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WHICH FACTORS DRIVE FIRM SURVIVAL WITHIN AN INDUSTRY BOUNDARY OVER TIME? THE UK ONSHORE OIL AND GAS PRODUCTION INDUSTRY 1984-1999

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Abstract

This thesis looks at the UK onshore oil and gas production industry and follows the history of a population of firms over a fifteen-year period following the industry's renaissance. It examines the linkage between firm survival, selection pressures and adaptation responses at the firm level, especially the role of discretionary adaptation, specifically exploration and exploitation strategies. Taking a Realist approach and using quantitative and qualitative methods for triangulation on a new data base derived from archival data, as well as informant interviews, it tests seven hypotheses[1] about post-entry survival of firms.

The quantitative findings suggest that firm survival within this industry is linked to discretionary adaptation, when measured at the firm level, and to a mixture of selection and adaptation forces when measured for each firm for each individual year. The qualitative research suggests that selection factors dominate. This difference in views is unresolved. However the small, sparse population and the nature of the oil and gas industry compared with other common research contexts such as manufacturing or service firms suggests the results be treated with caution as befits a preliminary investigation.

The major findings include limited support for the theory that the external environment is the major determinant of firm survival, though environment components affect firms differentially; resolution of apparent literature differences relating to the sequencing of exploration and exploitation and potential tangible evidence of coevolution. The research also finds that, though selection may be considered important by industry players, discretionary adaptation appears to play the key role, and that the key survival drivers for this population are intra-industry ties, exploitation experience and a learning/experience component. Selection has a place, however, in determining the life-cycle of the firm returning to be a key survival driver at certain ages of the firm inside the industry boundary.

[1] Including the null hypothesis.

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Secondly, thanks to everyone who contributed to the academic aspects of the research, especially Bob Phelps, Mitchell Koza and Arie Lewin, as well as various supporters at Cranfield, the Open University, Henley Management College and elsewhere, including those who gave feedback either through reviews or conferences. Thanks, too, to Livia Markoczy for starting me off on the right path to research, and to my internal and external examiners, Peter Allen and John McGee, as well as Sue Vinnicombe;

Thirdly, thanks to everyone connected with the oil industry who contributed to this research, especially the informants, the UK Onshore Operators Association, the Oil and Gas Directorate, IHS Energy and various librarians and archivists – all of whom were very generous with time and/or resources;

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I'd also like to remember two good friends from the oil industry who didn't live to see the end result, Peter Ellis–Jones and Roland Shaw. RIP.

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CHAPTER 1: THE RESEARCH PROBLEM

1.1 Summary

This chapter sets out the story behind the research on the survival of firms covered by this thesis, and defines the research question. It also includes a map of the succeeding thesis chapters. It is laid out as follows: introduction; background to the research; research objectives; why do some firms appear to remain in an industry for longer than others?; the natural resource context; the research question; and the structure of the thesis.

1.2 Introduction

This thesis is about the survival of firms within an industry boundary (that is the survival of firms viewed at the business level) as an outcome of their interaction with the external environment, and considers the mechanisms that contribute to their survival. It explores some of the mechanisms that appear to contribute to the continuation of this state of survival, and using the evolutionary metaphor proposes a model that attempts to explain how external selection events and adaptation by the firm can impact on a firm's survival. This has implications for policy-makers who are interested in fostering local industries.

The opening chapter looks at the background to the research, and provides a brief introduction to the research objectives, the research context, the research question and population. It outlines the structure of the thesis and it closes with a section providing a summary and conclusions.

1.3 Background to the Research

When I was a commercial and investment banker during the 1980s, I followed the fortunes of the smaller firms in the UK oil sector as a specialist lender and project finance expert. I knew all the key players in what was then a small, tightly knit community. I shared their joy when things went well (e.g. they had a successful discovery or a field became commercial). I also shared their gloom when all went wrong (e.g. the spectacular blow-out of an onshore well on the TV news; the dry holes; time and money spent on a field that wasn't ultimately commercially viable). I handled asset sales for these firms as they withdrew, as well as purchases of assets or firms. I bid to finance their onshore assets, and ultimately argued their corner in conferences, and industry institutions. For the smaller firms, onshore UK was going to be the place where they would discover a large onshore field, get it into production and make their names and personal fortunes. Of the original firms that were present in 1984, when this study starts, none are still active onshore in the UK[2]. Is this explained by the general argument that firms suffered *"corporate infant mortality"* (de Geus, 1997, p.8)?

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[2] Except for BP and Premier who are still participants in the Wytch Farm field, itself viewed as an offshore asset by many in the industry. The inclusion or exclusion of Wytch Farm is discussed further in later chapters of the thesis.

Or is it that the industry is no longer attractive (Porter, 1980) as a result of environmental changes?

Overall firm numbers are not declining, so new firms are replacing exiting firms, suggesting the argument about industry unattractiveness is untrue. Indeed, a recent Press announcement (14.08.03) of a successful onshore exploration oil well by one of the firms in this study has re-ignited all the debates about onshore oil discussed in this thesis, confirming a view that the UK's onshore province and therefore production is not yet dead. So why have most of these firms disappeared from the industry, and what mechanisms appear to have caused some to survive and prosper?

