic entrepreneurs' general human capital influence on their social capital.

Proposition 7: Lead academic entrepreneurs developing medical or dental devises on sponsored environments are more likely than other lead academic entrepreneurs on sponsored environments to seek investment outside Scotland.

Proposition 8: Lead academic entrepreneurs are more likely than lead non-academic entrepreneurs to experience a mismatch of resource synergy between their perceived needs and the ability of their investors to provide team members with matching skills.

Proposition 9: Lead academic entrepreneurs on sponsored environments were more likely than lead non-academic entrepreneurs on non-sponsored environments to better develop their scientific concepts as commercial opportunities because of Proof of Concept funding.

Proposition 10: Lead academic entrepreneurs are more likely than lead non-academic entrepreneurs to focus on team homogeneity during the opportunity identification phase.

Proposition 11: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to gain access to 'surrogate entrepreneurs'.

did not progress from the phase of opportunity identification during the whole study. Technological resources (Bower, 2003) associated with a product or process were either grounded in basic HEI research and manifest in IP contracts, or simply existed as tacit conceptual ideas as work in progress (Hindle and Yencken, 2004). Social capital relating to networks of potential resources providers (e.g. financial and commercial contacts) (Brush et al., 2001) or relating to proximity to other life science firms (Westhead and Batstone, 1999) and relating to the benefits of different environments (e.g. sponsored and non-sponsored) (Westhead and Storey, 1995; Lindelöf and Löfsten, 2004) exposed differences in access to resources. A comparison between the lead entrepreneur(s), in the four represented quadrants indicated that there was a tendency, not surprisingly, for lead academic entrepreneurs on sponsored environments to have less entrepreneurial experience than lead non-academic entrepreneurs on sponsored and non-sponsored environments. Their inability to network with individuals with prior venture creation human capital directly was compensated for by the social contacts offered by 'privileged witnesses' such as TTOs, on HEI sponsored environments, or the local business development agencies, on non-sponsored environments (Vanaelst, et al., 2006). 'Privileged witnesses' became vital, 'temporary,' (non-equity) team members whilst information was sourced and resources accumulated. They were 'temporary' in two senses. First, they were generally associated with one type of environment and second, associated with a certain phase of the entrepreneurial process. When entrepreneurs changed environment or moved through a critical juncture to new growth phases their relationship changed or ceased with both the previous environment and with the TTOs.

During this process lead academic entrepreneurs became eligible for governmental funding schemes (as did non-academic entrepreneurs). They saw firm formation as a way to enhance their research knowing that colleagues or their institutions were potential end users of their product / process. General human capital relating to education and level of education also had a positive effect on the willingness of finance providers to offer support. This finding may be specific to life science entrepreneurs and lies contrary to findings by Davidsson and Honig (2003) who studied nascent entrepreneurs only. The process of applying for funding at the opportunity identification and entrepreneurial commitment phases was guided by

TTOs. TTOs were HEI representatives promoting an ever increasing emphasis on the commercialisation of HEI knowledge. TTOs acted as gatekeepers between the non-commercial HEI environment and resource keepers for the commercial world and as bridges builders between critical junctures of the entrepreneurial process. At the venture credibility juncture, academic reputation also compensated for a lack of business acumen giving lead academic entrepreneurs credence with potential private investors. In addition, Mustar et al., (2006) indicated that the reputation of the HEI from where academic entrepreneurs originate may also signal quality to both investors and / or potential partners. This was an interesting finding. Investors overlooked academic's business inexperience but placed importance on academic, clinical and HEI reputations. Scientists' human capital in the form of scientific knowledge was converted to financial capital through firm formation (Bozeman and Mangematin, 2004). It seemed that the scientists (academic entrepreneurs) deployed scientific results as a form of technological capital to engage with investors and providers of financial capital.

However, lead academic entrepreneurs sought experienced personnel or surrogate entrepreneurs with life-science exposure to manage private investors' funds and achieve set milestones. Typically, eminent academic entrepreneurs retained full time positions in academia and contrary to financial capital providers took no risk as their intellectual investment could not destroy their scientific and technological human capital. In one case, commercial expertise came in the form of a managerial representative recruited by the supporting venture capital company. Subsequently, there was a mismatch between the requirements of a new firm exploring the medical device market and the recruitment of a highly respected and experienced manager from a blue chip medical device company. Wright et al., (2004) examined this relationship between spinoff firm and risk capital provider and found that access to resources was influenced by the capital provider. The management of high profile, eminent scientists' research for commercial gain was found to be wanting in this research. Academics, on the other hand, who were only team members, exploited their human capital strategically as scientific advisors to their companies. Social capital, more that human capital, played a significant role in networking lead entrepreneurs with experienced personnel but was enhanced by eminent academic entrepreneurs' reputation and scientific visibility (gauged through publications and

exposure during the conference circuit). Much of this capital especially at the interpersonal and social is embedded in social and professional networks. This was particularly evident in the functional role of mentors, advisors, TTOs and business development agencies who used their network links to favourably establish alliances (Nicolaou and Birley, 2003).

Lead non-academic entrepreneurs who showed evidence of prior entrepreneurial specific experience, on the other hand, tended to seek out scientific specific expertise associated with their business opportunity from academics within HEIs and relied on the advice of sponsored development agencies. Lead non-academic entrepreneurs reported similarities between the opportunity identification process and firm formation process of their present situations to that of their venture start up experiences from the past. Either they used their past experience as proof to potential investors that they had the necessary skills, or, in one case, demonstrated the adoption of bad practice and repeated this practice to their detriment. Extant literature expresses the danger of the transfer of both good and bad practice from previous entrepreneurial experience.

8.3.2 The Entrepreneurial Ownership Team Members (Theme 2)

To avoid attitudinal, resource and operational barriers to opportunity identification, lead entrepreneurs chose to facilitate the formation of entrepreneurial teams with equity ownership (permanent) and non-equity (temporary) team members in the hope for results. Ucbasaran et al., (2003) stated that such individuals provide the experience and knowledge that can be leveraged to address technical and business barriers to progression. The theoretical sample of academic and non-academic entrepreneurs in the life-sciences confirms this general result. However, it was observed in addition, that lead entrepreneurs with a narrow commercial resource profile, characterized as academic entrepreneurs, tended to select a rich resource sponsored environment to gain access to the resources in which they were themselves deficient but paradoxically in this such environments created entrepreneurial teams that re-enforced their narrow resource profile rather than broadening it when seeking to create and identify opportunities. To avoid potential team conflict, lead academic entrepreneurs recruited academics with more diverse technical human capital rather than individuals with more diverse managerial, entrepreneurial or prior business

ownership skills. Known academic colleagues were drawn into the entrepreneurial ownership teams to address technical barriers to product / process discovery (Clarysse and Moray, 2004). A mismatch in the opportunity identification process was detected. The dearth of managerial and entrepreneurial capabilities within the entrepreneurial teams in several instances led to an inappropriate focus on research, product and process development. Market, customer and financial issues were given insufficient attention by academic entrepreneurial ownership teams. Sponsored environments appeared to have a paradoxically initial negative impact on the progression of opportunity identification. There was a danger that the cushion of commercial support they provided in practice had the potential to undermine entrepreneurs' capacity to progress through the entrepreneurial process. Only one lead non-academic entrepreneur selected a sponsored environment and did so to broaden and enrich not narrow his access to human capital. He wanted access to people with knowledge in the life-sciences.

Moreover, lead academic entrepreneurs, aware of resource barriers, identified several network bridges to gain access to actors associated with financial resources, expertise and contacts. Commercial barriers to opportunity identification were addressed by using 'surrogate entrepreneurs' (Franklin et al., 2001). They provided essential knowledge about investors specialising in the life-science sector at the venture credibility phase of the entrepreneurial process. The latter 'outside team members' initially joined the entrepreneurial team as non-equity holders or as management team members. Some surrogate entrepreneurs subsequently became equity holders and entrepreneurial ownership team members. By encompassing organisational and managerial processes through the recruitment of new members, lead entrepreneurs were able to combine and reconfigure resources with existing assets (e.g. managerial expertise with gaining access to finance) to further progress their opportunities. Exploiting and combining resources through organisational routines allowed the entrepreneurs to build their capabilities to progress through critical junctures (Vohora et al., 2004) an observation confirmed by Druilhe and Garnsey (2004) in their dynamic view of the entrepreneurship associated with academic spinoffs. .

In marked contrast, three lead non-academic entrepreneurs focused from the outset on current and potential customer market needs and the size of the potential market(s). They were market-focused from the outset and avoided sponsored environments where that focus might have been diluted with a broader more technical orientation. Their entrepreneurial ownership teams were more likely to include individuals with managerial and entrepreneurial human capital, as well as prior business ownership experience. Experienced entrepreneurs were encouraged to join the entrepreneurial ownership teams because they provided customers, suppliers, finance, market and industry knowledge and contacts, as well as commercial credibility. Team members with experience dealing with market related issues were sought and valued. The market led opportunity-orientated lead non-academic entrepreneurs recruited team members with technical capabilities. The latter individuals provided additional knowledge to support new products or processes. In some instances, academics were encouraged to join the entrepreneurial ownership team in order to link product and process development to the specific needs of academic end-users.

8.4 The Entrepreneurial Process: Key Research Findings and Interpretation (Theme 3)

The following three sub-sections outline human and social capital differences in accordance to the entrepreneurial process (Theme 3) encapsulating information search and opportunity identification (e.g. Discovery); resource accumulation and management (e.g. Evaluation) culminating in the decision to form a firm (e.g. Exploitation). Propositions proposed in Chapter 6 are presented in Table 8.2.

8.4.1 Discovery (Theme 3)

Lead academic entrepreneurs displayed more control over the timing of their research and development process and tended to consider commercialisation only when IP rights covered their generated technical knowledge (even if it belonged to the HEI). Lead non-academic entrepreneurs either had not created new intellectual property or considered the creation and protection of new IP as part of the commercialisation process. Academic entrepreneurs on non-sponsored sites, although rare, reported that their freedom from their institutions allowed them to claim the ownership of their IP. In short, for the lead academic entrepreneur opportunity

Table 8.2 Summary of Propositions from Chapter 6: Entrepreneurial Process

8.4.1 Discovery (Theme 3)

Proposition 12: Lead academic entrepreneurs are more likely to identify an opportunity through a process of recognition conducting scientific exploration (e.g. supplying products for which there is a known market) than lead non-academic entrepreneurs who identify an opportunity through a process of discovery (e.g. identifying a demand with the supply of a product not yet fully developed).

Proposition 13: Lead academic entrepreneurs' general human capital (relating to education) allows for an opportunity identification approach reliant on scientific discovery whilst lead non-academic entrepreneurs' specific human capital (relating to prior working experience) allows for an opportunity identification approach reliant on recognising market demands.

8.4.2 Evaluation (Theme 3)

Proposition 14: Lead academic entrepreneurs on sponsored environments who are involved in the research and development of medical and dental devices are more likely than other lead entrepreneurs to have or to be offered direct ties with surrogate entrepreneurs by resources providers.

Proposition 15: Lead academic entrepreneurs on sponsored environments who recruit surrogate entrepreneurs are more likely than non-academic entrepreneurs on non-sponsored environments to receive capital investment from external investment providers.

Proposition 16: Lead academic entrepreneurs who are full professors based on sponsored environments are more likely to attract venture capital funding than lead non-academic entrepreneurs on non-sponsored environments.

8.4.3 Exploitation (Theme 3)

Proposition 17: Lead academic entrepreneurs on sponsored environments are more likely to have weaker ties to resource providers outside of their sponsored environment than non-academic entrepreneurs on non-sponsored environments.

identification came after the application and appropriation of IP whereas for the lead non-academic entrepreneur the exploration and discovery of the new knowledge was seen as part of the entrepreneurial process. This observation suggests that the technological resources available to academic entrepreneurs on sponsored environments were superior or that of non-sponsored environments.

Lead academic entrepreneurs, therefore, offered investors better developed ideas because their technical information search had to a greater extent been supplemented / supported with public funding, charity or industry backing. Non-

academic entrepreneurs did not have the privilege of being able to access funds, equipment and an infrastructure similar to an HEI and, therefore, had to contend with plans which included funding applications for basic research and development. Lead academic entrepreneurs, on the other hand, had evidence that their ideas were scientifically authentic because either they had accessed Proof of Concept funding from a government body, available only to HEIs and / or patent protection. Being 'further down the line' in research and development terms allowed them to be more efficient in their use of information when identifying both business opportunities and potential investors.

Knowledge of competitors' products or processes and their weaknesses, sourced through trade fairs and technical conferences, also encouraged lead academic entrepreneurs to enter known market areas (Sarasvathy et al., 2004). The use of, and search for sources of information was different for the lead academic and non-academic entrepreneur. In particular, academic entrepreneurs had access to the social network of contacts from the TTO; the academic community; industrial players met at conferences and sponsored business development agencies. These contacts put them in a stronger position for sourcing information about markets and funding. Non-academic entrepreneurs, on the other hand, had different information sources restricted to the business development agencies and contact with past customers, clients, suppliers and competitors.

As stated in Chapter 6 some lead entrepreneurs identified their opportunities from their past experience and by being attentive to the market but not necessarily from searching for information (Shane, 2004). This reflects the position of the lead academic entrepreneurs in the dental and medical device sector who both knew that there was a demand for their potential products for which there was currently no supply (e.g. opportunity discovery) (Sarasvathy et al., 2004). Non-academic entrepreneurs faced with the prospect of redundancy were forced to search for information intensively. Thus, the electronics engineers (Company 8), made redundant from the mobile phone sector, targeted the life-science sector only after intensive market research and networking with firms within the life-science sector, with the business development agencies and with representatives from academia. Their initial search was sponsored by a local business development agency supporting

the observation from Chandler et al., (2002) that proactive search opportunities are recognised only when there are sufficient resources around for the search and discovery to be made. In this particular case, information search facilitated the opportunity for co-operation between the engineers and academics. An observed capability to combine scientific knowledge with a commercially feasible offering that satisfies an unfulfilled market need was demonstrated (Vohora eta al., 2004). This particular team offered a product for which there was a known market (e.g. opportunity recognition) (Sarasvathy et al., 2004).

8.4.2 Evaluation (Theme 3)

Given the problems encountered by the lead entrepreneurs in their pursuit of commercially uncertain life-science opportunities at the entrepreneurial commitment phase, differences were revealed between the academic and non-academic lead entrepreneurs. This was due in part to information asymmetries and the precarious process of acquiring financial resources. In addition, lead academic entrepreneurs were motivated to form firms to access funding to continue their basic research, whilst non-academic entrepreneurs were often seeking funding to compensate an extrinsic experience in their life (e.g. as a reaction to redundancy or liquidation of a previous company). All lead entrepreneurs whether academic or non-academic had invested equity in their own firms and all were eligible and had, to differing degrees of success, been awarded governmental seed funding. At the entrepreneurial commitment phase, however, the barriers to reaching investors, either business angels or venture capitalists, were mainly overcome when the lead entrepreneurs were introduced to people with previous experience and contact with the investment sector (Vohora et al., 2004). Once that connection was made networks and knowledge of TTOs became redundant. Lead academic entrepreneurs, generally, did not have previous knowledge, contacts or experience of dealing with investors.

Lead academic entrepreneurs, therefore, relied on the assistance of surrogate entrepreneurs with prior contact with venture capitalists (Franklin et al., 2001; Vanaelst et al., 2006). In the two cases, where the initial investment to exploit the opportunity was large, both lead entrepreneurs were forced to London to seek interest. Since the lead entrepreneurs did not possess the direct social ties to the investors the role of the surrogate entrepreneur was vital for the leverage and acquisition of

financial resources. By recruiting the surrogate entrepreneurs the lead entrepreneurs were communicating to the investors their commitment to the opportunity (Vohora et al., 2004). In the particular cases of medical and dental research the clinical and academic reputation of the lead academic entrepreneurs, who were renowned full professors, also demonstrated a degree of proven general human capital in technical and managerial excellence. These particular entrepreneurs led and managed substantial research agendas for their HEIs. Lead academic entrepreneurs could also demonstrate to investors a continuing relationship with their own HEI and evidence of a cache of qualified academics on their entrepreneurial ownership team. Lead non-academic entrepreneurs reported much less success in being offered access to surrogate entrepreneurs and in turn less success with applications for funding.

8.4.3 Exploitation (Theme 3)

The dependence on external resources through networks with advisory agents for public grants and awards shifted during venture credibility to a reliance of contact with private investors. Lead academic entrepreneurs had greater access to support providers who had a wide range of commercial network exposure. Only one academic entrepreneur reported a prior contact, through a family connection, where there was evidence of entrepreneurial behaviour. Others relied on the efforts and extended network of surrogate entrepreneurs. Overall, following firm formation, lead academic entrepreneurs experienced a withdrawal of support from the TTOs and access to the HEI infrastructure. They were encouraged to change external environments in an effort to promote less dependence on the supportive infrastructure. Full entrepreneurial commitment was rare amongst lead academic entrepreneurs, especially if they were full professors. Managing the transition from being a publicly supported entity to becoming a commercially active venture was fraught with difficulty and uncertainty. Those who successfully managed the transition relied on recruited team members with prior commercial experience and with prior relations with the investor sector. The managerial capability of the lead academic entrepreneurs to guide this process was questionable and in one case the investors insisted on placing their own representative within the company.

Non-academic entrepreneurs on sponsored and non-sponsored environments, on the other hand, displayed capabilities learned from past business ownership

experience which manifest itself in heightened levels of managerial capability. Managerial capability benefited entrepreneurs in framing an opportunity, from initial idea to firm formation. Since these experienced entrepreneurs had 'been through the loop' already they understood the importance of organising resources, tasks and people, delegation and division of workloads. Entrepreneurs and entrepreneurial ownership team members reported similarities between establishing their latest venture compared to prior venture creations. However, those most disadvantaged were the lead non-academic entrepreneurs on non-sponsored environments with no prior commercial experience. Their access, even to public funding and grants, was curtailed by a reported lack of experience amongst business advisors guiding life-science firms in particular. Overall only one lead non-academic entrepreneur reported success in attracting private capital.

8.5 The External Environment and Location: Key Research Findings and Interpretation (Theme 4)

In the three sections below differences between external environments (e.g. sponsored and non-sponsored) and changes made by lead entrepreneurs in location are discussed in relation to the entrepreneurial process. Many HEIs, normally with cooperation from local authorities, have established property based locations to encourage and facilitate the creation of firms emanating from HEIs (e.g. incubators and science parks) (Siegel et al., 2003a,b; Phan et al., 2005). These spaces are considered sponsored or subsidised. Difference in access to these physical resources and facilities may influence the entrepreneurial process (Clarysse et al., 2005). Propositions proposed in Chapter 7 are presented in Table 8.3.