Since the discovery of North Sea Oil in the 1960s the international majors, including the so–called Seven Sisters[3], have dominated the UK oil industry. However, industry stakeholders had looked to the vibrant population of smaller independent firms active onshore in the USA, believing that this phenomenon could be replicated in the UK. This view still pertained in the late 1990s (Bleakley, Gee & Hulme, 1997). For smaller firms, the UK onshore area was of greatest interest. There was considerable optimism that another large onshore oil field would be discovered, a complement to the large Wytch Farm onshore field discovered in the 1970s and privatized in 1984 (Hoopes, 1996). Onshore oil was also a lot cheaper to discover and produce than offshore oil, especially given the challenging physical and technical conditions of the North Sea. So the expectation was that a population of strong UK independents would emerge from onshore UK production and then spread their expertise elsewhere. Some might even be fortunate enough to grow and be able to fund the substantially higher stakes needed for offshore exploration and production.

Hamish Gray, Minister for Energy, visiting the Humbly Grove onshore oil field in 1982, said: *"In today's uncertain world it becomes increasingly important for us to have as full a knowledge as possible of the resources which are available to us. All recoverable reserves make a vital contribution to our security of supply and thus to the economy as a whole."* (Huxley, 1983, p.7). Alex Salmond, then Energy Economist, Royal Bank of Scotland, and better-known more recently as the Head of the Scottish Nationalist Party, stated: *"Among his 'seven sound reasons' for developing onshore, the Minister of State last year said[4], 'there is the opportunity to build up a vigorous and modern oil exploration industry – an opportunity for the growth of smaller companies'. This is what the UK should be looking for from the onshore industry – an opportunity to establish a new generation of small oil companies, the best of which will find will find their growth accelerated through operating onshore UK… The Government should give thought to measures which will make onshore development easier for all companies and thus possible for the smaller 'players'."* (Salmond, 1985, pp.81-82).

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[3] Arco, BP, Chevron, Exxon (Esso), Mobil, Shell, Texaco, no longer seven as a result of mergers.

[4] I.e. the quote from Hamish Gray already cited.

The view from the smaller firms at the time supported this thinking: *"Independents have introduced new thinking into the North Sea… They have generated new geological ideas. But the big challenge for independents is to turn innovative thinking toward a new generation of marginal reservoirs and convert them to commercial development projects. The capabilities of independents also have found favour recently with DOE. Civil servants have noted that major company procedures often are a drawback in dealing with marginal reservoirs. Focusing major companies' vast reserves of technical expertise on a problem often produces a high cost solution."* (Vielvoye, 1985).

This rhetoric supports a view of the UK onshore oil province as a milieu for new, small UK oil and gas firms to acquire expertise and move on; a *"nursery"* to quote an informant interviewed for this research[5]. However, by 1989, a British parliamentary commission was expressing concern at the shrinking numbers of British independents in the UK oil sector as a whole: *"The energy committee of the House of Commons reported that less than half the active UK independents of 1982-83 were active at the end of 1987. The decline continued into 1988."* (Anon, 1989). So it appears that either the independents were not benefiting from the nursery or had failed to make the onshore to offshore transition successfully. It is the first group that this thesis is addressing.

Some of that loss of onshore industry optimism was due to poorer geological results than expected: e.g. Vic Colter, a senior geologist with British Gas, the co-founder of the giant Wytch Farm onshore oil field, summarised the pessimism of the later 80s: *"Who knows though, maybe someone some day will come along and find all the giant strat-traps that those who, over the years, compared the East Midlands with Alberta have always dreamed of. Maybe also someone will find the clue to solving the problem of what happened to the oil that was not trapped at Wytch Farm."* (Moreton, 1995 p.108).

So firms left the onshore industry because the returns were unattractive and moved on to other pastures, as suggested by Vic Colter, with other incumbent/new entrant firms acquiring their onshore assets or even the entire firm. Within the population under study, there were no bankruptcies or firm failures and the acquisitions would suggest that the assets had value if only as a collection of tax losses. However, there are also some long-term survivors – this thesis sets out to look at what characteristics, if any, they share that are linked to the length of their survival and what apparent mechanisms contribute to this survival?

The UK Government rhetoric concerning all oil exploration, as recently as 2002 continues to be that: *"The DTI is accelerating its strategy to foster increased exploration activity on the United Kingdom Continental Shelf (UKCS), and the drive to attract committed new entrants."* (Munns, 2002). In a presentation at

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[5] The nursery metaphor is discussed in more detail in Chapter 8 which looks at informant interviews.

the 2002 Petex[6] industry exhibition, Jim Munns confirmed that these comments are directed at new foreign firms, not at a new generation of UK firms, and also apply offshore rather than onshore. This loss of emphasis on onshore oil can also be seen at the government support level: a single individual at the DTI now handles UK onshore oil interests. The onshore nursery is no longer exclusively the province of small UK firms; new firms, albeit non-UK firms, are still entering the industry and the number of recorded fields in production continues to rise, so it appears to remain an attractive investment choice.

From this brief history, several questions arise which can be linked to the introduction:

1. What happened to the vision of a flourishing UK independent oil sector based on onshore oil?

2. Was the dream described by Alex Salmond realised in the intervening years?

3. Why did some firms survive for long periods of time, but others transit through the industry?

4. Are there lessons here for other countries fostering a natural resource industry?

This thesis sets out to explore some of these issues as a starting point for a larger proposed follow-on research project exploring firm survival inside an industry boundary over a longer period of time and across countries to compare different policy regimes.

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[6] Petex is the Petroleum Exploration Society of Great Britain's biennial exhibition and conference.

1.4 Research Objectives

Cournot suggests that: *"For a complete and precise solution of the particular problems of the economic system, it is inevitable that one must consider the system as a whole"* (Cournot, quoted in Blaug, 1978, p.603). In this thesis, the system, as a starting point, is defined as three distinct levels shown below in Figure 1.1.