8.5.1 Location at Opportunity Identification Phase (Theme 4)

At the opportunity identification phase lead academic entrepreneurs exploited the scientific and business support infrastructure and scientific human capital resources of their HEIs to develop their idea into a commercial opportunity. Lead academic entrepreneurs generally located on sponsored environments because their research originated within the sponsored environment of HEIs which gave them the advantage of having access to familiar facilities, people and systems surrounding scientific exploration and business development. If the academic entrepreneurs also worked as medical or dental clinicians, having contact with other clinicians eased the

process of gathering information about current products used on the market. Displaying higher rates of R&D is exemplified by a study conducted by Lindelöf and Löfsten (2004) which stated that firms with stronger links and networks with HEIs generally had higher R&D and growth rates. In addition, if the HEI had a business or management school, TTOs were able to connect scientists with interested and experienced students completing their MBAs indicating interdepartmental networks recognised by Nicolaou and Birley (2003). Current policy towards the commercialisation of HEI knowledge at national level allowed all lead academic entrepreneurs to apply for funding pre-firm formation for Proof of Concept and thereafter, for Smart, Spur and Co-investment awards. HEI departments and incubator units offered laboratory facilities and networks to business advice, financial assistance, business training and contact with a known physical and social infrastructure (Mustar et al., 2006).

The academic entrepreneurs appreciated proximity to other academics and students for advice, opinions and as a potential pool of employees. As noted before, a disadvantage to the sponsored environment was the lack of diversity amongst potential team members. On more than one occasion non-academic entrepreneurs commented on the access that academic entrepreneurs had to public funding early in the opportunity identification process which was not accessible to potential entrepreneurs outside of the HEI system. Lead academic entrepreneurs on sponsored environments were more likely to establish good working relationships with resource providers than lead non-academic entrepreneurs on non-sponsored environments because of the close proximity, assistance and networks advice given by the TTOs. TTOs were particularly sensitive to the needs of their lead academic entrepreneurs. Mustar (1997) also found that successful spinouts require to network with many different players and be integrated into networks allowing interaction with a variety of actors (e.g. the HEI, other enterprises, governmental bodies, technology programmes, customers and investors).

All lead academic entrepreneurs and members of their entrepreneurial ownership teams, who were also academics, whether on sponsored or non-sponsored environments, were employed by the HEI to which they were attached. At the opportunity identification phase few resigned from their academic posts. It was only

at the entrepreneurial commitment phase that some lead academic entrepreneurs resigned from their HEIs. All lead academic entrepreneurs who were clinicians remained full time employees of their HEIs throughout the process. Generally these lead academic entrepreneurs were at the top of their academic and clinical careers and leaders in their chosen fields. Their involvement in academia went beyond teaching and research to encompass advisory roles.

Table 8.3 Summary of Propositions from Chapter 7: The External Environment
8.5.1 External environment at the Opportunity Identification Phase (Theme 4) ***Proposition 18: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to submit more developed concepts to venture investors because of their superior access to physical resources (e.g. laboratories), technical human capital (e.g. scientists) social network capital (e.g. business advisers) and public funding (e.g. Proof of Concept).*** ***Proposition 19: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to have a reciprocal relationship with their resources providers at the opportunity identification phase.***
8.3.8 External environment at the Entrepreneurial Commitment Phase (Theme 4) ***Proposition 20: Lead academic entrepreneurs on sponsored environments are more likely than lead non-academic entrepreneurs on non-sponsored environments to be 'pushed' away from their environments to promote independence during the entrepreneurial commitment critical juncture.*** ***Proposition 21: Lead non-academic entrepreneurs located on non-sponsored environments are more likely than lead academic entrepreneurs on sponsored environments to change location because they need to access laboratory space at the entrepreneurial commitment critical juncture.***
8.3.9 External environment at the Venture Credibility Phase (Theme 4) ***Proposition 22: Lead academic entrepreneurs located on sponsored environments (external to their HEI) are more likely than lead non-academic entrepreneurs on non-sponsored environments to exploit two locations at one time.***

Resources relating to physical infrastructure were considered to be better within the sponsored environments of HEIs rather than on sponsored and non-sponsored sites outside HEIs. Laboratory refurbishments were required for all companies located on sponsored (non-HEI) and non-sponsored environments. Non-academic entrepreneurs who chose sponsored environments did so because they

lacked technical scientific knowledge and needed to be in close proximity to scientists during the opportunity identification process to define their product / process.

8.5.2 Location at the Entrepreneurial Commitment Phase (Theme 4)

During the entrepreneurial commitment critical juncture, all bar one lead academic entrepreneur were allocated space within the HEI to further develop their technical resources and to progress applications for financial resources. Normally a time restriction on HEI incubator occupancy was issued to lead academic entrepreneurs. Lead academic entrepreneurs were more likely to experience a 'forced push' away from the protection of their sponsored environments by resource providers representing the HEI. The 'forced push' may have been be indicative of TTOs assessment of academic entrepreneurs' enhanced resource profile ascertained from their physical surroundings and social networks (e.g. access to private investor funding). The lead non-academic entrepreneurs did not have access to a laboratory until after the entrepreneurial commitment critical juncture and only after they moved to a sponsored environment. The managerial consultancy company responsible for Company 9, led by a non-academic entrepreneur, out-sourced all their scientific work to different HEIs. Generally, all lead non-academic entrepreneurs commented that there was a general lack of adequate laboratory space for early research and development and desired access to a sponsored environment. The difference between lead academic entrepreneurs and lead non-academic entrepreneurs, on sponsored environments, appeared to be that the lead academic entrepreneurs had no commercial experience and sought advice from the support structures within the HEI system whereas lead non-academic entrepreneurs had acquired diverse capabilities relating to several industry settings not solely related to life-science research and sought scientific knowledge.

8.5.3 Location at Venture Credibility (Theme 4)

Lead academic entrepreneurs located within the walls of an HEI reported a negative customer perception of their company and a negative perception from venture capitalists (Locket et al., 2003). One academic entrepreneur reported a negative perception towards entrepreneurship from fellow members of academic staff as the incentive to move away from the sponsored environment of the HEI. In general, by the venture credibility phase lead academic entrepreneurs had been asked to show

autonomy from the HEI by leaving the confines of the protected environment of the sponsoring HEI. The move was generally 'forced' by the HEI. A voluntary shift was not recorded during this study. However, bearing in mind that academic entrepreneurs rarely resigned from their academic positions, these entrepreneurs were able to subsequently buy R&D services and resources from their HEIs for their newly formed firms. The entrepreneurs were acting as bridges between the world of academia and that of the R&D needs of their commercial firms in external sponsored environments. This observation revealed a functional diversity of roles played by many leading academic entrepreneurs which allowed them to take advantage of resources in both sponsored environments in parallel time (e.g. the external sponsored environment of the science park and the internal sponsored HEI environment).

It was at the venture credibility phase that surrogate entrepreneurs, recruited at the entrepreneurial commitment phase as managerial members, became entrepreneurial ownership team members owning equity in their firms. Surrogate entrepreneurs were an important source of commercial knowledge and skills confirming their importance in the entrepreneurial process (Franklin et al., 2001). A new dimension was added. Surrogate entrepreneurs took on different degrees of worth at different times in the dynamic entrepreneurial process. An equity commitment cemented this direct network tie.

Lead non-academic entrepreneurs, on the other hand, reported that their need to be close to a life-science community which offered a physical infrastructure and supporting scientific services (e.g. biological waste-disposal) influenced their decision to move to a sponsored external environment. In addition, on non-sponsored environments, where resource allocation was generally lower than that of a sponsored environment, lead entrepreneurs made progress through critical junctures relying on their own network of contacts (e.g. exploiting their own social capital) rather than relying on connections offered by outside mentors or business advisors. Lead entrepreneurs acted as their own ambassadors without necessarily being directed or guided by non-equity team members. Human capital alone was an insufficiently valuable resource to open doors to other resource providers in the form of tangible access to finance or intangible resources such as management and market experience. Shane and Stuart (2002) confirmed that social capital had an impact on fund-raising

and that new venture founders with direct and indirect relationships with investors were more likely to receive funding.

At the end of the study seven out of the nine firms had moved to, or had remained, on sponsored environments. Only two of the nine firms chose non-sponsored environments. Company 8 remained on a non-sponsored site because they needed access to manufacturing rather than scientific facilities and the other because they did not transcend the entrepreneurial credibility phase to reach venture credibility. This firm returned to the opportunity identification phase and to small city centre office facilities (Company 9).

8.6 A Synthesis of Key Research Findings and Interpretation

The initial resource profiles of lead academic entrepreneurs and non-academic entrepreneurs were found to differ with regard to their entrepreneurship-specific human capital profiles which, in part, shaped the opportunity identification process. Lead academic entrepreneurs generally exhibited a product / process discovery focus, whilst lead non-academic entrepreneurs exhibited a more market led opportunity-orientated focus. In turn this influenced what kind of opportunity they identified (Table 8.4). Academic entrepreneurs generally 'discovered' opportunities for which there was a demand but no supply whereas non-academic entrepreneurs offered products for known markets and 'recognised' their opportunities (Sarasvathy et al., 2003). Lead academic entrepreneurs extended their basic HEI research into commercial realms and relied on their superior educational levels and biases towards technical knowledge (i.e. general human capital) to influence access and acquisition of business expertise and funding. Their academic reputation overflowed into the industrial sector for which their ideas were relevant. An example would be the dental device aimed at prevention of decay. The device was of interest to the dental hygiene sector which saw the product as, at best, direct competition and, at worst, a threat to their own markets. Data suggests that lead academic entrepreneurs with no commercial or prior business ownership experience leveraged their technical capabilities to discover new products and / or processes. Their resource profiles, in part, shaped the composition of the entrepreneurial ownership team.

Table 8.4: New Contributions	
Theme	***New contribution***
Theme 1 Lead Entrepreneurs	• Lead academic entrepreneurs are technology focused and lead non-academic entrepreneurs are focused on market needs • Lead academic entrepreneurs have access to more physical, people, financial and advisory resources • In the life-science sector specific scientific human capital and specific commercial human capital is a prerequisite to opportunity identification • Level of education is a significant factor in successfully attracting venture funding • Specific and general human capital have different value for the entrepreneurs at different junctures in the conceptual framework • There is a lack of experience amongst entrepreneurs and resource providers in Scotland to take a firm from conception to launch as a public company
Theme 2 Team Formation	• Non-equity team members such as TTOs are vital because they guide entrepreneurs through the governmental funding process and are representatives and custodians of the HEI's equity stake in the potential firm • Team are often formed prior to firm formation
Theme 3 Information Search; Opportunity Identification; Resource Accumulation; Firm Creation	• There exists a vital pre-opportunity identification phase during which interaction between potential interested team members is conducted • The conference circuit frequented by academic entrepreneurs is a place: To source information To meet industrial players To promote their companies • Funding from venture capitalists in Scotland for the life-science sector was not recorded during the study
Theme 4 External Environment	• There is a bias from all entrepreneurs in favour of sponsored environments • There is a deficit of laboratory space in sponsored and non-sponsored environments outside of the protected HEI environment for small firms • There occurred movement between environments during the course of the study which had not been recorded before. Some moves were voluntary; some moves were imposed; some moves made to escape negative influences and attitudes of academics; some moves were deliberate • Lead academic entrepreneurs are able to manage their companies in sponsored environments external to the HEI and to manage research and development for their companies using the facilities within their sponsored HEIs • On non-sponsored environments, where access to resources was poor, the entrepreneurs' social capital was more important than human capital for making contact with resources providers.

To avoid potential team conflict, academics with more diverse technical capabilities rather than individuals with more diverse managerial, entrepreneurial or prior business ownership skills were drawn into the entrepreneurial ownership teams (Üçbaşaran et al., 2003; Clarysse and Moray, 2004). There appeared structural holes (Burt, 1972) between the academic research network and industry networks which may have constrained opportunity recognition (Mosey and Wright, 2007). The technical and academic conference circuit as a potential platform for opportunity identification, networking and resource accumulation needs further investigation but was outside the remit of this research (Table 8.4). Market, customer and financial issues, on the whole, were given insufficient attention by academic entrepreneurial ownership teams. Access to such specialist human capital was important at different times during the entrepreneurial process and not sourced within the confines of the HEI. Normally surrogate entrepreneurs with prior exposure to the life science sector were recruited from networks of contacts known to resource providers within the HEI environment (i.e., TTOs). It was observed that access to physical, social and financial resources was better within the confines of the HEI sponsored environment (Table 8.4).

Lead non-academic entrepreneurs, on the other hand, focused on current and potential market needs and their entrepreneurial ownership team were more likely to include individuals with managerial and entrepreneurial capabilities. Moreover, lead non-academic entrepreneurs aware of resource barriers identified several network bridges to gain access to actors associated with financial resources, expertise and contacts. In some instances, academics were encouraged to join the entrepreneurial ownership team in order to link product and process development to the specific needs of academic end-users. In life sciences access to both general (relating to technical knowledge) and specific (relating to prior business experience) human capital was a prerequisite to opportunity identification (Table 8.4).

As noted earlier, human capital (e.g. general and specific) has different significance and value at various phases before and after opportunity identification. Whilst lead entrepreneurs were searching for information, observations revealed that those with past managerial responsibility or past business ownership used greater numbers of information sources and were more intense in their networking with potential resource providers (e.g. lead non-academic entrepreneurs). In three

identified cases the lead non-academic entrepreneurs exploited their specific human capital managerial capability to seek information and assistance in different ways. One exploited information from industrial players; another piggybacked a market survey of the life-science sector with firm formation; and yet another relocated his firm in order to network with an existing life-science biotechnology cluster. Interestingly, all three candidates had prior start-up experience and, therefore, brought with them proven entrepreneurial capabilities. Their advantage rested in their ability to, not only source information independently of resource providers, but also to appreciate the value of the information and to exploit the information to their benefit. Lead academic entrepreneurs on sponsored environments, searched for less information because their opportunity centred on scientific discovery rather than information search. They displayed a high technical capability and were less aware of the demands of, and access to, markets and market needs. Several lead academic entrepreneurs were unsure about what product, or part of the product, or knowledge about the product, to offer to the market indicating a lack of initial information searching.

From presented data, lead entrepreneurs spent considerable time, within their own original environments, discussing opportunities with colleagues, business partners and potential team members, prior to the identification of an opportunity. During this pre-opportunity identification process a team evolved (Table 8.4). This pre-opportunity identification process has been understated in past research. Within their respective external environments in which this pre-phase took place, whether in residential, HEI or business environments, an inventory of the stock of available resources was conducted and a general assessment of the feasibility of the opportunity tested. The initial lead entrepreneur played a key role in providing required entrepreneurial capabilities for opportunity recognition (technical and / or commercial) and interacting within social networks to gain acceptance from and to add value to their opportunity. Mentors or advisors were only sought after the intension to form a firm was discussed. At pre-opportunity and during the process of opportunity identification these advisors literally became team members working on behalf of the lead entrepreneur to instigate progress in terms of legitimising the proposed firm or instigating funding rounds with governmental bodies. The merging scientific human capital of the lead entrepreneurs and the specialist commercial human capital of the

advisors aided the process towards firm formation. As the process progressed so the locus of entrepreneurial capabilities for value creation shifted from the initial lead entrepreneur to team members (Vohora et al., 2004). However, the process was far from linear. Data emerging from the qualitative interviews indicated that team members had to revisit prior phases to reassemble new or lost resources. If, for instance, the team considered the identified opportunity as not viable, then they had to return to an information search pattern of behaviour and start again. These re-visiting processes manifested themselves repeatedly at the firm formation phase. The data revealed a number of reasons for these iterations (e.g. patents for potential products already existed; changes in team membership; industrial players made offers to buy licences to their knowledge; R&D experiments determined a change to the initial opportunity; financial backing failed to materialise; contract work was given priority over the development of the new opportunity). The process was a constant looping backwards and forwards. A standard linear process leading to firm formation did not emerge but, as observed by Druilhe and Garnsey (2004), this longitudinal study revealed that lead entrepreneurs experienced a dynamic entrepreneurial process. These observations have a significant effect on the original Conceptual Framework offered in Chapter 3 (Figure 3.1). Adjustments to the process and access to resources are now presented in Figure 8.1 which also summarises important contributions to theory building.

From a human capital perspective, general human capital relating to scientific knowledge was fundamental in the identification of an idea in the laboratory. Specialist human capital relating to commercial issues allowed the potential of the idea to be tested for application in a commercial field. To compensate for the lack of the latter, lead academic entrepreneurs were allowed access to mentors who supplemented their deficit in business acumen. Non-academic entrepreneurs were less likely to generate IP and therefore generated ideas outside of a traditional laboratory setting. These entrepreneurs, not surprisingly, relied on their past entrepreneurial or industrial experience and their knowledge built through network ties with equity financers, industrial partners, and potential customers (Mosey and Wright, 2007) or through the skills of other non-equity team members representing the business development sector. As the manifestation of the identified opportunity strengthened

Figure 8.1: Adjustments to Conceptual Model

	THEME 1 *Lead Entrepreneurs*	THEME 2 *Team Member*	THEME 3 *Opportunity Identification*	THEME 4 *External Environment*
Academic entrepreneurs	Resource profile moves from general HK (individual education related to science) to specific HK (related to commercial knowledge) during the opportunity identification process	Initially focuses on team homogeneity based in technical HK More structural holes related to industrial contacts SK of TTO deteriorates (becomes redundant) closer to venture credibility phase Accesses surrogate entrepreneurs who join as non-equity members	Discovers opportunity in a resource rich environment (Knows there is a demand but no supply of a certain product)	Protected sponsored environment of HEI discourages the combination and reconfiguration of tacit and tangible resources because of emphasis on technical knowledge and lack of access to people with commercial experience
Non-academic entrepreneurs	Resource profiles move from specific HK (prior business ownership) to general HK (related to scientific knowledge) during the opportunity identification process	Initially team profiles relate to market and product Searches for members with scientific knowledge closer to entrepreneurial commitment phase	Recognises opportunity (product for known market) by increased information search indicating increased access to resources. SK networks offer increased access to information (market, customer, financial)	Non-sponsored environments lack physical resources fundamental to the development of a life science firm
Contribution to theory	In the life science sector HK related to technical scientific knowledge (Bozeman and Mangematin, 2004) and commercial knowledge are prerequisites to opportunity identification	Team formed prior to the entrepreneurial process. Although non-academic entrepreneurs have less structural holes to non-equity resource providers they are not offered as much access to surrogate entrepreneurs or equity investors	Dynamic process; not linear; iterative; confirming Druilhe and Garnsey, (2004) and Vohora et al., (2004) HK and SK have different values at different phases of entrepreneurial process	General bias towards sponsored environments. Change in environment associated with push and pull factors

specific commercial human capital became less important and general human capital relating to levels of education became much more beneficial to the lead non-academic entrepreneurs (Davidsson and Honig, 2003). The need for technical input became vital. The complete contrary held true for academic entrepreneurs where their needed input was entrepreneurial.