Looking at the system allows an examination of the different levels and their interactions, but to define the system the hierarchy also needs to be explained. Kline (1995, p.270) concludes: *"Hierarchy is a concept we must have, since it describes much (perhaps most) of the structure of many kinds of systems of importance."* In the context of this thesis, the system and its hierarchy are sense making tools (Weick, 1969).

In this research, three levels are used to define the system: the external environment, the population of firms and the individual firms (i.e. the aggregation of field interests held by each firm). These correspond with three of the levels used in Lewin, Long & Carroll (1999) – data is unavailable to permit exploration of the institutional level factors, which may be covered in a future study.

The thesis is concerned therefore with survival as an outcome of mechanisms inside the system under study, observed as a result of activity between the external environment and the firms: thus survival or demise at a firm level (adaptation) shapes the individual firms and thence their aggregate population, through response mechanisms initiated from inside the firms, while macro-economic factors shape the population by selecting out those firms unable to withstand adverse economic movements as a result of industry or macro-environmental forces outside the firm.

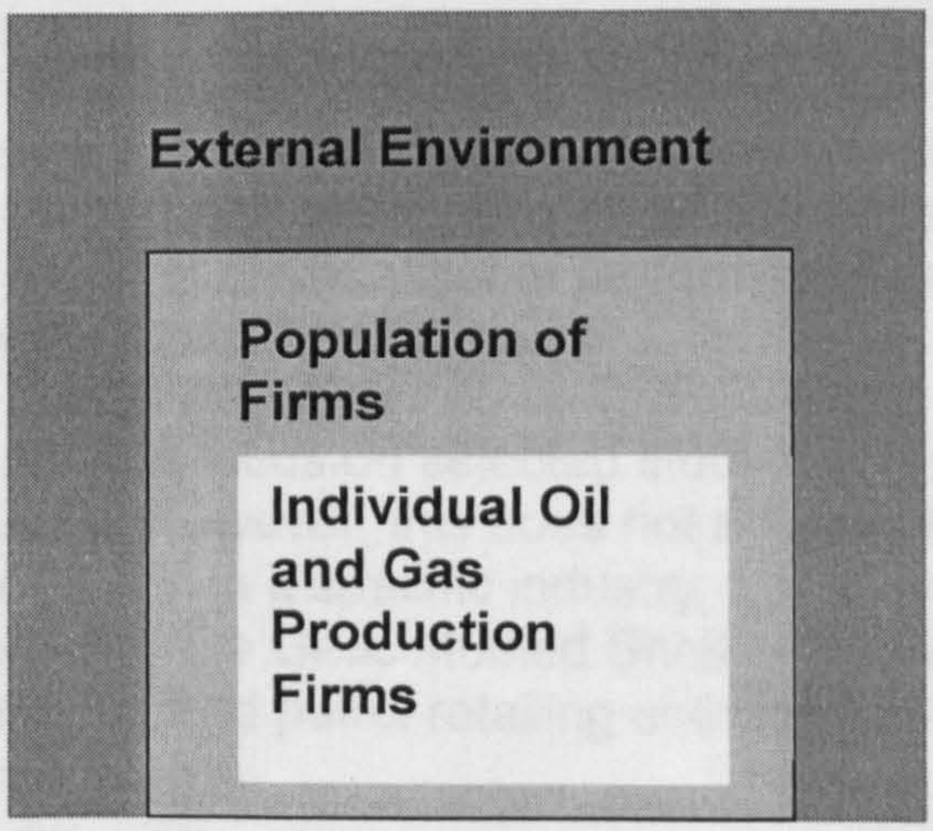

Figure 1.1: Levels of Analysis used in this Thesis

There are many theoretical perspectives on systems including Salthe (1985, p.9) who discusses the structure and order of the world in terms of causal and control relationships, complexity, stability and defines boundaries. Systems theories are time and context dependent. Checkland & Scholes (1999, p.A46) mentions Reed (1985) as discussing: *"The general shape (of the organization theory field) is that of the establishment of an orthodoxy (the systems/contingency model) that held sway from the 1930s to the 1960s and the challenge to the orthodoxy since then, with no single dominant alternative."* This belongs to the *"hard"* systems movement which reifies organizations, a perspective that informed contingency theorists (Pugh, Hickson, Hinings & Turner, 1969; Donaldson, 1996) and the theories and approaches that claim lineage from these works. The alternative perspective, that of the *"soft"* systems movement led by Gwilym Jenkins and Peter Checkland in the 1960s, develops a soft-systems methodology (Checkland & Scholes, 1999) that recognises that systems are not mechanically driven. In the soft systems view, reality is socially constructed (Berger & Luckman, 1966). Soft systems shift the "*systemicity*" from the system(s) to the process of inquiry, much closer to the approach used in this thesis.

The mechanisms for survival are explained through the use of an evolutionary metaphor, the literature background to which is explored further in Chapter 3. An evolutionary approach recognises the use of systems and hierarchies to explain change.

1.5 Why do some firms appear to remain in an industry for longer than others?

Researchers and managers alike are interested in the survival of firms and organizations. But what constitutes survival? Is it performance, or is it just *"being there"*?

Many of the studies in the literature focus on large organizations because data is easier to obtain for longitudinal studies. However, the universe of firms and organizations includes large numbers of smaller organizations that survive for shorter periods, or are less visible because they may occupy specialist niches. Classic industry studies in the field of organization ecology identify some of the roles of these smaller entities, but there remains an overall focus in the strategy literature on the *"Holy Grail"* of organizational performance or survival based on studies of groups of larger organizations.

Other research has tended to focus on selected studies of large firms, and their longevity (de Geus, 1997). However, this does not address the issue of presence or absence of a firm in a specific industry, but allows portfolio effects to dominate industry effects. De Geus studied Shell, which includes exploration, refining, mining, and petrol retailing activities, all industries with very different dynamics.

De Geus (1997, p.8) refers to an unpublished *"brief desk study"* by the Stratix Group suggesting that the average lifespan of firms is as low as 12.5 years, provided they survive the *"infant mortality period"*, defined as the first 10 years.

In contrast, this research considers survival within the context of an industry where smaller firms[7] predominate and, as a result of industry secrecy, assets and knowledge are highly asymmetric. Small firms are interesting because they make up the largest number of industry participants, and they tend to be shorter-lived. They rely on adaptation rather than resource endowment or legacy providing a basis for economic viability for survival, *"(While) organizational survival is enhanced by legitimacy, it is also enhanced by economic viability, especially in the case of private organizations."* (Pfeffer & Salancik, 1978, p.202).

Existing studies on organizational performance success have tended to look at financial metrics. Since many smaller entities are not cashflow positive in early life stages, this approach excludes them. The thesis follows the economists – (Barnard, 1938; Dertouzos, Lester, Solow & the MIT Commission on Productivity, 1989) - in looking at survival as a prerequisite for success (i.e. successful performance) and thence focusing on survival itself.

Survival is viewed inside the industry boundary, rather than as an organizational attribute. This thesis follows the definition of industry as *"the domains in which corporations operate "* (Carroll & Hannan, 2000, p.xx). Hence an organization's ability to persist by moving from industry to industry is excluded in favour of a single competitive landscape – the industry under study - to look at any outcomes that would have value to policy-makers as a key influence in shaping that landscape. This is congruent with Donald Campbell's philosophy calling for *"society ... (to)... be improved through policy evaluations based on hard-headed evaluation"* (Campbell & Russo, 1999, p.69).

Survival is also considered as post-entry survival in this thesis thus implicitly dependent on entry with one hypothesis considering entry mode and timing and its link to survival. Post-entry survival removes the *"noise"* in the population from short-term industry participants. The decision to use post–entry survival was taken after completion of the pilot study, which included all firms and produced heavy short-term weighting in the results.

One important consideration when assessing survival relates to the question of ownership of firms and the relationships with the recorded identity of a firm. Change of ownership, discussed as a specific issue in the later Research Design Chapter (Chapter 6), means that the firm as a recorded entity is considered to have exited from the industry, congruent with the position that though the assets and even managers may not have changed, the beneficial

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[7] In this thesis, small firms are defined by size of assets in the industry. This is not the same as formal definitions of SMEs used in other literatures, but circumvents the issues of access to and unavailability of detailed internal information on the history of many firms in the population, such as the number of employees.

ownership, stakeholders and direction have fundamentally altered the identity of the firm. This is an example of the limitation of the application of biological evolutionary metaphors to firms, which have fundamentally different properties. It also illustrates the limits to the reification of organizations characterising the hard systems approach briefly described above. In order to manage these boundary issues, this thesis takes the standpoint that a firm is considered to have survived in the population for as long as it is recorded as present with the same legal entity and the same ownership.

The theoretical model used in the thesis postulates three interlinked pillars of survival which constitute successful adaptation mechanisms as a response to selection pressures: industry embeddedness through the establishment of intra-industry networks, intra-industry experience, and the completion of specified exploration and exploitation events at the sub-firm level.

1.6 The Natural Resource Context

After some thought, the onshore oil industry was chosen as a context to explore the theoretical model as it:

1. Offered a more manageable population to use;
2. Theoretically offered some publicly available data from Government sources;
3. Offered the possibility of future studies on both offshore and international comparisons to control for certain key variables;
4. Made use of my prior knowledge of the industry.

Although data was reportedly publicly available for all producing firms, in practice there needed to be substantial cross-checking of the accuracy of this information, and the historic data proved less easy to acquire than originally expected. This research was conducted in a zero budget environment, so costly access to historic firm financial data was precluded.

The research context is an extractive industry where competitive advantage lies in access to both precursor resources and information and output is a commodity, very different from the more usual manufacturing or service firm contexts in the literature. Natural resource industries are usually very secretive (Stanley & Morrison, 1989) because competitive advantage lies in information about reserves, geological structures and operational processes. These industries often contain large numbers of small firms, interesting to national policy-makers trying to promote an indigenous fledgling industry. A UK Government data source (archival information) was used to produce statistical data on firms and fields. A longitudinal approach is used to ensure consistency of response, as well as the more common cross sectional study across the industry population. A semi-structured interview approach identifies key drivers for the statistics, and for triangulation purposes. These issues are discussed in Chapters 5, 6, 7, 8 and 9.

The research context includes the following key characteristics that differentiate this study: survival measured as post-entry survival to remove *"noise"* from firms transiting through the industry (Disney, Haskel & Heden, 1999); a population dominated by small firms[8]; a resource industry, with different industry dynamics from manufacturing and service industries; a high degree of information asymmetry and secrecy (Stanley & Morrison, 1989); state-owned firms, licensing[9] and competitive bidding; inter-firm collaboration to share risks and resources; and a complex web of stakeholders.

The study covers the period 1984-99, and the survival or demise of a final population of 45 firms as they enter or leave the onshore oil and gas production industry. Onshore oil and gas production was chosen as it offers an insight into a population of firms that are less volatile than offshore oil and gas production. Unlike offshore, onshore also does not favour larger firms, as investments are more modest in size, as indeed are returns.