By the venture credibility phase non-equity team members were withdrawing support and became instrumental in motivating lead academic entrepreneurs to change their 'outgrown' environment (Table 8.4). The withdrawal of TTO assistance was not due to conflict, as suggested by previous literature (Vanaelst et al., 2006), but as a measured and calculated strategy to withdraw support to enhance autonomy of their nurtured firms lead by academic entrepreneurs from their own institutions. A number of changes in location were mapped and different reasons recorded. The pull toward superior physical facilities offered on sponsored environments attracted non-academic entrepreneurs whilst academic entrepreneurs preferred to contract research for their companies back to their original HEIs where access to physical resources remains unmatched in any comparable sponsored environment external to the HEI (Table 8.4).

8.7 Implications for Stakeholders

The following sections consider the issues, events and processes for future reflection and potential implementation.

8.7.1 Implications for Lead Entrepreneurs

This study and previous literature suggests that firm success and survival benefits from a diversity of human capital. Human capital necessities to identify, evaluate and exploit opportunities vary at different critical junctures in the entrepreneurial process. Lead entrepreneurs, therefore, may want to work on their network of contacts to make themselves more open to potential members from diverse backgrounds. Company 8 offered an example of an engineer (lead non-academic entrepreneur) and academics (team members) collaborating to create a miniaturised laboratory process. The synergy of human capital in this case led to a prompt identification of an opportunity, a clear division of labour within the team, the establishment of a prototype, the beneficial exploitation of academic reputations to investors and promotion of the established company through the academic conference

circuit. Research, however, tells us that academic entrepreneurs have a preference for recruiting like minded team members to reduce conflict. Whilst recognising that human capital homogeneity exists at the opportunity identification phase, lead academic entrepreneurs would benefit from encapsulating team members whose human capital is complementary. Lead non-academic entrepreneurs, on the other hand, would benefit from more open contact with HEIs relating to the use of facilities and access to business advice. All non-academic entrepreneurs in this study did not have immediate access to laboratory facilities (e.g. a deficit in access to physical resources). Company 8, lead by a non-academic entrepreneur, located the company in an HEI at the invitation and agreement of his academic team members and permission from the HEI. Not only did this allow access to laboratory facilities but also allowed time to study the laboratory process to be miniaturised. All lead entrepreneurs exposed to operating in sponsored and non-sponsored environments outside of the HEI environment reported a distinct lack of small laboratory space for new firms. Future resource allocation needs to be considered by policy makers for the provision of such space. HEIs may consider how they utilise their redundant laboratory space by considering leasing arrangements with non-academic entrepreneurs.

8.7.2 Implications for the HEI

The recent over emphasis on "technology push" by HEIs needs to be monitored and routines within HEI institutions balanced between academic and market outputs and requirements. Future commercialisation roles of HEI should be scrutinised (Etzkowitz et al., 2000). Academic entrepreneurs associated with life sciences in particular may benefit from exposure to support routines that integrate internal HEI resources and external non-HEI resources for the exploitation of their identified commercial opportunities. One preliminary possible network bridge may be offered through training. Commercial training already exists within one HEI in Scotland. The Enterprise Fellowship Scheme offers training to life-science scientists who are considering commercialisation. Run in partnership with Scottish Enterprise (SE) and The Royal Society of Edinburgh (RSE), the Enterprise Fellowships Scheme provides academic entrepreneurs committed to creating a firm with a year's salary, business training, development fund and access to networks of mentors, experts and advisors. It is now in its 10th year. Two team members from Companies 2 and 5 had completed this scheme and reported on its benefits for 'starting a company'. Further

benefits from the course are difficult to gauge but would appear to mainly target 'start up.' The Enterprise Fellowship Scheme may provide a platform to provide greater exposure to actors from industry and the investment sector.

More personal interaction with people with market knowledge may lead to an increased identification of new opportunities. Academic researchers networking and interacting with industry players has been associated in the past with firm formation. Evidence of this was exposed when academic entrepreneurs reported meeting industrial representatives during the conference circuit where new knowledge was sourced relating to customer and market mechanisms. Industrial practitioners were also able to gauge research portfolios from HEIs. Information search exploiting the conference circuit may be a topic for future investigation. This implies that new knowledge creation is not just dependent on the technology driven opportunity but also influenced by key industrial players in related areas. Industrial players were perceived in this study to be the providers of funding for HEI research, as potential competitors to HEI created commercial knowledge or potential customers. This was particularly true for lead academic entrepreneurs in the dental and medical device market. Questions for future research might centre on 'how' and 'why' lead academic entrepreneurs source information and make network ties with actors from conference circuits.

Policy-makers would do well to take measure of the importance of the student population within the HEIs. On several occasions lead entrepreneurs paid tribute to the student population as being a source of specifically trained, potential employees but they could also stimulate the identification and development of opportunities for commercialisation. Targeting students may increase the supply of potential entrepreneurs. Following from this are the educational implications and considerations to be given to entrepreneurial specific education for the HEIs, the students and the TTOs. Informal structures could be implemented to introduce academic staff and students to practising academic entrepreneurs where individuals' motivations and incentives could be discussed at networking events. Networking events, hosted by a governmental body (e.g. Connect), were appreciated amongst the lead entrepreneurs interviewed for this study, especially at the early stages of the process.

Encouraging lead entrepreneurs to change their resource configurations as the opportunity identification process progresses could be done in several ways such as establishing cross-disciplinary entrepreneurial teams e.g. combining commercial (business schools) and technological (science faculties) with industrial competencies; co-operation with industry; promoting training for lead academic entrepreneurs and encouraging a cross mobility between industry and the HEI. However, a question remains. Should business school knowledge be taken to the scientists or the scientists taken to the business school? Having a greater non-academic input could expose potential led academic entrepreneurs to the nuances of the commercial world outside of the protected environment of the HEI. This study also revealed a beneficial relationship between Company 5 and a large chemical company which provided two experienced managers to sit on their board. Their technical knowledge about the biological and engineering components behind the product, knowledge and experience of the market place and their known contacts within the sector proved invaluable to the lead academic entrepreneur. This relationship widened his access to information, potential customers, raised the profile of his company prompting good publicity from the media and strengthening applications to funders. Demonstrating the ability to attract well known qualified board members indicated to funders a strengthening of the company's commercial specific human capital. The ability of experienced lead entrepreneurs to help build external networks indicates a future potential method of bridging structural holes between academia and industry. However, critical attention needs to be given to the contentious issue of the commercialisation of research which has been funded from the public purse. This study prompted questions about the ethics of the commercialisation of HEI created knowledge.

The HEI sponsored environment was particularly valuable to lead academic entrepreneurs at opportunity identification because of the access to both commercial advice and specialised laboratory equipment and scientific personnel and a scientific infrastructure. Non-academic entrepreneurs, on the other hand, were attracted to sponsored environments and would have benefitted from earlier access to the R&D facilities within HEIs. In this study, all non-academic entrepreneurs conducting R&D had to dedicate financial resources to refurbish laboratory space when they moved from non-sponsored to sponsored environments. A theme for future consideration

might investigate greater cooperation between non-academic entrepreneurs and access to R&D facilities within HEIs.

8.7.3 Implications for TTOs and Business Advisors

There is scope for information providers (e.g. TTOs and business advisory agencies) to increase access to new information and networks from which informational advantages accrue. Organisational capabilities are required of the information providers to increase resources such as entrepreneurial competence and market knowledge and to widen their links to providers of venture capital funding and specialists from the life-science sector (e.g. surrogate entrepreneurs, advisors, industrial players, governmental regulatory bodies). This study, for example, revealed that those lead entrepreneurs in the medical and dental devices sector had to go to London to access venture capital (Table 8.4). The investment sector in Scotland did not support such applications. Both Companies 3 and 4 had recruited surrogate entrepreneurs whose experience may have been attained in regions of the UK where the life-science sector is in maturity. TTOs could pro-actively encourage more academic entrepreneurs to utilize the skills and knowledge of 'surrogate entrepreneurs' who are not seeking (from the outset) an equity stake in supported entrepreneurial ownership teams (Üçbaşaran et al., 2003; Vanaelst et al, 2006). TTOs and sponsored business development agencies need to widen their networks to identify appropriately experienced 'surrogate entrepreneurs' (Lockett and Wright, 2003). 'Surrogate entrepreneurs' in the life-science sector are at a premium in Scotland and because of their rarity a scheme of implementing a peripatetic 'surrogate entrepreneurship' scheme might be investigated. 'Surrogate entrepreneurs' were attracted to new ventures in Scotland having nurtured other life-science companies and could benefit new companies because their speciality is in the 'establishment' of new companies. Three of the five companies led by academic entrepreneurs in this study reported the benefits of exploiting the specific human capital and social capital resources of surrogate entrepreneurs in terms of prior knowledge of and access to customers or investment sources.

There is also a need to encourage learning and deliver training to the TTO and business development agency staff to deal with the dialectic setting of academia and industry (Lockett and Wright, 2005). Lead academic entrepreneurs in particular

recognised the limitations of TTOs experience. In the case of Company 3 it was recognised that no TTO had had the experience taking a firm public. One option would be to invite relevant stakeholders from mature life-science clusters to impart their knowledge to other clusters that are not so well developed. Another possible strategy could be to introduce industrial practitioners to academics early in the research process and to introduce academics to practitioners who are further down the line. Advisors such as TTOs may also have a role in encouraging more academic entrepreneurs to consider from the outset the markets for their new products and services. In this regard, practitioners advising lead entrepreneurs need skills not just in intellectual property protection, accessing governmental awards and financial feasibility but also in understanding how the diversity of human capital within a team impacts on the entrepreneurial process at different phases of that process. In addition, information and networking activities, sponsored by practitioners, could encourage more academic entrepreneurs to address barriers to opportunity identification. Lead non-academic entrepreneurs, on the other hand, would benefit from additional initiatives that encourage potential co-operation with academics. The experience of engineers and academics coming together to form Company 8 is a flagship for all practitioners in terms of the successful merging of commercial human capital and technological human capital. Non-academic entrepreneurs would also benefit from customers highlighting their needs to entrepreneurial ownership teams who can provide the required technical solutions. Evidence from this research indicates that there is an influential learning cycle occurring when academic entrepreneurs network with industrial players (Companies 3 and 5) and that non-academic entrepreneurs benefit from the technical knowledge of academics (Company8).

8.8 Strengths and Weaknesses of the Study

In addition to the recent proliferation in entrepreneurship research addressing opportunity identification (Shane, 2000; Sarasvathy et al., 2003), the influences of learning (Minniti and Bygrave, 2001; Corbett, 2007) and human and social capital (Davidsson and Honig, 2003; Dimov and Shephard, 2005; Mosey and Wright, 2007) the observable changes in the dynamic external environment, recorded in ‘real time’, may be considered as another component to the entrepreneurial process. Conclusions must, however, be seen in the light of the particular context of the research and from

the view point of those being studied (e.g. the lead academic and non-academic entrepreneurs), the sector in which they operated (e.g. life-science) and the external environment in which they conducted the process (e.g. sponsored and non-sponsored environments). The following sections highlight the strengths and weaknesses associated with the early boundary activities influencing definitions and conceptualisations.

In this study, the entrepreneurial process was defined as one which involved all functions, activities and actions associated with the identification of an opportunity and the creation of an organisation thereafter to pursue it (Bruyat and Julien, 2001). Opportunity identification was defined as the result of a collection of personal, social, cultural, financial and technological resources, which merged leading to the perception of a possible product / process and a potential market (Fletcher, 2006). Opportunities were created imaginatively by combining individual experiences and subjective understanding. The relevance of human and social capital in understanding this process moved personal resources, such as education, prior business ownership and network ties, towards becoming organisation resources (e.g. a combining of these resources to create capabilities and add value to the process) (Druihle and Garnsey, 2001). Centring on these working definitions, this study set boundaries around the industrial sector to be studied, the types of entrepreneurs under investigation and the environments in which they operated.

First, the investigation of the life-science sector encompassed all researchers and / or firms in the field of biotechnology, pharmaceuticals, biomedical technologies, medical devices, food processing, environmental and biomedical devices (Smith, 2004) and was chosen because it has been identified as growth industrial sector for a peripheral economy in Europe (i.e., Scotland) (Scottish Enterprise, 1994, 1996). Firms were involved in some form of R&D and suppliers of life-science equipment and service organisations eliminated. In addition, since the external conditions were considered to be similar over all cases the numbers needed to be explored were deemed fewer. However, future studies need to be more specific about which sector in life-science is being studied. This would allow for a multi-resource examination of a narrower section of the literature (e.g. that associated with the research and development of medical or dental devices; ventures involved in DNA separation).

Further studies examining the impact of the phase of firm formation and resources accumulation for opportunity identification in these specific sectors of life-science are undoubtedly specialised and required.

Second, my definition of the lead academic entrepreneur as an academic or researcher whose occupation, prior to playing a leading role in an enterprise start-up, and possibly concurrent with that process, is or was that of an academic, clinician or researcher, affiliated with an HEI (Samson and Gurdon, 1993) guaranteed a consistency in choice of lead entrepreneurs, who were the main unit of analysis. The non-academic entrepreneur was defined as a person who was previously employed in the same industry sector and who identified opportunities in the life science sector. Third, the definition adopted for this study required team members to have jointly established the firm with the lead entrepreneur; to have a financial interest in the firm and direct influence on strategic choice in the firm (Ensley et al., 1990). During this study, non-equity members such as TTOs were also considered members because of their importance to the process but only for a limited time. The original definition should have made provision for the role of team members who are motivated not because of holding an equity stake but because their employers dictate that it is part of their job to support potential firms and to care take the HEI's stake in the business.

Fourth, the emphasis on events and behaviour leading to opportunity identification lent itself to a process theory approach where explanation for change was based on information from the lead entrepreneurs and team members. Change, including change in team membership, change in external environment, change in the opportunity identification process and changes in what product to offer the market unfolded as narratives were elicited from participants in the cases about the perceptions of events leading to opportunity identification. Process theory encompasses behaviours and events where time ordering is critical to addressing 'why', 'how', 'where' and 'when' questions. Three complementary theories enhanced the study of the opportunity identification process. The human capital perspective linked past relevant experiences of lead entrepreneurs, such as prior business ownership to their opportunity identification behaviour (i.e. a process). Social capital theory determined that certain networks of relationships were valuable resources for conducting the entrepreneurial process (i.e. a condition) and lastly the RBV

perspective related the entrepreneurs' ability to draw on and combine new resources leading to firm formation (i.e. an event). In this light, the entrepreneur was seen as an evolving entity balancing existing internal and external resources and developing new ones.

In this study the individual academic and non-academic entrepreneur encompassed the central unit of analysis because prior to firm formation and during the opportunity identification process, they were the main and sometimes the only resource. Opportunities identified by lead academic entrepreneurs with sophisticated technical knowledge and with technology driven competitive advantage, suffered from a lack of complementary commercial capabilities and had to source these either through team members or from the external environment (Colombo and Grilli, 2005). During the course of the research, team members associated with the lead entrepreneur were interviewed to elicit additional views about the opportunity identification process (i.e., as in respondent triangulation). The constraint of only collecting data from 9 cases is recognised but since the study relied on theoretical sampling, each type of entrepreneur and type of environment was covered as illustrated in the developed typology (Figure 4.3). However, based on the classification of the other firms identified during the initial email survey, results could be generalised to the 28 valid respondents identified as being close to the opportunity identification phase (Figure 4.12). Capturing further data on opportunity identification from these firms would have to be conducted retrospectively because it may be assumed that they have 'changed' since the time of the email survey. In this study, the data was collected from personal interviews but a weakness of such an approach, when dealing with events in retrospect, is that people are open to bias, hindsight, rationalisations and memory flaws. In future, interviews should be sought prior to the intention or consideration of entrepreneurial action. This is perhaps feasible for the potential academic entrepreneur who is more easily identifiable than the non-academic entrepreneur.

In addition, the research encompassed three critical junctures in the entrepreneurial process (e.g. opportunity identification, entrepreneurial commitment and venture credibility) (Vohora et al., 2004) even although the intention was to study entrepreneurs at opportunity identification. This came about because the division

between the junctures and growth phases overlapped and progress from one to the other was not linear or in one direction. Original identified opportunities were found to change or evolve over real time and the opportunity identification phase was persistently revisited. Often this occurred when new market knowledge was uncovered. It is speculated that if the entrepreneurs were interviewed again it is unlikely that their original plan, product or process would remain unchanged. One outstanding issue for the lead entrepreneurs in the life-science sector which remained relevant throughout the research was 'what' they should commercialise (e.g. a completed product, a process, a prototype or a licence to their knowledge). The lead entrepreneurs fluctuated between opportunity identification, evaluation and early stage exploitation because they were researching and developing a product or process which was not separate but part of the entrepreneurial process. In addition, the investors financing R&D lacked access to managers with appropriate human capital to care-take certification and regulatory protocol (e.g. for medical devices). This limitation may also be seen as an opening to return to individual 'surrogate entrepreneurs' or implanted CEOs to research 'how' they support their latest venture, to explore past records and to conduct human and social capital comparisons amongst these special and important 'privileged witnesses' (Vanealst et al., 2006). The experience of venture capital managerial expertise in Company 4, with networks of contacts to assist the lead academic entrepreneurs to participate in a domain in which the latter lacked autonomous expertise, proved to be futile and contrary to benefits presented in past research (Colombo and Grill, 2005).