The shorter 1984-99 period was chosen as it marks the perceived start of onshore production from more than one oil field, and allows the capture of various industry shocks and firm survival or demise resulting from them.

The production industry was chosen because the inclusion of exploration firms caused data collection problems - this data is not available in the public domain and there is evidence to suggest that the industry drivers are different (Smith & McCardle, 1998). The industry context is discussed further in Chapter 5.

1.7 Research Question

The Research Question is:

> *What factors, in particular the impact of environmental events (uncontrollable by firms), and the impact of adaptive actions (controllable by firms), appear to drive firm survival within an industry and why?*

From the primary question flows a set of sub questions:

- Which factors, exogenous and endogenous to the firm, appear to enhance firm survival?

- Are environmental (exogenous) factors more likely to influence survival than firm level (endogenous) factors?

- Does adaptation and specifically discretionary adaptation appear to enhance survival?

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[8] Smaller natural resource firms are under-researched. Grant & Cibin (1996) looks at larger oil and gas firms but the smaller resource firms are a comparatively neglected research context, possibly due to their almost paranoid secrecy and thence limits on access to data.
[9] The US spelling of license is the accepted norm in this industry.

1.8 The Structure of the Thesis

The thesis is structured in 10 chapters, arranged into the four blocks shown in Figure 1.2:

Block 1 - The background philosophy and literature supporting the research.	**Block 2 – The specific theoretical and industry context and structure of the research.**	**Block 3 - Data and data Analysis.**	**Block 4 – Results and application of the research**
Chapter 1 - The Research Problem	Chapter 4 - The Theoretical Framework and Hypotheses	Chapter 7 - The Pilot Quantitative Data Study	Chapter 10 – Discussion, Limitations, Conclusions and Future Directions
Chapter 2 – The Philosophical Approach	Chapter 5 - The Research Context	Chapter 8 - The Qualitative Data Study	
Chapter 3 – Literature Review	Chapter 6 - The Research Methodology, Methods and Design	Chapter 9 – The Main Quantitative Study	

Figure 1.2: The Structure of the Thesis

1.9 Conclusions

This thesis looks at firm survival inside the industry boundary at the population and individual firm level over a 16-year period, 1984-99. It follows the thrills and spills of an industry that was expected to blossom and provide a vibrant new UK industry. Although the industry still exists, despite various government initiatives it remains small. Using this unusual opportunity to study the survival of smaller firms over time, as the thesis unfolds it will: offer some reasons why firms survive inside an industry, or fail to do so, based on theory; advance a theoretical model and test it; consider survival strategies that may be deduced from the data; and discuss the scope and limitations of the conclusions.

CHAPTER 2: THE PHILOSOPHICAL APPROACH

2.1 Summary

This chapter explores the philosophical approach underpinning this research project from three viewpoints: the researcher, the extant literature, and the research project demonstrating a consistency between the three.

In addition, it briefly discusses the particular Realist epistemological approach, *"Campbellian Realism"*, that has been adopted by researchers taking a coevolutionary approach in organizational research in the Social Sciences. Finally, it examines the congruence between the Realist epistemology and the specific research strategy and methods used in this thesis.

The chapter is laid out as follows: introduction, the researcher's position, epistemological approaches in existing organizational research, the research strategy and methods employed in this thesis, and conclusions.

2.2 Introduction

The major literatures supporting this research come from two of the core disciplines of Social Science: Sociology and Economics. However, research traditions are very different in these two disciplines when considering the basis of knowledge. While research published in mainly US journals tends to be empirically based, especially in Economics, the corpus of European research is looking more and more to an approach based on Realism as offering better explanatory powers.

Brunswik (1952) refers to the cognitive lenses through which we see the world and filter information. In any discussion of research therefore, there will be cognitive biases from the researcher and from any informants or recorded sources used as well as from various researchers. This is recognised in the Realist epistemological tradition as a development from the former scientific tradition developed over preceding centuries. The scientific tradition developed from an approach that valued experimental methods to demonstrate causality between observed phenomena, using an Inductive process. This view sees the world of the experiment as a closed system such that all effects can be recognised, observed and measured. These traditions and beliefs continue in many scientific disciplines today. The world of the experiment can be viewed as *"artificially created"* which permits effective outcomes (Smith, 1998, p.39).

In the world of Social Science, however, the system is difficult to represent as closed because the boundaries are *"messy"* or *"fuzzy"*. Absolute causality is less clear and latent factors may provide the explanations for phenomena, e.g. the effect of diet and human height, where genetic heritage will also have an effect. Smith (1998, p.42) discusses the importance of system closure to those disciplines such as Economics that "*have sought to establish objective knowledge*". He differentiates between three forms of closure: experimental

closure, used in psychological experimentation; theoretical closure, where a model's outputs are matched with those observed, e.g. econometric models; and statistical closure using correlation. Each of these approaches has problems with replication by the research of the phenomenon under study, especially experimental and theoretical closure, and these are the subject of literature debates such as those between Himmelweit (1958), Eron (1963) and Belson (1978) (all cited in Smith, 1998, p.45). Indeed Dahl (1982) (also cited in Smith 1998, p.44), suggests *"when human actions are to be accounted for, complete closure is sure to require a vast system"*.

The Positivist approach to Social Science research arose from desires by researchers to emulate the rigour and approaches from Natural Science research. Blaikie (1993) identifies six key assumptions common to the various forms and developments of the positivistic approach: naturalism, phenomenalism, nominalism, atomism, scientific laws, and facts/values. The principal problem with a purely Positivist approach is that it failed to account for context and indeed diversity, and thence became entangled with Social Darwinism with consequent loss of credibility. It has survived in a modified form (Logical Positivism) in the work of Twentieth Century philosophers such as Ayer (1936).