The omission to quantify financial related assistance may also be considered a weakness of this study. In at least two cases, lead academic entrepreneurs were awarded substantial financial resources due in part to their academic excellence and reputation. As indicated in the propositions, those with greater educational human capital and academic achievement were in a better position to acquire funds. However, there is a human capital factor to further explore when it comes to managing funding. It would appear that, at these early stages, the lead entrepreneur who recruited people with relevant experience (e.g. surrogate entrepreneurs) were better equipped to use and manage funding appropriately and according to the requirements of the investors. Further research exploring the importance of human capital in the management of financial capital warrants investigation. This study offered an

example of a major investor withdrawing support after agreed milestones in R&D failed to materialise.

The reluctance of the investment sector in Scotland to provide funds to some entrepreneurs in this study is also worthy of further examination. Where had the surrogate entrepreneurs in this study extrapolated experience and with what investors? As already stated the life science sector in Scotland is some 10 years behind that of the USA (Forbes and Low, 2004) and there will be by definition fewer surrogates with relevant experience. The research did not measure progress or success in any quantifiable manner because the lead entrepreneurs and their firms were close to opportunity identification. Initial funding was awarded through a government grant scheme and open to public scrutiny but this changed when presenting proposals to venture capitalists or business angels. Outcomes depended on the social networks and specific commercial human capital attributes embedded in surrogate entrepreneurs who had prior investor contact.

8.9 Recommendations for Future Research

In this study sourcing surrogate entrepreneurs was a process conducted in conjunction with or exclusively by the business development agencies. It was noted however, that recommendations were only made to lead academic entrepreneurs and non-academic entrepreneurs did not appear to be eligible for such offers. Future research might study how it could be possible to link non-academic entrepreneurs, who may come from a predominantly scientific industrial background, to surrogate entrepreneurs. Some non-academic entrepreneurs displayed as little business acumen as lead academic entrepreneurs but were respected scientists in their own right (e.g. scientists creating cell-lines). Future studies should therefore focus on the differences between social capital and the role of surrogate entrepreneurs and relate this to their human capital derived from their past commercial experiences at different phases of the opportunity identification process to add to the debate about demand side issues. Such a study may reveal why non-academic entrepreneurs are excluded from surrogates networks.

Wealth creation multipliers associated with opportunities identified and pursued in the four conceptualized environmental contexts could be explored in the future and quantified. Additional research is warranted to look at whether particular contexts are associated with higher levels of research productivity (Siegel et al., 2003) relating to the HEI and industry commercialisation process and the cost effectiveness of the opportunity identification process needs also to be monitored with reference to the four conceptualized contexts. The time dimension relating to the entrepreneurial process is also attracting attention (Jones and Coviello, 2005) and linkages between access to resources and the speed of the entrepreneurial process measured.

Recommendations made by other studies about entrepreneurs committing 100% to their new start-ups are considered unappreciative of, and inappropriate for, the clinical, academic, advisory and administrative work of the academic entrepreneurs leading firms in this investigation. Clinicians, for example, who were the lead academic entrepreneurs of such companies, did not and could not resign from their medical / dental jobs. In their firms there was also a recognised lack of access to information and knowledge about the regulatory field specific to the testing of new medical devices which the clinicians and investors were not fully conversant with. Additionally, these firms required a much larger and higher initial investment. Cognisance of these differences and difficulties warrants examination.

Another avenue for exploration is the comparison of benefits of experiential learning from within HEI environments where there has traditionally been a culture of support through TTOs, other academics and cross departmental co-operation, to external environments where no resource support for commercialisation was offered e.g. within a hospital trust. It is difficult to imagine that the NHS can become involved in investing cash into product development and difficult to imagine how the NHS could negotiate effectively with interested HEIs as equal potential partners in medical research. The introduction of commercialisation into traditionally non-commercial environments may have negative consequences on science and the scientific discovery system. Some studies have aired concern about the effect on culture and the use of public funding and facilities (Klöfsten and Jones-Evans 1999). Further investigation into the relationship between the non-commercial institutions, from which ideas and opportunities evolve, the lead entrepreneur, industry and their

industrial counterpart (see Siegel et al., 2007) may reveal uneven power relationships relative to commercial gain and academic recognition. The dialectic relationship between academic and industrial culture could be given more attention if policy-makers continue to support the commercialisation of HEI knowledge and if the culture of the entrepreneurial HEI continues (Etzkowitz et al., 2000).

The use of a process-based study allowed a rich investigation of the reasons behind events and did not predetermine answers by offering a list of options. In addition, this study observed changes over time and sought reasons for changes over time (e.g. changes to the external environment). However, the use of theoretical sampling did not allow for generalisation of a statistical nature to be made across a predefined population. The sample was a diverse array of life-science projects located within a recognised life-science triangle between Glasgow, Edinburgh and Dundee which was controlled by a national policy towards commercial activities in the sector. It provides, however, a useful foundation upon which the understanding of opportunity identification in the life-science sector is based and may be further advanced. National and regional variations may influence how opportunities in the life-science sector are identified. Notwithstanding, this study could be replicated in other countries. Extending it to the USA, for example, where the concept of sponsored environments and the commercialisation of HEI knowledge originated, may reveal influences from differences in culture, attitude towards entrepreneurship, policies and resources found in the external environment.

In addition, there exists a fruitful opportunity for an investigation of human and social capital using a quantitative approach. If, for example, human capital was categorised (e.g. entrepreneurial experience, prior business ownership, prior business formation, parental entrepreneurial influence, managerial experience etc.) additional knowledge could be garnered about the affect of human capital on opportunity identification within the four contexts (Colombo and Grilli, 2005). Positive relationships could be measured between educational levels and opportunity identification, and educational achievement and access to and success in gaining venture funding. Research question 9 could also be addressed quantitatively to investigate if sponsored environments have an impact on entrepreneurs' access to resources. Using a larger sample we would be able to measure access to and quantify

resources such as financial, physical, technical, marketing and business skills, people and social capital. However, this was beyond the scope of this study because I used a phenomenological paradigm and theoretical sampling which led to the formation of propositions.

8.10 Summary

This study introduced a novel typology differentiating entrepreneurs and conceptualising different external environments. Similar information did not exist prior to the electronic survey conducted to collect resource profiles of individual types of entrepreneur (e.g. academic or non-academic) and individual types of external environment (e.g. sponsored or non-sponsored) within the life-science sector in Scotland. All participating entrepreneurs were close to opportunity identification and had not started trading. The novel typology created to capture differences was extended to map the location changes recorded during the longitudinal study. Change occurred because some moves were 'forced' (e.g. the push imposed by the rules of the HEI). Some moves were 'voluntary' (e.g. pulled towards resources). At other times change was a reaction against negative influences from fellow academics to the commercialisation of HEI knowledge (i.e. voluntary) and some were deliberately planned and focused. Some moves were 'desired' but not easily attainable as was the case with non-academics seeking sponsored environments (e.g. pulled toward resources). Moves between non-sponsored environments were always seen as stop-gap or 'temporary' changes (Figure 7.6). Resistance to commercialising HEI knowledge from fellow academics is perhaps a reflection on a negative attitude towards entrepreneurship in Scotland which is less than other regions in the UK (Scottish Enterprise, 1994, 1996). Mosey et al., (2006) has already claimed that unexploited structural holes exist not only between networks external to HEIs (Hoang and Antoncic, 2003) but between many academic and this has a negative impact on the university commercialisation process.

Another significant contribution of this study is its reliance on a paradigm which gave the entrepreneurs and team members a voice to answer questions grounded in the literature about opportunity identification which has not been fully explored. The dominant paradigm in entrepreneurship is positivistic (Gartner and

Birley, 2002) but this study adopted a phenomenological outlook searching for reasons behind actions and behaviours. Opportunity identification was found to be pre-empted by a pre-opportunity phase whereby interested potential team members discussed and planned potential cooperation with the lead entrepreneur. Although recorded as a research phase in prior literature (Vohora et al., 2004) this pre-opportunity identification phase was used to enhance firm formation possibilities, through social networking more than to enhance research and development of the potential product or process.

Insights about specific and general human capital indicated significant differences in value at different times during the iterative opportunity identification processes. Academic entrepreneurs exhibited an initial over reliance on general human capital, centred on their technological knowledge, at the opportunity identification phase prior to a realization that actors with specific human commercial capital were a requisite factor in the substantiation of their perceived idea. Non-academic entrepreneurs generally exhibited the contrary and began the process with strong specific human capital related to business experience which they had to support by searching for actors with general human capital relating to scientific knowledge.

Social networking was found to be more dominant in lead academic and non-academic entrepreneurs located on non-sponsored environments which indicated an exploitation of social capital and a broader social network (Mosey and Wright, 2007), or an elevated 'social condition' (Anderson et al., 2007). This was based on prior business ownership and past network ties rather than an advantageous component of their human capital, a finding recently substantiated in research focusing specifically on the significance of social capital (Mosey and Wright, 2007). Academic entrepreneurs on sponsored environments encountered structural holes between their scientific network and access to a commercial advisory network which constrained the opportunity identification process. Regardless of whether the entrepreneur was academic or non-academic, prior business ownership was essential to learn about contact, establish relationships and become known to potential equity providers. Academic reputation and level of education influenced equity providers' decisions to support academic entrepreneurs with no prior business ownership experience. No similar evaluation of non-academics' human capital was observed even although some

non-academic entrepreneurs were scientists. This leads me to believe that it was reputation rather than educational attainment which influenced equity providers.

In addition, the value of the resources provided through social network actors (like TTOs) was restricted to certain critical junctures. Resources associated with start up (e.g. access to advisory services related to funding and legal issues) were important at opportunity identification and entrepreneurial commitment phases but thereafter entrepreneurs were guided to new sources of direction from other resources providers (e.g. surrogate entrepreneurs and business development agencies). There was deterioration in some social capital (Lester et al., 2008) and that, not unlike human capital, social capital had a different value at different critical junctures. Consequently, the study enhanced understanding about the influence of not only human capital but the centrality of social capital to seeking and leveraging resources.

On the basis of the findings further understanding of differences between lead academic and non-academic entrepreneurs has been made in terms of their access to resources and how this is influenced by human and social capital inputs and their access to supportive or sponsored external environments. Several recommendations have been presented to both practitioners and a number of policy recommendations implied. Whilst the information induced from the data did not quantify financial assistance, access to private investors was highlighted as being more difficult for the non-academic entrepreneur. However, suggestions about 'soft' support issues such as the provision of laboratory space and access to business advice were questioned. Based in the identified needs of lead entrepreneurs and the observation about the life-science cluster in Scotland being in its infancy, recommendations about training for TTOs and business advisors were presented as was a heightened contact with surrogate entrepreneurs. The study has offered points in an agenda for future research in the area.

BIBLIOGRAPHY

Aldrich, H. E. (1999). *Organizations Evolving*. London, Sage.

Aldrich, H. E. (2001). "Who wants to be an evolutionary theorist?" *Journal of Management Inquiry* 10(2): 115-127.

Aldrich, H. E. and T. Baker (1997). Blinded by cites? Has there been progress in entrepreneurship research? *Entrepreneurship 2000*. D. L. Sexton, Smilor, R.W. Chicago, Upstart Publishing: 377-400.

Aldrich, H. E. and M. Fiol (1994). "Fools rush in? The institutional context of industry creation." *Academy of Management Review* 19(4): 645-670.

Allen, S.D., Link, A.N. and D. T. Rosenbaum (2007). "Entrepreneurship and human capital: Evidence of patenting activity from the academic sector." *Entrepreneurship, Theory and Practice* 31(6): 937-951.

Alvarez, S. A. and L. W. Busenitz (2001). "The entrepreneurship of resource-based theory." *Journal of Management* 27(6): 755-775.

Alvesson, M. and S. Deetz (2001). *Doing Critical Management Research*. London, Sage.

Amit, R. and P. H. J. Schoemaker (1993). "Strategic assets and organisational rents." *Strategic Management Journal* 14(1): 33-46.

Anderson, A., Park, J. and S. Jack (2007). "Entrepreneurial Social Capital." *International Small Business Journal* 25(3): 245-272.

Anderson, A. R. and S. L. Jack (2002). "The articulation of social capital in entrepreneurial networks: A glue or a lubricant?" *Entrepreneurship and Regional Development* 14(3): 193-210.

Anon (2002). UK, Biotechnology Industry. House of Commons. London. HC 87.

Anon (2004). *The Work of the Biotechnology and Biological Sciences Research Council. Third Report of the Session 2003-2004*. London. House of Commons Science and Technology Committee. HC6.

Ardichvili, A., Cardozo, R.N., and S. Ray (2003). "A theory of entrepreneurial opportunity identification and development." *Journal of Business Venturing* 18(1):
105-123.

Arrow, K. (1962). "The economic complications of learning by doing." *Review of Economic Studies* 29(3): 153-173.

Audretsch, D. B. (2001). "Research issues relating to structure, competition, and performance of small technology-based firms." *Small Business Economics* 16(1): 37-51.

Autio, E. (1997). "New technology-based firms in innovation networks symplectic and generative impacts." *Research Policy* 26(2): 263-281.

Baker, T., Miner, A.S., and D. T. Eesley (2003). "Improvising firms: bricolage, account giving and improvisational competencies in the founding process." *Research Policy* 32(2): 255-276.

Barbieri, P. (2003). "Social capital and self-employment: A network analysis experiment and several considerations". *International Sociology* 18(4):681-701.

Barney, J. (1986). "Strategic Factor Markets. Expectations, Luck and Business Strategy" *Management Science* 32(10): 1231-1241.

Barney, J. (1991). "Firm resources and sustained competitive advantage." *Journal of Management* 17(1): 99-120.

Barney, J., Wright, M., J. Ketchen, et al. (2001b). "Special issue-The resource-based view of the firm: Ten years after 1991." *Journal of Management* 27(6): 625-642.

Barney, J. B. (2001a). "Is the resource-based "view" a useful perspective for strategic management research? Yes." *Academy of Management Review* 26(1): 41-56.

Baron, R. A. and M. D. Ensley (2006). "Opportunity recognition as the detection of meaningful patterns: Evidence from comparisons of novice and experienced entrepreneurs." *Management Science* 52(9): 1331-1344.

Bates, T. (1990). "Entrepreneurial human capital inputs and small business longevity." *Review of Economics and Statistics* 72(4): 551-559.

Bates, T. (1995). "Self employment entry across industry groups." *Journal of Business Venturing* 10(6): 143-156.

Baum, J. A. C. and B. S. Silverman (2004). "Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups." *Journal of Business Venturing* 19(3): 411-436.

Becker, G. S. (1993a). *Human Capital. A theoretical and empirical analysis with special reference to education.* New York, National Bureau of Economic Research.

Becker, G. S. (1993b). "Nobel Lecture: The Economic Way of Looking at Behavior." *The Journal of Political Economy* 101(3): 385-409).

Bergmann Lichenstein, B. M. B. and C. G. Brush (2001). "How do "resource bundles" develop and change in new ventures? A dynamic model

and longitudinal exploration." *Entrepreneurship Theory & Practice* 25(3): 37-58.

Bickman, L. and D. J. Rog (1998). *Handbook of Applied Social Research Methods*. London, Sage.

Biotechnology and Biological Sciences Research Council (BBSRSC) (2004/2005). *Operating Report*.

Birley, S. (2002). "Universities, Academics, and Spinout Companies: Lessons from Imperial." *International Journal of Entrepreneurship Education* 1(1): 1-21.

Birley, S. and S. Stockley (2000). Entrepreneurial Teams and Venture Growth. *The Blackwell Handbook of Entrepreneurship*. D. L. Sexton and H. Landstorm. Oxford, Blackwell: 287-307.

Blackler, F. (1995). "Knowledge, knowledge work and organizations: An overview and interpretation." *Organization Studies* 16(6): 1021-1046.

Bontis, N., Dragonetti, N.C., Jacobsen, K and G. Roos (1999). "The knowledge toolbox: A review of the tools available to measure and manage intangible resources." *European Management Journal* 17(4): 391-402.

Bower, D. J. (2002). "Matching technology push to market pull: strategic choices and the academic spinout firm." *International Journal of Entrepreneurship and Innovation Management* 2(4/5): 339-353.

Bower, D. J. (2003). "Business model fashion and the academic spinout firm." *R & D Management* 33(2): 97-106.

Bozeman, B. and Mangematin, V. (2004). "Editor's introduction: Building and developing scientific and technical human capital. *Research Policy* 33(4): 565-568.

Bray, M. J. and J. N. Lee (2000). "University revenues from technology transfer: Licensing fees vs. equity positions." *Journal of Business Venturing* 15(5-6): 385-392.

Breton, G. and M. Lambert (2003). *Universities, Globalization: Private Linkages, Public Trusts*. Quebec, Unesco Publishing, Universite Laval, Economica.

Brüderl, J., Preisendörfer, P. and R. Ziegler (1992). "Survival chances of newly founded business organisations." *American Sociological Review* 57(2): 227-242.

Brush, C. G., Greene, P.G. and M. M. Hart (2001). "From initial idea to unique advantage: The entrepreneurial challenge of constructing a resource base." *Academy of Management Executive*. 15(1): 64-80.

Bruton, G. D. and Y. Rubanik (2002). "Resources of the firm, Russian high-technology startups, and firm growth." *Journal of Business Venturing* 17(6): 553-576.

Bruyat, C. and Julien. P. A. (2001). "Defining the field of research in entrepreneurship." *Journal of Business Venturing* 16(2): 165-180.

Bryman, A. B. (2001). *Social Research Methods*. Oxford, Oxford University Press.

Burrell, G. M. and G. Morgan (1979). *Sociological Paradigms and Organisational Analysis*. London, Heinemann Educational Books.

Burt, R.S. (1992). *Structural Holes: The Social Structure of Competition.* Cambridge, MA, Harvard University Press.

Busenitz, L. W., West III, P., Shepherd, D., Nelson, T., Chandler, G. and A. Zacharakis (2003). "Entrepreneurship research in emergence: Past trends and future directions." *Journal of Management* 29(3): 285-309.

Carayannis, E. G., Rogers, E. G., Kurihara, K. and M. M. Allibritton (1998). "High technology spin offs from government R&D laboratories and research universities." *Technovation*, 18(1): 1-11.

Carlsen, S. (2000). Biotechnology Contributes to Sustainable Development. *Ernst and Young's Seventh Annual European Life-sciences Report, 2000*. G. Cocker, C. Keenan, and M. Warde. London, Ernst and Young International.

Carlsson, B. (2002). "Institutions, entrepreneurship and growth: Biomedicine and polymers in Sweden and Ohio." *Small Business Economics* 19(1): 105-121.

Carpenter, M. A., Sanders, W.G. and H. B. Gregersen (2001). "Bundling human capital with organizational context: the impact of international assignment experience on multinational firm performance and CEO pay." *Academy of Management Journal* 44(3): 493-511.

Carter, N., Gartner, W.B. and P. D. Reynolds (1996). "Exploring start-up event sequences." *Journal of Business Venturing* 11(6): 151-166.

Casson, M. (2003). *The Entrepreneur: an Economic Theory*. Cheltenham, UK, Edward Elgar.

Castanias, R. P. and C. E. Helfat (1991). "Managerial resources and rents." *Journal of Management* 17(1): 155-171.

Chandler, G. and S. H. Hanks (1998). "An examination of the substitutability of founders human and financial capital in emerging business ventures." *Journal of Business Venturing* 13(5): 353-369.

Chandler, G., Honig, B. and J. Wiklund (2005). "Antecedents, moderators, and performance consequences of membership change in new venture teams." *Journal of Business Venturing* 20(5): 705-725.

Chandler, G. N., Dahlqvist, J. and P. Davidsson (2002). Opportunity Recognition Processes: A Taxonomy and Outcome Implications. *Frontiers of Entrepreneurship Research*. Wellesley: MA, Babson College: 38-48.

Chandler, G. N. and S. H. Hanks (1991). How important is experience in a highly similar industry? *Frontiers of Entrepreneurship Research*. N. C. Churchill. Wellesley: MA, Babson College: 1-10.

Chandler, G. N. and D. Lyon (2001). Entrepreneurial teams in new ventures: composition, turnover and performance. *Academy of Management Conference Proceedings*. Washington DC. August 2001.

Chell, E. (1985). "The entrepreneurial personality: A few ghosts laid to rest?" *International Small Business Journal* 3(3): 43-54.

Chell, E. and K. Allman (2003). "Mapping motivations and intentions of technology orientated entrepreneurs." *R & D Management* 33(2): 117-134.

Chiesa, V. and A. Piccaluga (2000). "Exploitation and diffusion of public research: The case of academic spin-off companies in Italy." *R&D Management* 30(4): 329-339.

Churchill, N. C. and V. L. Lewis (1983). "Growing concerns: The five stages of small firm growth." *Harvard Business Review* May-June: pp. 31, 32, 34, 40.

Clarysse, B. and N. Moray (2004). "A process study of entrepreneurial team formation: the case of a research-based spin-off." *Journal of Business Venturing* 19(1): 55-79.

Clarysse, B., Wright, M., Lockett, A., Van de Velde, E. and A. Vohora (2005). "Spinning out new ventures: A typology of incubation strategies from European research institutions." *Journal of Business Venturing* 20(2): 183-216.

Cohen, W. M. and D. A. Levinthal (1990). "Absorptive capacity: A new perspective on learning and innovation." *Administrative Science Quarterly* 35(1): 128-152.

Collis, D. (1994). "How valuable are organizational capabilities?" *Strategic Management Journal* 15(S1): 143-152.

Collis, J. and R. Hussey. (2003). *Business Research; A practical guide for undergraduate and postgraduate students*. Basingstoke, Hampshire, Palgrave.

Colombo, M. G. and M. Delmastro (2002). "How effective are technological incubators? Evidence from Italy." *Research Policy* 31(7): 1103-1122.
Colombo, M. G. and L. Grilli (2005). "Founder's human capital and growth of new technology-based firms: A competence-based view." *Research Policy* 34(6): 795-816.

Colquitt, J. A. and C. P. Zapata-Phelan (2007). "Trends in theory building and theory testing: A five-decade study of the Academy of Management Journal." *Academy of Management Journal* 50(6): 1281-1303.

Cooke, P. (2001). "Biotechnology clusters in the UK: Lessons from localisation in the commercialisation of science." *Small Business Economics* 17(1-2): 43-59.

Cooney, T. M. (2005). "Editorial; What is an entrepreneurial team?" *International Small Business Journal* 23(3): 226-235.

Cooper, A. C. and A. V. Bruno (1977). "Success among high tech firms." *Business Horizons* 20(2): 16-23.

Cooper, A. C. and C. M. Daily (1997). Entrepreneurial Teams. *Entrepreneurship 2000*. D. L. Sexton and R. W. Smilor. Chicago, Upstart: 127-150.

Cooper, A. C., Woo, C.Y. and W. C. Dunkelberg (1989). "Entrepreneurship and the initial size of firms." *Journal of Business Venturing* 4(5): 317-132.

Cooper, A. C., Gimeno-Gascon, F.J. and C. Y. Woo (1994). "Initial human and financial capital as predictors of new venture performance." *Journal of Business Venturing* 9(5): 371-395.

Cope, J. (2005). "Researching entrepreneurship through phenomenological inquiry." *International Small Business Journal* 23(2): 163-189.

Cope, J. and G. Watts (2000). "Learning by doing. An exploration of experience, critical incidents and reflection in entrepreneurial learning." *International Journal of Entrepreneurial Behaviour & Research* 6(3): 104-124.

Corbett, A. C. (2007). "Learning asymmetries and the discovery of entrepreneurial opportunities." *Journal of Business Venturing* 22(1): 97-118.

Costello, N. (1996). "Learning and routines in high-tech SMEs: analysing rich case study material." *Journal of Economic Issues* 30(2): 591-597.

Creswell, J. W. (1998). *Qualitative Inquiry and Research Design: Choosing among Five Traditions*. London and Thousand Oaks, CA, Sage.

Crosa, B., Aldrich, H.E. and L. A. Keister (2002). Is there a wealth affect? Financial and human capital as determinants of business startups. *Frontiers*

of Entrepreneurship Research, Wellesley, MA: Centre for Entrepreneurial Studies, Babson College.

Cyr, L. A., Johnson, D.E. and T. M. Welborne (2000). "Human resources in initial public offering firms: Do venture capitalists make a difference?" *Entrepreneurship Theory and Practice* 25(1): 77-91.

Davenport, S., Carr, A. and D. Biddy (2002). "Leveraging talent: Spin-off strategy at industrial research." *R&D Management* 32(3): 241-254.

Davidsson, P. and B. Honig (2003). "The role of social and human capital among nascent entrepreneurs." *Journal of Business Venturing* 18(3): 301-331.

Davidsson, P. and J. Wiklund (2000). "Level of analysis in entrepreneurship research practice and suggestions for the future." *Entrepreneurship, Theory and Practice* 25(4): 81-100.

Deakins, D. and M. Freel (1998). "Entrepreneurial learning and the growth process in SMEs." *The Learning Organisation* 5(3): 144-155.

Debackere, K. (2000). "Managing academic R&D as a business at K.U. Leuven: context, structure and process." *R&D Management* 30(4): 323-328.

Degroof, J. J. (2002). *Spinning off new ventures from research institutions outside high tech entrepreneurial areas*. Unpublished Doctoral Thesis. Cambridge, MA, Massachusetts Institute of Technology.

Degroof, J. J. and E. B. Roberts (2003). "Spinning-off new ventures from academic institutions in areas with weak entrepreneurial infrastructure: Insights on the impact of spin-off processes on the growth-orientation of ventures." Social Science Research Network Electronic Paper Collection Working Paper.

Del Canto, J. G. and I. S. Gonzalez (1999). "A resource-based analysis of the factors determining a firm's R&D activities." *Research Policy* 28(8): 891-905.

Delivering the Commercialisation of Public Sector Science HC 580 (2001-2002).

Delmar, F. and S.A. Shane (2004). "Legitimating first: Organizing activities and the survival of new ventures." *Journal of Business Venturing* 19(3): 385-410.

Denzin, N. K. and Y. S. Lincoln (1998). *Handbook of Qualitative Research*. Thousand Oaks, CA, Sage.

Department for Employment and Learning (DEL) (2004). *Higher Education-Business Interaction Survey 2001-02*. Department for Employment and Learning.

Department of Trade and Industry (DTI) (1999a). *Biotechnology Clusters*. London, Department of Trade and Industry.

Department of Trade and Industry (DTI) (1999b). *Genome Valley: The Economic Potential and Strategic Importance of Biotechnology in the UK*. Department of Trade and Industry. 1-64.

Department of Trade and Industry (DTI) (1999c). *Our Competitive Future: UK Competitiveness Indicators 1999*. Department of Trade and Industry. 1-64.

Department of Trade and Industry (DTI) (2003). *Select Committee on Trade and Industry Twelfth Report.* Department of Trade and Industry.

Department of Trade and Industry (DTI) (2000). *Excellence and Opportunity: a Science and Innovation Policy for the 21st Century*. London: The Stationery Office. 1-57.

Department of Trade and Industry (DTI) (2005). *Comparative Statistics for the UK, European and US Biotechnology Sectors: Analysis Year 2003*. Department of Trade and Industry.

DiGregorio, D. and S. Shane (2003). "Why do some universities generate more start-ups than others?" *Research Policy* 32(2): 209-227.

Dimov, D. P. and D. A. Shepherd (2005). "Human capital theory and venture capital firms: Exploring home runs and strike outs." *Journal of Business Venturing* 20(1): 1-21.

Djokovic, D. and V. Souitaris (2006). "Spinouts from academic institutions: A literature review with suggestions for further research." [online] *The Journal of Technology Transfer*. Springer Netherlands. Available at: http://www.springerlink.com/content/01763u2811r13351/ (25-09-07).

Druilhe, C. and E. Garnsey (2001). Academic Spin-off Ventures: A Resource Opportunity Approach. *New Technology-Based Firms in the New Millennium*. D. During, Oakey, W. and S. Kauser. London, Pergamon: 175-190.

Druilhe, C. and E. Garnsey (2004). "Do academic spin-off firms differ and does it matter?" *Journal of Technology Transfer* 29(3-4):269-285.

Dyer, W. G. and A. L. Wilkins (1991). "Better stories, not better constructs, to generate better theory: a re-joiner to Eisenhardt." *Academy of Management Review* 16(3): 613-619.

Easterby-Smith, M., Thorpe, R. and A. Lowe (1997). *Management Research: An Introduction*. Sage Publications.

Eckhardt, J. T. and S. A. Shane (2003). "Opportunities and Entrepreneurship." *Journal of Management* 29(3): 333-349.

Eisenhardt, K. M. (1989). "Building theories from case study research." *Academy of Management Review* 14(4): 532-550.

Eisenhardt, K. M. (1991). "Better stories and better constructs: The case for rigor and comparative logic." *Academy of Management Review* 16(3): 620-627.

Eisenhardt, K. M. and L. J. Bourgeois (1988). "Politics of strategic decision making: Towards a midrange theory." *Academy of Management Journal* 31(4): 737-771.

Eisenhardt, K. M. and M. E. Graebner (2007). "Theory building from cases: Opportunities and challenges." *Academy of Management Journal* 50(1): 25-32.

Eisenhardt, K. M. and J. A. Martin (2000). "Dynamic capabilities: What are they?" *Strategic Management Journal* 21(10/11): 1105-1121.

Eisenhardt, K. M., Schoonhoven, C. and C. Bird (1990). "Organizational growth: Linking founding team, strategy, environment and growth among U.S. semiconductor ventures, 1978-1988." *Administrative Science Quarterly* 35(3): 504-529.

Ensley, M. D., Carland, J.C., Carland, J.W. and M. Banks (1999). "Exploring the existence of entrepreneurial teams." *International Journal of Management* 16(2):
276-286.

Ensley, M. D., Carland, J.W. and J.C. Carland (2000). "Investigating the existence of the lead entrepreneur." *Journal of Small Business Management* 38(4): 59-77.

Ernst and Young (2003). *Endurance: the European Biotechnology Report 10th Anniversary Edition*.

Ernst and Young. (2004). *Beyond Borders: The Global Biotechnology Report 2004.*

Etzkowitz, H., Webster, A., Gebhardt, C. and Cantisano Terra, B.R. (2000). "The future of the university and the university of the future: Evolution of the ivory tower to entrepreneurial paradigm." *Research Policy* 29(2): 313-330.

Evans, D. and L. Leighton (1989). "Some empirical aspects of entrepreneurship." *American Economic Review* 9(3): 519-535.

Fama, E. and M. Jensen (1983). "Separation of ownership and control." *Journal of Law and Economics* 26(2): 301-325.

Faulkner, W., Senker, J. and L. Velho (1995). *Knowledge Frontiers. Public Sector Research and Industrial Innovation in Biotechnology, Engineering Ceramics, and Parallel Computing*. Oxford, Claredon Press.

Felnstien, D. (1994). "University-related science parks –'Seedbeds' or 'Enclves' of innovation." *Technovation* 14(22): 93-110.

Fernandez, E., Montes, J.M. and C. J. Vazquez (2000). "Typology and strategic analysis of intangible resources. A resource-based approach." *Technovation* 20(2): 81-92.

Fetterman, D. M. (1998). *Ethnography step by step*. California: Thousand Oakes.

Fletcher, D. E. (2006). "Entrepreneurial processes and the social construction of opportunity entrepreneurship and regional development." *Entrepreneurship and Regional Development* 18(5): 421-440.

Flynn, D. M. (1993). "A critical exploration of sponsorship, infrastructure, and new organisations." *Small Business Economics* 5(2): 129-156.

Fontana, A. and J. Frey (1994). Interviewing: the Art of Science. *Handbook of Qualitative Research*. N. K. Denzin and Y. S. Lincoln. Thousand Oaks, CA, Sage.

Forbes, D. P., Borchert, P. S. Zellmer-Bruhn, M. E. and H. J. Sapienza. (2006). "Entrepreneurial team formation: An exploration of new member addition." *Entrepreneurship Theory and Practice* 30(2): 225-248.

Forbes, T. and G. Low (2004). "Strategy characteristics and biotechnology: Observations from the Scottish biotechnology sector." *Entrepreneurship and Innovation* 5(3): 179-190.

Foss, N. J. (1997). Resources and Strategies: Problems, Open Issues and Ways Ahead. Resources, Firms and Strategies: *A Reader in the Resource-Based Perspective*. N. J. Foss, Oxford University Press. 1: 345-365.

Francis, S. (1997). "A time for reflection: Learning about organisational learning." *The Learning Organisation* 4(4): 168-179.

Franklin, S. J., Wright, M. and A. Lockett (2001). "Academic and Surrogate Entrepreneurs in University Spin-out Companies." *Journal of Technology Transfer*
26(1-2): 127-141.

Gaglio, C. M. and J. A. Katz (2001). "The psychological basis of opportunity identification: Entrepreneurial alertness." *Small Business Economics* 16(2): 95-111.

Galbraith, J. (1982). "The stages of growth." *Journal of Business Strategy* 3(1): 70-79.

Galbreath, J. (2005). "Which resources matter the most to firm success? An exploratory study of resource-based theory." *Technovation* 25(9): 979-987.

Gartner, W. (1989). ""Who is an entrepreneur" is the wrong question." *Entrepreneurship Theory and Practice* 13(4): 47-68.

Gartner, W. and S. Birley (2002). "Introduction on the special issue in qualitative methods in entrepreneurship research." *Journal of Business Venturing* 17(5): 387-395.

Gartner, W. B. (1985). "A conceptual framework for describing the phenomenon of new venture creation." *Academy of Management Review* 10(4): 696-706.

Gartner, W. B., Shaver, K.G., Gatewood, E. and J. A. Katz (1994). "Finding the entrepreneur in entrepreneurship." *Entrepreneurship, Theory & Practice* 18(3): 5-9.

Gatewood, E., Shaver, K. and W. Gartner (1995). "A longitudinal study of cognitive factors in influencing start-up behaviors and success at venture creation." *Journal of Business Venturing* 10(5): 371-391.

Gephart, R. (2004) 'Qualitative research and the Academy of Management Journal' *Academy of Management Journal* 47(4) 454-462.

Gibbons, M. and R. Johnston (1974). "The roles of science in technological innovation." *Research Policy* 3(3): 220-242.

Gibbons, M., Limoges, C., Nowotny, H., Schartzman, S., Scott, P. and M. Trow (1999). *The New Production of Knowledge*. London, Sage Publications.

Gibbs, G. R. (2002). *Qualitative Data Analysis Explorations with NVivo*. Buckingham, Open University Press.

Gimeno, J., Folta, T.B., Cooper C.Y. and C. Y. Woo (1997). "Survival of the fittest? Entrepreneurial human capital and the persistence of under performing firms." *Administrative Science Quarterly* 42(4): 750-784.

Glaser, B. G. and A. L. Strauss (1968). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. London, Wiedenfeld and Nicolson.

Godfrey, P. C. and H. L. Gregersen (1997). "Where do resources come from? A model of resource generation." *Journal of High Technology Management Research* 10(1): 37-60.

Graham, A. F. (2002). *Scottish Economic Report: June 2002. Scottish Enterprise / Royal Society of Edinburgh Enterprise Fellowships: Stimulating Innovation and Entrepreneurship.* Scottish Executive.

Grandi, A. and R. Grimaldi (2003). "Exploring the networking characteristics of new venture founding teams." *Small Business Economics* 21(4): 329-341.

Granovetter, M. (1973). "The strength of weak ties." *American Journal of Sociology* 78(6): 1360-1380.

Granovetter, M. (1985). "Economic Action and Social Structure: The Problem of Embeddedness." *American Journal of Sociology* 91(3): 481-510.

Grant, P. and L. Perren (2002). "Small business and entrepreneurial research: meta-theories, paradigms and prejudices." *International Small Business Journal*
20(2): 185-211.

Grant, R. M. (1991). "The resource-based theory of competitive advantage: Implications for strategy formulation." *California Management Review* 33(spring): 114-135.

Greene, P. G. (2000). "Self employment as an economic behaviour: An analysis of self employed women's human and social capital." *National Journal of Sociology* 12(1): 1-55.

Guba, E. and Y. S. Lincoln (2000). Competing paradigms in qualitative research. *Handbook of Qualitative Research*. N. K. Denzin and Y. S. Lincoln. Thousand Oaks, CA, Sage.

Hall, R. (1992). "The strategic analysis of intangible resources." *Strategic Management Journal* 13(2): 135-144.

Hall, R. (1993). "A framework linking intangible resources and capabilities to sustainable competitive advantage." *Strategic Management Journal* 14(8): 607-618.

Heirman, A. and B. Clarysse (2004). "How and why do research-based start-ups differ at founding? A resource-based configurational perspective." *Journal of Technology Transfer* 29(3-4): 247-268.

Heydebreck, P., KLöfsten, M. and J. C. Maier (2000). "Innovation support for new technology-based firms: the Swedish Teknopol approach." *R&D Management*
30(1): 89-99.