The methodology of Positivism relied, like its predecessor, on an Inductive approach to research, until (Hempel, 1965) and others in the Vienna Circle modified it to work from a Deductive process in theory formation, exemplified in the derivative approach termed Operant Conditioning or Behaviourism and the work of the psychologist, B.F. Skinner (Skinner, 1938). The latter proposed a theory of behaviour modification and learning for individuals' behaviour based on the Stimulus-Response mode of Operant Conditioning and using an examination of consequences of behaviour with reinforcement of good behaviour whilst removing possible precursors to perceived anti-social behaviour. This approach believes the system to be closed, and the rules and observations to encompass all possible causes of behaviour.

A development of the Positivist approach came from Karl Popper (Popper, 1959; 1972), who continued to challenge the boundary of scientific and non-scientific knowledge using an approach based on the ideas of *"falsification"* and a *"hypothetico–deduction"* to explore the limits of new theories, proposing a view that truth is relative, not absolute. Popper retained the use of empirical evidence from the largely discredited Positivist research movement, and focused on the problems with the Inductive approach which had originally characterised it. Nevertheless, the Inductive approach lives on in research in Economics and Psychology and even in organizational research. Positivist approaches have been subsumed into the Empiricist research tradition, to which Popper also belongs and which accepts three of Blaikie's assumptions: phenomenalism, atomism and the existence of general scientific laws (Smith, 1998, p.118).

Kuhn (1970) introduced the construct of paradigms as *"universally recognised scientific achievements that ... provide model problems and solutions to a community of practitioners"* (Kuhn, 1970, p.viii). Paradigms are incommensurable, and therefore exclusive. They can also represent models that dominate in a school of thought or practice. These three characteristics are not always found to be consistent, and in an attempt to clarify matters, Kuhn offered five characteristics of good scientific theory: accuracy, consistency, broad scope, simplicity, and fruitfulness (Kuhn, 1977, pp.320-9). Some difficulties with the application of Kuhn's work in the natural sciences to a social science are described in Smith (1998, p.198). Paradigms in the Kuhnian sense are short–lived in social science. The lack of clarity about what a paradigm really is has not helped - the term is often used loosely and with a different meaning to Kuhn, e.g. Johnson (1987). This thesis follows Kuhn's usage, describing a model used in a community of practice.

In the Empiricist viewpoint described above, ontology and epistemology are collapsed into a *"flat ontology"*. In contrast, an alternative to the Positivist/Empiricist paradigm in the study of organizations, the Realist viewpoint offers an ontology separated from epistemology. The latter is divided into three layers of reality: empirical, actual and deep or real. Smith (1998, p.299, Figure 7.5) observes that Realists tend to focus on the structures, mechanisms and powers/liabilities found in the real/deep level. Realists see empirical confirmation as only being contextual – events predicted may occur now, but could equally well not occur tomorrow, and are analysed using an open systems approach and favour, as suggested by Bhaskar (1979, p.15), a Retroductive research strategy (Peirce, 1931; Bhaskar, 1986). Bhaskar (1993, p.547), as cited in Northover (1999), identifies three types of Realism: Perceptual Realism, Predicative Realism, and Scientific Realism. It is the last category, Scientific Realism, that looks at the study of phenomena existing and acting independently of researchers using a *"scientific"* approach, that is an attempt to reconcile Realism with some aspects of Empiricism.

A Scientific Realist epistemology is often used in case study research and qualitative research and is relevant here in as much as it offers an integrating epistemology to permit the coexistence of a longitudinal empirical study and a qualitative interview programme in the same research project. It is also consistent with the existing literatures supporting this research as discussed in the next section.

2.3 The Researcher's Position

With a background in Natural Science, and finance, it would be easy to describe my viewpoint as essentially Positivist and Empiricist in nature. However, this would be to deny a number of other significant influences that have shaped my personal philosophy away from these labels, and indeed others bestowed on me such as Marxist and Critical Theorist. I have concluded that I am most comfortable working within the Realist agenda but recognise the weaknesses of this and indeed other approaches to the understanding of how knowledge is known. Inevitably, because I worked in the industry I am researching, I cannot

be an impartial observer, but as a mitigating circumstance, I have had no contact with it for some 10 years prior to beginning this research. Nevertheless, this makes triangulation of the data very important in order to try to manage any biases or misinterpretations.

2.4 Epistemological Approaches in Existing Organizational Research

The Aston group, and especially Derek Pugh, pursued a Positivist approach to organizational research in their studies of contingency and context on organizational form, decision-making, etc. (Pugh, Hickson, Hinings & Turner, 1969). This legacy has been taken up by Lex Donaldson who, in debating its relevance today (Donaldson, 1995, p.6), considers some 15 different paradigms prevailing in management research, all introduced since 1967, and contributing to *"academic inflation in organization theory"* (Donaldson, 1995, pp.10-11). A well-cited statement in Pfeffer (1982, p.1) that *"The domain of organization theory is coming to resemble more of a weed patch than a well-tended garden"* is still true today some 20 years later, with no further resolution or reconciliation of the different approaches, and with paradigmatic plurality now an established tradition. At a practical level, however, this means that for each research project it is important to show consistency in the paradigms used, consistency across epistemology, methods, strategy, etc. and consistency in the use of theory to support the research being undertaken.

This research project has its roots in Natural Science, specifically the constructs of evolution, selection, adaptation, survival, and coevolution; as such it must consider the controversy of the adoption and transfer of ideas from Natural Science to the Social Sciences. For example, Schütz (1963) quoted in Blaikie (1993, p.11) summarizes the dilemma for social scientists, finishing by using the simplistic division of characterising the methods of Natural Scientists as "*explaining*" and Social Scientists as *"understanding"*. In this research project, the supporting literature body is multi-disciplinary and even inter-disciplinary in origin, so the currents in the two main core disciplines are discussed in the next section. Methodological Pluralism is not just confined to these groups, but is even a current thread in Systems Thinking (Jackson, 1997).

2.4.1 Sociology based epistemologies

The sociology–based literature using biological theories of evolution to explain changes in firms over time initially followed a largely Positivist and Empiricist tradition, with closed systems under scrutiny and a tacit philosophical paradigm in use. In contrast, the transfer of newer ideas from biology, especially those using evolution and coevolution, has caused researchers to discuss their approaches and debate the ways to approach research into organizations using an epistemology that is valid. Many members of this research movement are empirical researchers, inevitably looking at survival, entry, exit and change by firms or populations of firms over long periods of time, but some have concentrated on in-depth case studies, closer to a Realist epistemology. In an attempt to set out a manifesto for this group, one researcher, Bill McKelvey, has published what are essentially a series of manifestos described below working towards a unifying epistemology (McKelvey, 1994, 1999c, 2001a, 2001b).

These are based on the writings of a psychologist who turned to philosophy in his later writings and who has had a profound influence on those researchers using a coevolutionary perspective (described in more detail in the next chapter), Donald T. Campbell. Campbell focused on a *"scientific approach"* to research problems, though his legacy encompasses a variety of epistemological and methodological approaches. Campbell's views parallel General Systems Theory, e.g. Parsons & Shils (1951) and functionalism, coming from a background as a *"bench-scientist"* (Baum & McKelvey, 1999a). He uses metaphors, models and ideas from natural science and complexity theory to investigate issues of importance to managers in a scientific (i.e. rigorously objective) manner which he termed *"Organization Science"*. McKelvey (2001b) considers Pfeffer's *"weed patch of theory"* discussed above and offers what he terms *"contra–science ontology"* to explain the diversity in responses from studies of organizations, as opposed to the universal laws observed in (say) physics.

Baum & McKelvey (1999a, p.3) suggest that there are four key Campbellian ideas about scientific inquiry, further developed and integrated by McKelvey (1999b): a focus on selectionist evolutionary explanations of emergent order, and differential survival; an evolutionary epistemology; multimethod triangulation perspectives and experiments and quasi-experiments – a more deterministic approach. This range of methodological opportunities has allowed and encouraged the literature in the coevolutionary perspective as a unifying theory and also enriched the research output of the individual subject themes.

McKelvey (1994, p.315) reviews evolutionary epistemology as the Evolutionary Concept (Level 1), nested within the Evolutionary Paradigm (Level 2) within Organization Science (Level 3). Acknowledging the influence of Popper (1959) on Donald Campbell, he contends that selection applies in the epistemological world as well: the research agenda needs to produce better work in Level 3 to: "*selectively eliminate poor evolutionary concepts at Level 1*". In a later paper (McKelvey, 1999a), he discusses the Campbellian epistemological approach in some detail, arguing congruence with other eminent theorists in the Realist tradition such as Kuhn (1970); Popper (1959); Popper (1972); Bhaskar (1979) and Bhaskar (1986).

In discussing the epistemology of what he terms the *"New Social Science"*, which embraces *"New Organization Science"*, McKelvey (2001a) looks to Suppe (1977) and Hunt (1991) for an epitaph on positivism and relativism, but even in this new Realism, there is no single prevailing paradigm. A reader dedicated to Campbell's legacy (Baum & McKelvey, 1999b), encompasses views from researchers working inside a wide spectrum of epistemological traditions united by McKelvey's approach, and Lewin & Volberda (1999) also show a range of paradigms supporting their coevolutionary perspective, also strongly rooted in Campbell's work as continued by McKelvey (1999c).

The multiplicity of approaches under the Campbellian umbrella results from a predominantly Realist perspective being filtered by individual researchers' own

cognitive lenses as well as the lenses used by literature they rely on, their informants or sources. This results in the exploration of different perspectives using common epistemological routes. Several paradigms flourish simultaneously, in turn permitting continued cross development and fertilization of ideas between the research groups and thence improving the robustness of theory developed, giving rise to a blend of Pfeffer's weed patch and the garden metaphor cited earlier. This approach mirrors the work of Feyerabend (1975) and the ideas of *"paradigm proliferation"* - almost diametrically opposed to the Kuhnian approach favoured by McKelvey, an irony that has possibly spurred the latter in his publications on the quasi-scientific approach, and his advancement of the New Organization Science paradigm. The diversity in approaches also reflects Campbell's own work in favouring different approaches to the same problem to enrich the findings and build better theory, e.g. Campbell & Russo (1999, Chapter 13).