Higher Education Review (HER) (2004). *A Framework for Higher Education in Scotland: Higher Education Review Phase 2.* Scottish Executive.

Higher Education Council for England (HECE) (2002b). *Higher Education Business Interaction Survey: Academic Session 2000/2001: Results for Scotland*. Higher Education Council for England.

Hills, G. E., Lumpkin, G.T. and R. Singh (1997). "Opportunity Recognition: Perceptions and Behaviours of Entrepreneurs." *Frontiers of Entrepreneurship Research,* Wellesley, MA: Babson College, 105-117.

Hindle, K. (2004). "Choosing qualitative methods for entrepreneurial cognition research: A canonical development approach." *Entrepreneurship, Theory and Practice*
28(6)*:* 575-607.

Hindle, K. and J. Yencken (2004). "Public research commercialisation, entrepreneurship and new technology based firms: an integrated model." *Technovation* 24(10): 793-803.

Hoang, H. and B. Antoncic (2003). "Network-based research in entrepreneurship a critical review." *Journal of Business Venturing* 18(2): 165-182.

Hollis, M. (1994). *The Philosophy of Social Science, an Introduction*. Cambridge, Cambridge University Press.

Holstein, J. A. and J. F. Gubrium (2004). Active Interviewing. *Qualitative Research. Theory, Method and Practice*. D. Silverman. London, Sage Publications: 140-161.

Hughes, J. (1990). *The Philosophy of Social Research*. London, Longman.

Humphreys, M. (1999). *An Ethnographic Study of the Professional Cultures of Two Higher Education Faculties*. Doctoral Thesis. Nottingham University Business School. Nottingham.

Hussey, J. and R. Hussey. (1997). *Business Research; A practical guide for undergraduate and postgraduate students*. Basingstoke, Hampshire, Palgrave.

Jack, S. L. and A. R. Anderson (2002). "The effects of embeddedness on the entrepreneurial process." *Journal of Business Venturing* 17(5): 467-487.

Jensen, R. A. and Thursby, M. (2001). "Proofs and prototypes for sale: The licensing of university inventions." *American Economics Review* 91(1): 240-259.

Johannisson, B. (1986). "Network strategies: management technology for entrepreneurship and change." *International Small Business Journal* 5(1): 19-30.

Johannisson, B. (1998). "Personal networks in emerging knowledge-based firms: spatial and functional patterns." *Entrepreneurship and Regional Development* 10(4): 297-312.

Johannisson, B., Alexanderson, O., Nowicki, K. and K. Senneseth (1994). "Beyond anarchy and organisation: entrepreneurs in contextual networks." *Entrepreneurship and Regional Development*. 6(4): 329-356.

Jones, M. and N. Coviello (2005). "Internationalisation conceptualising an entrepreneurial process of behavior in time." *Journal of International Business Studies* 36(3): 284-303.

Jones-Evans, D., KLöfsten, M., Andersson, E., and Pandya, D. (1999). "Creating a bridge between university and industry in small European countries: the role of the Industrial Liaison Office." *R&D Management* 29(1): 47-56.

Jovanovic, B. (1982). "Selection and evolution of industry." *Econometrica* 50(3): 649-670.

Kakati, M. (2003). "Success criteria in high-tech new ventures." *Technovation*
23(5): 447-457.

Kamm, J. B., Shuman, J.C. and A. J. Nurick (1990). "Entrepreneurial teams in new venture creation: A research agenda." *Entrepreneurship Theory and Practice* 14(4): 7-17.

Kamm, J. B. and A. J. Nurick (1993). "The stages of team venture formation: a decision making model." *Entrepreneurship Theory and Practice* 17(2): 17-25.

Katz, J.A. (1994). "Modelling entrepreneurial career progressions: concepts and considerations." *Entrepreneurship Theory and Practice* 19(2):23-40.

Katz, J. and W.B. Gartner (1988). "Properties of emerging organizations." *Academy of Management Review* 13(3):429-442.

Keil, T. (2004). "Building external corporate venturing capability." *Journal of Management Studies* 41(5): 799-825.

Kirzner, I. (1973). *Competition and Entrepreneurship*. Chicago, University of Chicago Press.

Kirzner, I. (1979). *Perception, Opportunity, and Profit*. Chicago, University of Chigaco Press.

Klepper, S. and S. Sleeper (2005). "Entry by spinoffs." *Management Science* 51(8): 1291-1306.

KLöfsten, M. and Jones-Evans. (2000). "Comparing academic entrepreneurship in Europe-The case of Sweden and Ireland." *Small Business Economics* 14(4): 299-309.

Kolb, D. A. (1984). *Experiential Learning-Experiences as the Source of Learning and Development*. Englewood Cliffs, NJ, Prentice-Hall.

Kor, Y. Y. and J. T. Mahoney (2000). "Penrose's resource-based approach: The process and product of research creativity." *Journal of Management Studies* 37(1): 109-139.

Kvale, S. (1996). *Interviews: An Introduction to Qualitative Research Interviewing*. London, Sage publications.

Langley, A. (1999). "Strategies for theorizing from process data." *Academy of Management Review* 24(4): 691-710.

Lambert, M. (2003). *Lambert Review of Business-University Collaboration*. London, HM, Treasury.

Larson, A. and J. A. Starr (1993). "A network model of organization formation." *Entrepreneurship, Theory and Practice* 17(2): 5-15.

Leana, C. R. and Van Buren, H. J. (1999). "Organizational social capital and employment practices." *Academy of Management Review* 24(3): 538-555.

Lechler, T. (2001). "Social interaction: A determinant of entrepreneurial team venture success." *Small Business Economics* 16(4): 263-278.

Leonard-Barton, D. (1990). "A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites." *Organization Science* 1(3): 248-266.

Lester, R.H., Hillman, A., Zardkoohi, A. and Cannella JR, A.A. (2008). "Former governmental officials as outside directors: The role of human and social capital." *Academy of Management Journal* 51(5): 999-1013.

Levinthal, D. (1996). Learning and Schumpeterian dynamics. *Organization and Strategy in the Evolution of the Enterprise*. G. Dosi and F. Malerba. London, MacMillan Press Ltd: 27-41.

Li, H. and Y. Zhang (2002). Founding team comprehension and behavioural integration: Evidence from new technology ventures in China. Entrepreneurship, *Academy of Management Conference Proceedings*. Washington DC.

Liao, J. and H. Welsch (2003). "Social capital and entrepreneurial growth aspiration: a comparison of technology- and non-technology-base nascent entrepreneurs." *The Journal of High Technology Management Research* 14(1): 149-170.

Lincoln, Y. S. and E. Guba (1985). *Naturalistic Inquiry*. New York. Sage.

Lindelöf, P. and H. Löfsten (2002). "Growth, management and financing of new technology-based firms-assessing value-added contributions of firms located on and off Science Parks." *Omega* 30(3): 143-154.

Lindelöf, P. and H. Löfsten (2004). "Proximity as a resource base for competitive advantage: university – industry links for technology transfer." *Journal of technology Transfer* 29 (3 – 4): 311-326.

Lockett, A. and M. Wright (2005). "Resources, capabilities, risk capital and the creation of university spin-out companies." *Research Policy* 34(7): 1043-1057.

Lockett, A., Wright, M. and S. Franklin (2003b). "Technology transfer and universities' spin-out strategies." *Small Business Economics* 20(2): 185-200.

Lockett, A. and S. Thompson (2001). "The resource-based view and economics." *Journal of Management* 27(6): 723-754.

Lockett, A., Vohora, A. and M. Wright (2003). "Universities as incubators without walls." *Entrepreneurship and Innovation* 3(4): 245-256.

Löfsten, H. and P. Lindelöf (2001). "Science parks in Sweden-industrial renewal and development?" *R&D Management* 31(3): 309-321.

Löfsten, H. and P. Lindelöf (2002). "Science parks and the growth of new technology-based firms-academic-industrial links, innovation and markets." *Research Policy*
31(6): 859-876.

Löfsten, H., and P. Lindelöf (2003). "Determinants for an entrepreneurial milieu – Science parks and business policy in growing firms." *Technovation* 23(1): 51-64.

Low, M. and I. C. MacMillan (1988). "Entrepreneurship: Past research and future challenges." *Journal of Management* 14(2): 139-161.

Mahoney, J. and J. Pandian (1992). "The resource-based view within the conversation of strategic management." *Strategic Management Journal* 13(5): 363-380.

Makadok, R. (2001). "Towards a synthesis of the resource-based and dynamic-capability views of rent creation." *Strategic Management Journal* 22(5): 387-401.

Marshall, C. and G. B. Rossman (1999). *Designing Qualitative Research*. Thousand Oaks, CA, Sage.

Martin, B. M., Salter, A., Hicks, D., Pavvit, K. Senker, J., Sharp, M. and N. Von Tunzelmann (1996). *The Relationship between Publicly Funded Basic Research and Economic Performance*. Brighton: HM Treasury.

Marvel, M. R., and G. T. Lumpkin (2007). "Technology Entrepreneurs' Human Capital and Effects on Innovation Radicalness." *Entrepreneurship Theory and Practice* 31(6): 807-828.

Mason, C. M. and R. T. Harrison (2002). "Barriers to investment in the informal venture capital sector." *Entrepreneurship and Regional Development* 14(3): 271-287.

Mason, C. M. and R. T. Harrison (2003). "Closing the Regional Equity Gap? A Critique of the Department of Trade and Industry's Regional Venture Capital Funds Initiative." *Regional Studies; The Journal of Regional Studies Association* 37(8): 855-868.

Mason, J. (2002). *Qualitative Researching*. London, Sage Publishing Ltd.

Massey, D., Quintas, P. and D. Wield (1992). *High Tech Fantasies: Science Parks in Society and Space.* Routledge.
Matlay, H. and P. Westhead. (2005). "Virtual teams and the rise of e-entrepreneurship in Europe." *International Small Business Journal* 23(3): 279-302.

McAdam, R. (2002). "Large scale innovation-reengineering methodology in SMEs: Positivistic and phenomenological approaches." *International Small Business Journal* 20(1): 33-52.

McGill, M.E. Slocum, J.W. and D.Lei (1992). "Management practices in learning organisations." *Organisational Dynamics* 22(2): 5-17.

McKelvie, A. and J. Wiklund (2004). How Knowledge Affects Opportunity Discovery and Exploitation among New Ventures in Dynamic Markets. *Opportunity Identification and Entrepreneurial Behavior*. J. E. Bulter, Information Age Publishing. 4: 219-239.

Meyer, J. W. and B. Rowan (1977). "Institutionalized organizations: Formal structure as myth and ceremony." *American Journal of Sociology* 83(2): 340-363.

Meyer, M. (2003). "Academic entrepreneurs or entrepreneurial academics? Research-based ventures and public support mechanisms." *R & D Management* 33(2): 107-115.

Miles, M. B. and A. M. Huberman (1994). *Qualitative Data Analysis*. Thousand Oaks, CA., Sage Publications.

Miller, D. and J. Shamsie (1996). "The resource-based view of the firm in two environments: The Hollywood firm studios from 1936 to 1965." *Academy of Management Journal* 39(3): 519-543.

Miller, J. and B. Glasser (1998). The 'Inside' and the 'Outside'. Finding Realities in Interviews. *Qualitative Research. Theory, Methods and Practice*. D. Silverman. London, Sage Publications: 99-112.

Minniti, M. and W. Bygrave (2001). "A dynamic model of entrepreneurial learning." *Entrepreneurship, Theory and Practice* 25(3): 5-16.

Mohr, L. B. (1982). *Explaining Organizational Behavior*. San Francisco, Jossey-Bass Publishers.

Moray, N. and B. Clarysse (2005). "Institutional change and resource endowments to science-based entrepreneurial firms." *Research Policy* 34(7):1010-1027.

Morgan, G. and L. Smircich (1980). "The case for qualitative research." *Academy of Management Review* 5(4): 491-500.

MORI (1999). *Attitudes to Entrepreneurship*. Scottish Enterprise.

Mosey, S., Lockett, A. and P. Westhead (2006). "Creating network bridges for university technology transfer: The Medici fellowships programme." *Technology Analysis and Strategic Management* 18(1): 71-91.

Mosey, S. and M. Wright (2007). "From human capital to social capital: A longitudinal study of technology-based academic entrepreneurs." *Entrepreneurship, Theory and Practice* 31(6): 909-935.

Mustar, P. (1997). "Spin-off enterprises-how French academics create hi-tech companies: the conditions for success or failure." *Science and Public Policy* 24(1): 37-43.

Mustar, P., Renault, M., Colombo, M.G., Piva, E., Fontes, M., Lockett, A., Wright, M., Clarysse, B. and N. Moray (2006). "Conceptualising the heterogeneity of research-based spin-offs; A multi-dimensional taxonomy." *Research Policy* 35(2): 289-308.

Nahapiet, J. and Ghoshal, S. (1998). "Social capital, intellectual capital and the organizational advantage." *Academy of Management* 23(2): 242-266.

Ndonzuau, N., Pirnay, F. and B. Surlemont (2002). "A stage model of academic spin-off creation." *Technovation* 22(5): 281-289.

Nelson, R. (2004). "The market economy, and the scientific commons." *Research Policy* 33(3):455-471.

Nelson, R. R. and S. G. Winter (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA, Belknap Press of Harvard University Press.

Nicolaou, N. and S. Birley (2003a). "Academic networks in a tricotomous categorization of university spinouts." *Journal of Business Venturing* 18(3): 333-359.

Nicolaou, N. and S. Birley (2003b). "Social networks in organizational emergence: The University spinout phenomenon." *Management Science* 49(12): 1702-1725.

Nonaka, I. (1994). "A dynamic theory of organizational knowledge creation." *Organization Science* 5(1): 14-37).

Oakey, R. (1995). *High-technology New Firms. Variable Barriers to Growth.* Paul Chapman, London.

Oakey, R., Faulkner, W., Cooper, S. and V. Walsh (1990). *New Firms in the Biotechnology Industry: Their Contribution to Innovation and Growth*. London, Printer Publishers Limited.

Oatley, N. (1998). "New Initiative: The role of further and higher education in local economic development." *Local Economy* 13(3): 255-257.

Oliver, C. (1997). "Sustainable competitive advantage: Combining institutional and resource-based views." *Strategic Management Journal* 18(9): 697-713.

Oppenheim, A. N. (2000). *Questionnaire Design, Interviewing and Attitude Measurement*. London, Continuum.

Organisation for Economic Co-Operation and Development (OECD) (2001). *Fostering High-Tech Spin-offs: A Public Strategy for Innovation.* Organisation for Economic Co-Operation and Development. STI Review No. 26.

Organisation for Economic Co-Operation and Development (OECD) (2002). *Science, Technology and Industrial Outlook.* Organisation for Economic Co-Operation and Development.

Packalen, K. A. (2007). "Complementing capital: The role of status, demographic features, and social capital in founding teams' ability to obtain resources." *Entrepreneurship, Theory and Practice* 31(6): 873-891.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods*. London, Sage.

Penrose, E. T. (1972). *The Theory of the Growth of the Firm.* Compton Printing Ltd., London and Aylesbury.

Perren, L. and M. Ram (2004). "Case-study method in small business and entrepreneurial research: Mapping boundaries and perspectives." *International Small Business Journal* 22(1): 83-101.

Pettigrew, A. M. (1990). "Longitudinal field research on change: Theory and Practice." *Organizational Science* 1(3): 267-292.

Pfeffer, J. and G. R. Salancik (1978). *The External Control of Organisations: A Resource Dependency Perspective*. Stanford, California, Stanford Business Books.

Phan, P.H., Siegel, D.S. and Wright, M. (2005). "Science parks and incubators: observations, synthesis and future research." *Journal of Business Venturing* 20(2): 165-182.

Phillimore, J. (1999). "Beyond the linear view of innovation in science park evaluation: An analysis of Western Australian Technology Park." *Technovation*, 19(11): 673-680.

Pirnay, F., Surlemont, B. and F. Nlemvo (2003). "Towards a typology of university spin-offs." *Small Business Economics* 21(4): 355-369.

Porter, M. (1980). *Competitive Strategy: Techniques for Analysing Industries and Competitors*. New York, The Free Press.

Portes, A. (1998). "Social capital: Its origins and application in modern sociology." *Annual Review of Sociology* 24(1): 1-24.

Powers, J. B. and P. P. McDougall (2005). "University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship." *Journal of Business Venturing* 20(4): 291.

Radosevich, R. (1995). "A model for entrepreneurial spin-offs from public technology sources." *International Journal of Technology Management* 10(7/8): 879-893.

Ragin, C. C. (1992). Introduction: Cases of "What is a Case?" *What is a Case: Exploring the Foundation of Social Enquiry* C. C. Ragin and H. S. Becker. Cambridge, Cambridge University Press.

Rappert, B. and A. Webster (1997). "Regimes of ordering: The commercialisation of intellectual property in industrial-academic collaborations." *Technology Analysis and Strategic Management* 9(2): 116-130.

Rappert, B. and A. Webster (1998). "Links between universities and their spin-offs: variation by type and sector." *Industry and Higher Education* 12(6): 332-338.

Rasmussen, E. (2007). *Facilitating University Spin-off Ventures–An Entrepreneurship Process Perspective*. Doctoral Thesis. Graduate School of Business. Bodo, Bodo Graduate School of Business.

Reynolds, P. (1997). "Who starts a firm? Preliminary explorations of firms in gestation." *Small Business Economics* 9: 449-462.

Reynolds, P. D., Storey, D.J. and P. Westhead (1994). "Cross-national Comparisons of the Variations in New Firm Formation Rates." *Regional Studies* 28(4): 443-445.

Roberts, E. B. (1991). *Entrepreneurs in High Technology: Lessons from MIT and Beyond*. Oxford, Oxford University Press.

Roberts, E. B. and D. E. Malone (1996). "Policies and structures for spinning off new companies from research and development organisations." *R&D Management* 26(1): 17-48.

Robertson, P. B. and E. A. Sexton (1994). "The effect of education and experience on self-employment success." *Journal of Business Venturing* 9(2): 141-156.

Rod, M.R.M. (2006). "An innovative biotechnology start-up company approach." *Entrepreneurship and Innovation* 7(2): 99-103.

Rogers, E. (1986). "The role of the research university in spin-off high-technology companies." *Technovation* 4(3): 169-181.

Rogers, E. M., Takegami, S. and J. Yin (2001). "Lessons learned about technology transfer." *Technovation* 21(4): 253-260.

Rogers, E. W. (2001). "A theoretical look at firm performance in high-tech organisations. What does existing theory tell us?" *Journal of High Technology* 12(1): 39-61.

Roure, J. B. and R. H. Keeley (1990). "Predictors of success in new technology based ventures." *Journal of Business Venturing* 5(4): 201-220.

Roure, J. B. and M. A. Madique (1986). "Linking pre-funding factors and high-technology venture success: An exploratory study." *Journal of Business Venturing* 1(3): 295-306.

Rouse, M. J. and U. S. Daellenbach (1999). "Rethinking research methods for the resource-based perspective: Isolating sources of sustainable competitive advantage." *Strategic Management Journal* 20(5): 487-494.

Salazar, A. and L. Georghiou (2002). *Conceptualisating the relationship between university and industry in the knowledge age: Insights from the biotechnology sector in the United Kingdom*. Manchester, The Business School, Manchester Metropolitan University.

Samson, K. J. and M. A. Gurdon (1993). "University scientists as entrepreneurs: A special case of technology transfer and high technology venturing." *Technovation* 13(2): 63-71.

Sarasvathy, S.D. (2001). "Causation and effectuation: Towards a theoretical shift from economic inevitability to entrepreneurial contingency." *Academy of Management Review* 26(2): 243-288.

Sarasvathy, S. D., Dew, N., Velamuri, S.R. and S. Venkataraman (2004). A Testable Typology of Entrepreneurial Opportunity: Extensions of Shane and Venkataraman (2000); Working Paper. Academy of Management Review.

Sarasvathy, S. D., Dew, N., Velamuri, S.R. and S. Venkataraman (2003). Three views of Entrepreneurial Opportunity. *Handbook of Entrepreneurship Research*. Z.J. Acs and D.B. Audretsch. Great Britain, Kluwer Academic Publishers:141-160.

Saxenian, A. (1985). Silicon Valley and Route 128: Regional Prototypes or Historic Exceptions? *High-Technology, Space and Society*. M. E. Castells. Beverly Hills and London, Sage Publications: 81-105.

Schumpeter, J. (1976). *The Theory of Economic Development*. Cambridge: Harvard University Press.

Schwandt, T. A. (2001). *Dictionary of Qualitative Inquiry*. London, Sage.

Scott, M. and R. Bruce (1987). "Five Stages of Growth in Small Business." *Long Range Planning* 20(3): 45-52.

Scott, M. and P. Rosa (1996). "Has firm level analysis reached its limits? Time for a re-think." *International Small Business Journal* 14(4):81-84.

Scottish Enterprise (1994). *Network Strategy*. Glasgow, Scottish Enterprise.

Scottish Enterprise (1996). *Commercialisation Enquiry: Final Research Report*. Glasgow, Royal Society of Edinburgh.

Scottish Enterprise (2003). *Biotechnology Scotland, Source Book 2003*. Glasgow, Scottish Enterprise.

Scottish Executive (2002a). *Research & Development Expenditure and Employment by Businesses in Scotland; Comparisons with the UK*, Business Enterprise Research and Development Scotland (BERD).

Scottish Executive (2004). *A Framework for Higher Education in Scotland: Higher Education Review Phase 2.*

Scottish Institute for Enterprise (2004). *Celebration of Biotechnology in Scotland*. Glasgow, Scottish Institute for Enterprise and MIT Entrepreneurship Centre.

Shane, S. (2000). "Prior Knowledge and the discovery of entrepreneurial opportunities." *Organisational Science* 11(4): 448-469.

Shane, S. (2002). "Selling University technology: patterns from MIT." *Management Science* 48(1): 1173-1190.

Shane, S. (2003). *A General Theory of Entrepreneurship*. The Individual-Opportunity Nexus. Cheltenham, Edward Elgar.

Shane, S. (2004). *Academic Entrepreneurship: University Spinoffs and Wealth Creation*. Cheltenham, Edward Elgar.

Shane, S. and R. Khurana (2003). "Bringing individuals back in: The effects of career experience on new firm founding." *Industrial and Corporate Change* 12(3): 519-544.

Shane, S. and T. Stuart (2002). "Organizational endowments and the performance of university start-ups." *Management Science*. 48(1): 154-170.

Shane, S. and S. Venkataraman (2000). "The promise of entrepreneurship as a field of research." *Academy of Management Review* 25(1): 217-226.

Shepherd, D. A. and D. DeTienne (2005). "Prior knowledge, potential financial reward, and opportunity identification." *Entrepreneurship, Theory and Practice* 29(1): 91-112.

Shrader, R., and D. S. Siegel (2007). "Assessing the Relationship between Human Capital and Firm Performance: Evidence from Technology-Based New Ventures." *Entrepreneurship Theory and Practice* 31(6): 893-908.

Siegel, D., Waldman, D. and Link, A. (2001). "Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study." *Research Policy* 13(75): 1-22.

Siegel, D., Westhead, P. and M. & Wright (2003a). "Science Parks and the performance of new technology-based firms: A review of recent U.K. Evidence and an agenda for future research." *Small Business Economics* 20(2): 177-184.

Siegel, D. S., Westhead, P. and M. Wright (2003b). "Assessing the impact of university science parks on research productivity: Exploratory firm-level evidence from the United Kingdom." *International Journal of Industrial Organization* 21(9): 1357-1369.

Siegel, D.S., Wright, M. and A. Lockett. (2007). "The rise of entrepreneurial activity at universities: organizational and societal implications." *Industrial Corporate Change*
16(4): 489-504.

Silverman, D. (2004). *Qualitative Research: Theory, Method and Practice*. London, Sage Publications.

Smilor, W. R., Gibson, D.V. and G. B. Dietrich (1990). "University spin-out companies: Technology start-ups from UT-Austin." *Journal of Business Venturing* 15(1): 63-76.

Smith, J. E. (2004). *Biotechnology*. University Press. Cambridge.

Spanos, Y. E. and S. Lioukas (2001). "An examination into the causal logic of rent generation: contrasting Porter's competitive strategy framework and the resource-based perspective." *Strategic Management Journal* 22(10): 907-934.

SPRU (1996). *The Relationship between Publicly Funded Basic Research and Economic Performance*. London, HM Treasury.

Stake, R. E. (1998). Case-Studies. *Handbook of Qualitative Research*. N. K. Denzin and Y. S. Lincoln. Thousand Oaks, CA, Sage: 435-454.

Starkey, K. and R. Whittington (2000). *Postmodernism and the Conversation of Strategic Management*. Discussion paper. Nottingham University Business School.

Steffensen, M., Everett, M. R. and K. Speakman (2000). "Spin-offs from research centres at a research university." *Journal of Business Venturing* 15(1): 93-111.

Stinchcombe, A. (1965). Social Structure and Organisations. *Handbook of Organisations*. J. March: 142-193.

Storey, D. J. (1997). *Understanding the Small Business Sector*. London, International Thomson Business Press.

Storey, D. J. and B. S. Tether (1998). "New technology-based firms in the European union: An introduction." *Research Policy* 26(9): 933-946.

Strauss, A. L. and J. Corbin (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Newbury Park, CA, Sage.

Strauss, A. L. and J. Corbin (1998). *Basics of Qualitative Research*. Thousand Oaks, CA, Sage.

Suddaby, R. (2006). "From the Editors: What grounded theory is not." *Academy of Management Journal* 49(4): 633-642.

Schwandt, T. A. (1994). Constructivist, Interpretivist approaches to human inquiry. *Handbook of Qualitative Research*. N. K. Denzin and Y. S. Lincoln. Thousand Oaks, CA, Sage.

Szarka, J. (1990). "Networking and small firms." *International Small Business Journal* 18(1): 16-22.

Tait, J. and R. Williams (1999). "Policy approaches to research and development: foresight, framework and competitiveness." *Science and Public Policy* 26(2): 101-112.

Talent Scotland. www.talentscotland.com.

Teece, D. J., Pisano, G. and A. Shuen (1997). "Dynamic capabilities and strategic management." *Strategic Management Journal* 18(7): 509-533.

Teece, D. J., Rumelt, R., Dosi, G., and S. G. Winter (1994). "Understanding corporate coherence. Theory and evidence." *Journal of Economic Behaviour and Organisation* 23(1): 1-30.

Timmons, J. A. (1999). *New Venture Creation: Entrepreneurship for the 21st Century*. Boston Mass., Irwin McGraw-Hill.

Üçbaşaran, D. (2004). *Business Ownership Experience, Entrepreneurial Behaviour and Performance. Novice, Habitual, Serial and Portfolio Entrepreneurs*. Doctoral Thesis. Nottingham, Nottingham University Business School.

Üçbaşaran, D., Westhead, P. and M. and Wright (2001). "The focus of entrepreneurial research: contextual and process issues." *Entrepreneurship, Theory and Practice*
25(4): 57-80.

Üçbaşaran, D., Lockett, A., Wright, M. and P. Westhead (2003a). "Entrepreneurial founder teams: factors associated with member entry and exit." *Entrepreneurship, Theory and Practice* 28(2):107-127.

Üçbaşaran, D., Wright, M. and P. Westhead (2003b). "A longitudinal study of habitual entrepreneurs: Starters and acquirers." *Entrepreneurship and Regional Development* 15(3): 207-228.

UNICO (2002). *UK University Commercialisation Survey Financial Year*, Nottingham University Business School.

UNICO (2003). *UK University Commercialisation Survey Financial Year*, Nottingham University Business School.

Upstill, G. and D. Symington. (2002). "Technology transfer and the creation of companies. The CSIRO experience." *R&D Management* 32(3): 233-239.

Vanaelst, I., Clarysse, B., Wright, M., Lockett, A., Moray, N. and R. S'Jegers (2006). "Entrepreneurial team development in academic spin-outs: An examination of team heterogeneity." *Entrepreneurship, Theory and Practice* 30(2): 249-271.

Van de Ven, A. H. (1989). "Nothing is quite so practical as a good theory." *Academy of Management* Review 14(4): 486-489.

Van de Ven, A. H. and R. M. Engleman (2004). "Event-and outcome-driven explanations of entrepreneurship." *Journal of Business Venturing* 19(3): 343-358.

Van Maanen, J. (1983). *Qualitative Methodology*. London, Sage.

Vedovello, C. (1997). "Science parks and university - industrial interaction: geographical proximity between the agents as a driving force." *Technovation* 17(9): 491-502.

Venkataraman, S. (1997). The distinctive domain of entrepreneurship research: an editor's pespective. *Advances in Entrepreneurship, Firm Emergence and Growth*. J. A. Katz and S. Brockhaus. Greenwich, JAI Press. 3: 119-138.

Vogt, W. P. (1993). *Dictionary of Statistics and Methodology*. London, Sage.

Vohora, A., Wright, M. and A. Lockett (2004). "Critical junctures in the development of university high tech spinout companies." *Research Policy* 33(1): 147-175.

Watson, W. E., Ponthieu, L.D. and J. W. Critelli (1995). "Team interpersonal process effectiveness in venture partnerships and its connection to perceived success." *Journal of Business Venturing* 10(5): 393-411.

Wernerfelt, B. (1984). "A resource-based view of the firm." *Strategic Management Journal* 5(2): 171-180.

West, G. P. and J. De Castro (2001). "The Achilles heel of firm strategy: Resource weakness and distinctive inadequacies." *Journal of Management Studies* 38(3): 417-442.

Westhead, P. (1995). "Survival and employment growth contrasts between types of owner-managed high-technology firms." *Entrepreneurship, Theory and Practice*
20(1): 5-27.

Westhead, P. (1997). "R&D 'inputs' and 'outputs' of technology-based firms located on and off science parks." *R&D Management* 27(1): 45-62.

Westhead, P. and S. Batstone (1998). "Independent technology-based firms: The perceived benefits of a science park location." *Urban Studies* 35(12): 2197-2219.

Westhead, P. and S. Batstone (1999). "Perceived benefits of a managed science park location." *Entrepreneurship and Regional Development* 11(2): 129-254.

Westhead, P., Üçbaşaran, D., Wright, M. and M. Binks (2005). "Novice, serial, portfolio entrepreneur behaviour and contributions." *Small Business Economics* 25(2): 109-132.

Westhead, P. and D. J. Storey (1995). "Links between higher education institutions and high technology firms." *Omega* 24(4): 345-360.

Westhead, P., Wright, M. and D. Üçbaşaran (2001). "The internationalization of new and small firms: A resource-based view." *Journal of Business Venturing* 16(4): 333-358.

Westhead, P. and M. Wright (1998). "Novice, portfolio and serial founders: are they different?" *Journal of Business Venturing* 9(1): 173-204.

White, H. C. (1992). Cases are for identity, for explanation, or for control. What is a Case? *Exploring the Foundations of Social Enquiry*. C. C. Ragin and G. S. Becker. Cambridge, Cambridge University Press: 83-104.

Wolcott, H. F. (1994). *Transforming Qualitative Data: Description, Analysais and Interpretation*. Thousand Oaks, CA: Sage.

Wright, M., Binks, M., Vohora, A., and A. Lockett (2002). *Annual UNICO-NUBS Survey on University Commercialisation Activities: Financial Year 2001*. Nottingham, Nottingham University Business School.

Wright, M., Binks, M., Vohora, A., and A. Lockett (2003). *Annual UNICO-NUBS Survey on University Commercialisation Activities: Financial Year 2002*. Nottingham, Nottingham University Business School.

Wright, M., Birley, S. and S. Mosey (2004a). "Entrepreneurship and university technology transfer." *Journal of Technology Transfer* 29(3-4): 235-246.

Wright, M., Hmieleski, K.M., Siegel, D. and E.D. Ensley (2007). "The role of human capital in technological entrepreneurship." *Entrepreneurship, Theory and Practice* 31(6); 791-806.

Wright, M., Vohora, A., Lockett, A. and N. Nicolaou (2004b). "The evolution of teams in university high-tech spinouts: team member entry and exit." Working Paper.

Wright, M., Vohora, A. and Lockett, A. (2004c). "The formation of high tech university spinout companies: the role of joint ventures and venture capital investors." *Journal of Technology Transfer* 29(3-4): 287-310.

Wright, P. M., McMahan, and A. McWilliams (1994). "Human resources and sustained competitive advantage: a resource based perspective." *International Journal of Human Resource Management* 5(2): 301-326.

Yin, R. K. (1989). *Case Study Research: Design and Methods*. Sage Publications.

Zahra, S. A. (2007). "Contextualizing theory building in entrepreneurship research." *Journal of Business Venturing* 22(3): 443-452.

Zimmerman, M. A. and G. J. Zeitz (2002). "Beyond survival: Achieving new venture growth by building legitimacy." *Academy of Management Review* 27(3): 414-431.

Zucker, L., Darby, M.R. and J. S. Armstrong (2002). "Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology." *Management Science* 48(1): 138-153.

Appendices

Appendix 1: The Literature behind the questions (Opportunity Identification)

Question and prompts	Theme	Source
OPPORTUNITY RECOGNITION		
1. What factors influenced the identification and selection of the commercial idea (opportunity) behind the spinout firm?	Absorptive capacity determined by the entrepreneur /team's ability to exploit opportunities.	Levinthal, 1996.
People involvement	The entrepreneur as the primary resource.	Venkataraman, 1997
"Market Pull"	Entrepreneurial process	Alvarez and Busenitz, 2001
"Research push"	Entrepreneurial process	Shane, 2000
IP capabilities	University spinouts	Druilhe and Garnsey, 2001
2. What factors influenced the decision to form the spinout?	Influence of Human Capital on opportunity recognition e.g. the ability to frame an idea and have potential market and customer knowledge.	Bower, 2000
What triggered the idea of founding the firm?	Resources	Nicolaou and Birley, 2003a&b
Who triggered the idea of founding the firm?	Resource base importance	Birley, 2002
Did that person commercialise it?		
Why did they commercialise it?		
Who commercialised it?	Why encourage commercialisation?	Etkowitz, et al., 2000; Oatley, 1998.
	Different routes to commercialisation. Spinout development.	Franklin et al., 2001; Debackere, 2000; Davenport et al., 2002; Scottish Enterprise, 1996; Salzar and Georghiou, 2002; Shane, 2002.
Licensing versus Spinout.		Bower, 2002a&b; Bray and Lee 2000.
Funding		Carlsson, 2002; Baum, 2004; Lambert Review, 2003.
Technology transfer office		Carlsson, 2002; Digregorio and Shane, 2003; Phillmore, 1999; Siegel et al., 2002; Vedovello, 1997; Jones Evans et al 1999
University commercialisation policies		Lockett et al., 2003
Business plan development		Gatewood et al., 1995
3. What factors (people or events) hindered the decision to form the spinout firm?	Over optimism	Storey, 1997

4. What challenges were faced when forming the university spinout firm?	Resource restrictions, resource deficiencies, barriers, surrogate entrepreneurship.	Shane and Stuart, 2002; Brush et al., 2001; West and De Castro, 2001; Aldrich and Foil, 1994; Franklin et al., 2001.
5. What influence did the parent company have in the process of forming the spinout firm and commercialising the idea?	Resource accumulation.	Barney, 1986; Teece et al., 1994.
	Resource accumulation.	Grant, 1991.
	Capital	Barney, 1991.

Appendix 2: The literature behind the questions (Team Formation)

Question and prompts	Theme	Source
TEAM FORMATION		
6. What people assisted in the formation of the spinout firm?	Entry and exit of members of entrepreneurial; founder teams	Ensley et al., 1999; Clarysse and Moray, 2004; Gartner, et al., 1994; Kamm et al., 1990; Üçbaşaran et al., 2004; De Groof, 2002; Esienhardt et al., 1990; Roberts, 1991; Roure and Maidique, 1986.
Where did they come from?	Social networks	Mustar, 1997
How did you know them?	Networks and social networks confer organisational credibility	Johannison et al., 1998; Granovetter, 1973;1985
What experience did they bring?	Team survival.	Zimmerman and Zeitz, 2002.
	Sales growth.	Chandler and Lyon, 2001.
	Previous experience of team members is a determinant of performance.	Chandler and Hanks, 1991.
What did they offer the firm?	The development of a team may be a resource.	Kamm and Nurick, 1993.
	May offer marketing knowledge for the newly formed firm.	Grandi and Grimaldi, 2003.
	Teams provide venture with access to finance, social and human capital because of diversity of membership.	Kor and Mahoney, 2000.
	Roles within the team.	Rogers et al., 2001;
		Carayannis et al., 1998.
	Previous experience of team members is a determinant of performance.	Chandler and Hanks, 1991.
	Resource accumulation and	

	human capital	
		Davidsson and Honig, 2003.
Were they equity holders?	There are poor definitions of team membership.	Cooper and Daily, 1997; Ensley et al., 1999; Üçbaşaran et al., 2004.
		Cooney, 2005.
	Role of non-equity holders.	Watson et al., 1995. Eisenhardt and Scoonhoven, 1990.
	Definitions of entrepreneurial teams around ownership and control.	
	A diversity of experience and heterogeneity in general human capital between team members fills competencies.	Cooper and Daily, 1997.
7. What factors influenced the access to people to assist in the formation of the (university) spinout firm.		
8. What factors in your past work/education/training experience have influenced your ability to assist in the formation of a spinout firm?	Human capital benefits from having superior education.	Becker, 1993.
	Ability to exploit opportunities.	
	Knowledge about the sector and management lead to better predictive powers to more accurately predict the nature of the commercial potential of change in the environment.	Shane and Venkataraman, 2000.
	Resource accumulation and human capital.	
		Davidson and Honig, 2003.
9. What factors influenced the changing composition of the people in the firm (e.g. (entry) recruitment or (exit) dismissal of the people who assisted in the formation of the spinout firm?	Changing composition of entrepreneurial ownership teams.	Üçbaşaran et al., 2004.
	Changing needs of the firm e.g. writing proposals, business plans, negotiating skills.	Mason and Harrison, 2002.
	Managerial competence.	Storey and Tether, 1998.
	Need for a professional team in business and technical elements.	Roure and Keeley, 1990; Cyr et al., 2000.

Appendix 3: The literature behind the questions (External Environment)

Question and prompts	Theme	Source
THE EXTERNAL ENVIRONMENT		
10. What factors influenced the decision to establish the spinout in this environment?	Geographical proximity between biotechnology and universities.	Gibbons and Johnston, 1993; Crosa et al., 2002.
	List of characteristics for a supportive incubator.	Etzkowitz et al., 2000; Meyer, 2003
11. When did the move occur?		
12. What challenges were faced when moving from the parent organisation to this environment?		
13. What advantages are gained for the spinout firm from this environment?	Local networks recognised as a source of entrepreneurial learning with the focus on individual learning not collective learning.	Szarka, 1990.
	Sponsored environments assist firms overcome barriers such as under-capitalisation and lack of information networks.	Flynn, 1993.
	Resource rich environments encourages knowledge-based firm formation.	
	Tenant location choices and satisfaction with facilities on Science Parks.	Pfeffer and Salancik, 1978; Siegel et al., 2003.
	Universities as incubators	Löfsten and Lindelöf, 2001;2002; Lindelöf and Lindelöf 2002; Siegel et al., 2003, Westhead and Batstone, 1998; 1999; Johannisson et al., 1994. Lockett et al., 2003
14. What disadvantages are gained for the (university) spinout from this environment?		
15. Did the (university) spinout firm use office space and laboratory equipment form the (university) parent organisation at formation?		

Appendix 4; Literature behind the questions (Learning)

Question and prompts	Theme	Source
LEARNING		
16. What problems have you faced during the formation of the spinout firm and what and how did you learn from them?	The entrepreneur's ability to learn.	Deakins and Freel, 1998.
	Internal dynamic capabilities allow firms to learn over time.	Eisenhardt and Martin, 2000; Penrose, 1972.
	Knowledge based resources may be intangible, tacit, non-codified.	Amit and Schoemaker, 1993.
	Accumulation of resources depends on particular organisational or managerial processes defined as organisational ability to integrate, build and reconfigure competencies.	Teece et al., 1997.
	Organisational learning	
	Non-planned learning	Kolb, 1984; Francis, 1997.
	Learning by doing.	Cope and Watts, 2000.
	Choices amongst competing beliefs and actions.	Baker et al., 2003.
	Experiential learning of entrepreneur happens through exploitation of networks and knowledge therein.	Minniti and Bygrave, 2001. Johannissson, 1986.
	Routines to learn routines.	
	Static and dynamic routines for everyday actions and new actions in a volatile environment.	Nelson and Winter, 1982. Teece et al., 1994; Fernandez et al., 2000

Appendix 5: Interview Guide

Draft interview schedule

The study will attempt to answer four research questions.

- What processes are used by (academic) entrepreneurs involved in commercialisation of university (parent organisation) created knowledge through the formation of a (university) spinout firm at two growth phases (opportunity recognition and sustainability)?
- 'Why' do (academic) entrepreneurs form entrepreneurial ownership teams?
- 'How' do (academic) entrepreneurs form entrepreneurial ownership teams?
- 'How' do external sponsored and non-sponsored environments assist in the formation of a resource base for the (university) spinout firm?

The interview schedule is developed in five parts.

The first part contains a series of general administrative questions.

The second part contains a series of background questions on the entrepreneurs' involvement in opportunity identification.

The third part of the schedule investigates the formation of the entrepreneurial team.

The fourth part of the schedule investigates the influence of the sponsored and non-sponsored environment.

The fifth part contains questions about learning.

The interviews will be semi structured with minimal use of prompts using open-ended questions.

(Opportunity Recognition) Pilot Interview Schedule

PART 1
GENERAL INTRODUCTION

- Proposed project/firm name:
- Address:
- Parent organisation(s):
- Industrial sector:
- Respondent's Name:
- Date of joining the firm:
- Date of leaving the firm:
- Reason for leaving the firm:
- Job title(s) and function(s) of respondent:
- Telephone number:
- E-mail address:
- Firm URL:
- Date and time of interview:

DESCRIPTION OF THE FIRM

- Legal form of the firm:
- Legal founding date of the firm:
- Date when project/firm research began within the parent organisation:
- Description of main good/service/technology:
- Current status of the project/firm:
- Maturity of technology:

PART 2
OPPORTUNITY RECOGNITION PHASE

1. What factors influenced the identification and selection of the commercial idea (opportunity) behind the (university) spinout firm?
    - ***PROMPTS***
    - People involvement
    - "Market pull"
    - "Research push"
    - IP capabilities
    - Licensing/Patenting
    - Technology Transfer Office
    - University/parent organisation commercialisation policy
    - Funding
    - Parent organisation/university

2. What factors influenced the decision to form the (university) spinout firm?
    - What triggered the idea of founding a firm?
    - Who triggered the idea of founding a firm?
    - Did that person commercialise it?
    - Why did they commercialise it?
    - Who commercialised it?
    - How was contact established with that person?
    - Who recognised the commercial market need?
    - Who had the business due diligence and planning skills?
    - Research project/Inventor/Event/Business experience
    - Licensing vs Spinout?
    - Government grant/competitions
    - Funding
    - Mentoring
    - Technology Transfer Office
    - University commercialisation policies
    - Parent organisation
    - Business plan development

3. What factors (people and events) hindered the decision to form the (university) spinout firm?

4. What challenges were faced when forming the (university) spinout firm?
    - Finance
    - Human
    - Technological (stage of development; awards; publications)
    - Organisational
    - Physical
    - Networking

5. What influence did the university (parent organisation) have in the process of forming the (university) spinout firm and commercialising the idea?
    - IP protection
    - Finance
    - Equipment
    - Human
    - Social Networks
    - University Departments
    - University agencies

PART 3
TEAM FORMATION

6. What people assisted in the formation of the (university) spinout firm?
    - Where did they come from?
    - How did you know them?
    - What experience did they bring?
    - What did they offer the firm?
    - Were they equity holders?
    - What was their role?
    - What was their relationship to the firm?
    - Why were they recruited?
    - Why were they dismissed?
    - What was their educational background?
    - What was their motivation for helping form the firm?

7. What factors influenced the access to people to assist in the formation of the (university) spinout firm?

8. What factors in your past work/education/training experience have influenced your ability to assist in the formation of a (university) spinout firm?
    - Prior start-up experience
    - Managerial experience
    - Mentors

9. What factors influenced the changing composition of the people in the firm e.g. (entry) recruitment or (exit) dismissal of the people who assisted in the formation of the (university) spinout firm?
    - Have there been changes in the team composition?
    - What factors influenced the formation of the team?
    - What factors influence the functioning of the team?
    - What factors influenced the shift of entrepreneurial capabilities from the venture champion to the entrepreneurial team?
    - Have there been changes in the roles of the people in the (university) spinout firm?

PART 4
THE EXTERNAL SPONSORED AND NON-SPONSORED ENVIRONEMNT

10. What factors influenced the decision to establish the (university) spinout in this environment?

11. When did the move occur?

12. What challenges were faced when moving from the (university) parent organisation to this environment?

13. What advantages are gained for the (university) spinout firm from this environment?

14. What disadvantages are experienced for the (university) spinout firm from this location?

15. Did the (university) spinout firm use office space and laboratory equipment from the (university) parent organisation at formation?

PART 5
LEARNING

16. What problems have you faced during the formation of the (university) spinout firm and what and how did you learn from them?
    - What structures did you put in place to resolve these problems?
    - Would you have done anything differently?
    - Did you adopt a different mindset?
    - Did it encourage you to recruit new members?
    - Did it make you more cautious?
    - Can you identify milestones/tasks/junctures during the formation of the firm?

Appendix 6: Scottish Biotechnology Firm Email Survey

Biotech Firm Profile

Sir/Madam,

The purpose of this questionnaire is for academic purposes only and all information will be kept confidential.

I am a second year PhD research student at Nottingham University Business School (NUBS). My area of interest is entrepreneurship and I wish to identify biotechnology firms which have originated from universities, from industry or from other sources. Additionally, I would like to establish in which environment they have located and the maturity of their product or service. In total there are three (3) questions to answer. Contact details were provided by Scottish Enterprise, "Source Book 2003".

Your participation would be much appreciated. Please write your answers in the spaces provided.

1. Which of the following options best describes the firm?

a) Originated from a university (e.g. using university created knowledge and formed by an academic, researcher or student).
b) Originated from industry (e.g. using knowledge created in industry and formed by an ex-employee).
c) Formed by an academic entrepreneur employed by the university.
d) Formed by an entrepreneur not employed by the university.
e) Other (please specify).

ANSWER:

2. Which of the following options best describes the environment of the location of your firm?

a) University incubator unit.
b) Science Park.
c) Managed incubator not located on a university.
d) Industrial estate.
e) Office location.
f) Home address.
g) Other (please specify).

ANSWER:

3. Which of the following options best describes the phase of development of your firm?

a) Research.
b) Product/process development.
c) Product/process testing.
d) Business is trading and generating sales.
e) Other (please specify).

ANSWER:

Thank you for your participation.

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Appendix 7: Letter Requesting Face-to-Face Interview

Lixmhb1@nottingham.ac.uk

Date

Dear Name of Recipient,

RE: INTERVIEW REQUEST

Thank you for responding to the e-mail survey sent to you in July, 2004 (Biotech Firm Profile). I am extremely grateful for the information supplied relating to your business (i.e., origin, location and phase of development).

My doctoral studies at Nottingham University Business School are focusing upon the development of biotechnology firms in Scotland. I am particularly interested in how barriers to commercialisation are being addressed. My research is exploring the resources and methods used by entrepreneurs to convert ideas into commercial products and services. To encourage the wider commercialisation of knowledge by entrepreneurs in Scotland, I am seeking to identify various forms of best practice exhibited by bio-technology firms.

I am inviting a select group of entrepreneurs and firms to participate in my study. My qualitative study will explore the roles and contributions played by equity holders and key decision-makers in bio-technology firms. Specifically, I will explore the contributions played by the key equity holders in the opportunity pursuit stage of commercialisation.

I would be extremely grateful if you would agree to participate in the study. You can trust me not to divulge your name or the name of your firm to anyone else. I will ensure complete confidentiality. Code names will be allocated to respondents and only the code names will be reported in my doctoral dissertation. If requested, Professors Mike Wright and Paul Westhead (Nottingham University Business School) will verify my doctoral student status and will confirm that collected information will be reported with the utmost care not to reveal the identity of each respondent. The key findings of the study will be sent to all participants.

Next week, I will personally telephone you. I hope you will be able to recommend individuals from your organization who will share information relating to the development of your firm. To ensure confidentiality, I would like to personally interview the key equity holders who you recommend to be interviewed. I plan to personally conduct face-to-face interviews between January and April 2005. In advance, many thanks for your assistance with regard to this important study.

Yours sincerely

Maris Bruce
PhD Doctoral Student

cc. Professor Mike Wright
Professor Paul Westhead

Appendix 8: Movement of lead entrepreneurs encountered at critical junctures

Company	*Opportunity identification*	*Entrepreneurial commitment*	*Venture credibility*
Company 1 **Lead Academic Entrepreneur**	**External Environmental Context:** **Sponsored (HEI) Environment.** The lead entrepreneur realised and identified the opportunity whilst completing his PhD.	**External Environmental Context:** **Sponsored (HEI) Environment.** The lead entrepreneur won a business plan competition and was firmly committed to forming a firm during his PhD write up. He identified a commercial application and an experienced MBA student joined as an equity holder.	**External Environmental Context:** **Sponsored (HEI) Environment.** With assistance from mentors and an MBA student, market research was conducted to establish a viable product for potential customers. Business plans modified to attract business angel funding to support research and development.
Company 2 **Lead Academic Entrepreneur**	**External Environmental Context:** **Sponsored (HEI) Environment.** The lead entrepreneur worked in the HEI department where the chemical process had been researched as part of an academic project. He recognised the opportunity to commercialise his research because of the value of the process to the chemical sector. Research and development was supplemented with industrial contract work.	**External Environmental Context:** **Sponsored (HEI) Environment.** A team of four committed to the commercialisation process. One academic stayed in his research post; another academic embarked on a fellowship program for entrepreneurship; the practicing entrepreneur searched the market for customers with the lead entrepreneur.	**External Environmental Context:** **Sponsored (HEI) Environment.** With assistance from the TTO, government funding was successful granted and contract customers attracted to use the company's services. Research continued on the development of the chemical process.
Company 3 **Lead Academic Entrepreneur**	**External Environmental Context:** **Sponsored (HEI) Environment.** The lead entrepreneur had been conducting research within the HEI for 20 years and had developed a new diagnostic dental instrument which had commercial potential but he was unsure how to exploit it.	**External Environmental Context:** **Sponsored (HEI) Environment.** The lead academic and his colleague did not leave their academic posts because they had many responsibilities as academics, researchers and clinicians.	**External Environmental Context:** **Sponsored (Technology Park) Environment.** HEI forces the company to find alternative accommodation. A surrogate entrepreneur is attracted to the company, becomes an equity holder and chair of the board. 1st round funding gained from local and national venture capitalists.

Appendix 8 (continued): Movement of lead entrepreneurs encountered at critical junctures

Company	*Opportunity identification*	*Entrepreneurial commitment*	*Venture credibility*
Company 4 **Lead Academic Entrepreneur**	**External Environmental Context: Sponsored (HEI) Environment.** The lead entrepreneur identified the commercial value of a fluid flow technology observation during a fellowship program at an HEI in the USA and applied it to a medical device.	**External Environmental Context: Sponsored (Technology Park) Environment.** Entrepreneurial team members did not leave their clinical posts but were forced to move away from the HEI. Laboratory space had to be customised and constructed.	**External Environmental Context: Sponsored (Technology Park) Environment.** An engineer produces a prototype and successful presentations made to major venture capitalists known to the engineer.
Company 5 **Lead Academic Entrepreneur**	**External Environmental Context: Non-Sponsored Environment.** The lead entrepreneur and engineering colleague identified the opportunity when both their skills sets were combined.	**External Environmental Context: Sponsored (HEI) and Non-Sponsored Environment.** The lead entrepreneur formed a company and then moved to an HEI to conduct further proof of concept and recruited another academic to assist with research and management of the re-formed company.	**External Environmental Context: Non-Sponsored and Sponsored (HEI) Environment.** Government funding successfully granted and further applications to business angels positive. Funding allowed a return to a sponsored environment.
Company 6 **Lead Non-academic Entrepreneur**	**External Environmental Context: Non-Sponsored Environment.** The lead entrepreneur identified opportunity from market research with his customers from his previous liquidated company.	**External Environmental Context: Non-Sponsored Environment.** The lead entrepreneur re-located to another part of the country to attract local authority funding and form an entrepreneurial team and new company.	**External Environmental Context: Sponsored (Technology Park) Environment.** Delayed access to funding and access to laboratory facilities delays R&D. Move enables access to laboratories and proximity to like companies.
Company 7 **Lead Non-academic Entrepreneur**	**External Environmental Context: Non-Sponsored Environment.** The lead entrepreneurs realized their opportunity from their scientific skills and knowledge of the pharmaceutical industry whilst in employment.	**External Environmental Context: Non-Sponsored Environment.** The lead entrepreneurs were made redundant from their jobs and wrote business plans from their homes.	**External Environmental Context: Sponsored (Science Park) Environment.** Contract work was won but public funding denied partly because of lack of appropriate advice from the business development agencies.

Appendix 8 (continued): Movement of lead entrepreneurs encountered at critical junctures

Company	*Opportunity identification*	*Entrepreneurial commitment*	*Venture credibility*
Company 8 **Lead Non-academic Entrepreneur**	**External Environmental Context: Sponsored (HEI) Environment.** The lead entrepreneur identified his opportunity through co-operation and skill sharing with academics within an HEI.	**External Environmental Context: Sponsored (HEI) and Non-Sponsored Environment.** The lead entrepreneur was invited to an HEI laboratory to have close proximity to academics to learn about laboratory processes and write business plans. The academics remained in academia and the engineers committed all their time to the newly formed company.	**External Environmental Context: Non-Sponsored Environment.** Company remains on industrial site and upgrade size of rented unit. The entrepreneurial team highly credible in terms of business acumen and technical capability and able to attract funding and support from business angels.
Company 9 **Lead Non-academic Entrepreneur**	**External Environmental Context: Non-Sponsored Environment.** The lead entrepreneur's reaction to the harmful affects on humans of chemicals in an animal insecticide was to search for a safer alternative.	**External Environmental Context: Non-Sponsored Environment.** The lead entrepreneur attracted funding to conduct experiments on a farm. A company was formed but the entrepreneurial ownership team lacked business knowledge and understanding.	**External Environmental Context: Sponsored and Non-Sponsored Environment.** A management company specialising in early stage start-ups were paid to manage the firm. There was a change in product and change in management which took Company 9 back to the opportunity identification critical juncture. Sources of new funding were sought and confirmation of the new product verified.