2.4.2 Economics-based epistemologies

Whilst the sociology–based evolution/coevolutionary research movement described above has located itself firmly in the Realist paradigm, evolutionary economists, who contribute an alternative voice to the literature debate are at an earlier stage of epistemological consensus. Economics as an evolutionary science can be traced back to the work of Thorstein Veblen and his question, *"Why is economics not an evolutionary science?"*, the subject of a recent memorial lecture (Lawson, 2002). Lawson reinterprets Veblen and the latter's taxonomic project to parallel a Deductivist approach with a predictive *"scheme"* which is then tested by comparison with observation and *"authenticated by induction"*. Lawson locates this in the institutional economics tradition (Lawson, 2003), and uses what he terms the *"North American strand of institutional thinking"* wherein social life is perceived as decomposing into technology and institutions, of which the latter are static and the former dynamic in nature and recognises dynamic system properties such as emergence, also associated with complexity in physics and the sociological view of evolution. He describes classical economists as pre-Darwinian (p.179) and postulates a philosophical model for research, also based on Bhaskar's Realism, but using a different variant, that of Transcendental or Critical Realism, identical with that discussed in the previous section and possessing the same three levels. This view has not, however, been without debate and dissension (Fullbrook, 1998; Parsons, 1999). The latter agreed with the sentiments, but disagreed with the Transcendental Realist approach and saw a conflict between human intentionality and the Naturalism that is retained from Positivism in Bhaskar's approach.

Uskali Mäki, an economic philosopher, has also written extensively on a Realist approach to economics (including evolutionary economics) over the last 25 years, developing a form of Semantic Realism based on the convergence of three forms of Realism as it relates to theory building: Referential Realism; Representational Realism, and Veristic Realism (with this form of Semantic Realism then subdividing to into Scientific Realists and Scientific Instrumentalists who rely on empirical statements). Mäki has been the subject

of some criticism too (Hausman, 1998) to which he replied (Mäki, 2000), suggesting a misunderstanding of the term *"Realism"*.

Other evolutionary economists have also pursued the Realist agenda. Foss (1994) sees evolutionary economics as Realist, with the principal difference from classical economics being ontological. He points to the nature of the closed systems of neo-classical economics as suppressing novelty unlike the open systems studied in the evolutionary economic research stream, but he also recognises the lack of a *"conceptual unity"*, lamenting the lack of explicit application of Bhaskar's reasoning and his Realist approach to research in evolutionary economics at this time. He uses a term drawn from Mäki (1993, p.40), to define evolutionary economics as a *"causal process theory"*.

A reconciliation of these differing viewpoints (Peter, 2001), begins by returning to an even earlier debate, that of rhetoric in economics and unofficial methodologies in practice (McCloskey, 1983) looking back to the Systems approach of Argyris & Schön (1974) and the differing Realist views espoused by Lawson and Mäki. Peter (2001) sees commonality between the three approaches in the dismissal of a positivist epistemology and agreement about the impact of (negatively perceived) Deductivist methodologies on economic research. However, she sees deadlock in the approaches to a rejection of rational science, with Lawson and Mäki unwilling to relinquish the idea. Nevertheless, raising the questions and stimulating a debate, in which as yet there is no alternative to Realism, is important to pursue for *"self–understanding of the discipline"*.

Nelson & Winter (1982), in taking an evolutionary approach to economics and a dynamic approach to strategy at the firm level, have caused parallel debates about appropriateness of epistemology and consequent methodologies in this subject area. Northover (1999) uses Mäki to critique Nelson and Winter in terms of Bhaskar's Transcendental Realism. Her findings are that, though there are elements consistent with a Realist approach, fundamentally Nelson and Winter are trapped in the path-dependence of the dominant Logical Positivist epistemological paradigm while espousing what Northover sees as inconsistent formal and appreciative theoretical approaches.

Philip (1995) re-interprets Lawson's version of Realism to include an alternative to a Deductive research methodology - that of Abduction, favouring this over Retroduction and stressing its inclusion of both Inductive and Deductive strategies. In a world recognised as more complex by natural scientists and economists, he sees pluralism as *"adding to the explanatory stock of knowledge"*, following Campbell's approach described in the previous section, but he ultimately argues that Lawson's Transcendental Realism is *"a suitable starting point for the formulation and articulation of philosophical foundations of evolutionary economics."* (p.33). The debate will clearly continue.

2.5 Research Strategy and Methodological Approach

In considering a research strategy, there are several considerations of importance that relate to choice and methodology employed, Are the findings expected to be applicable to many situations or even independent of them? Or are they generalisable or embedded in the context and the moment?

Blaikie (1993, Chapter 5) considers four strategies:

- Inductive, where knowledge is produced from observation;

- Deductive, where similar to Popper's (1972) approach described above, a rule, hypothesis or explanation is proposed linked to current theory and then tested with data to prove/disprove it;

- Retroductive, where the phenomenon is observed, an explanation proposed, tested with the data and then explanation itself becomes the phenomenon under scrutiny; and

- Abductive, which is based on hermeneutics, meanings and interpretations, and is described in Blaikie (1993, p.177) as *"....the process of moving from lay descriptions of social life to technical descriptions of social life...."*. It is largely used for research in the Interpretivist tradition, where the phenomenon is the key driver.

Induction and Deduction have been discussed above. The third category, Retroduction, is described as being adopted by the Realist approach, whereas Abduction is largely used by the Interpretivist social scientist. For a Retroductive strategy, a conundrum lies in the derivation of the postulated structures to engage in the research spiral, *"is there a logic of discovery?"*

Peirce (1934) describes the research process as beginning with Retroduction and hypothesis formulation, followed by testing using Inductive and Deductive reasoning. His next stage looks at the consequences of this, and using Induction in a third stage, the sequence completes with testing of these consequences.

This research project follows a mixed approach combining elements of Inductive, Deductive and Retroductive approaches. Each approach has shortcomings, and though McKelvey's argument favours a more Deductive approach, with its ideas of Popperian falsification, Bhaskar (1979) suggests that the usage of models that characterise the Realist approach moves beyond the simple Inductive/Deductive model shown in Figure 2.1 towards a Retroductive approach.

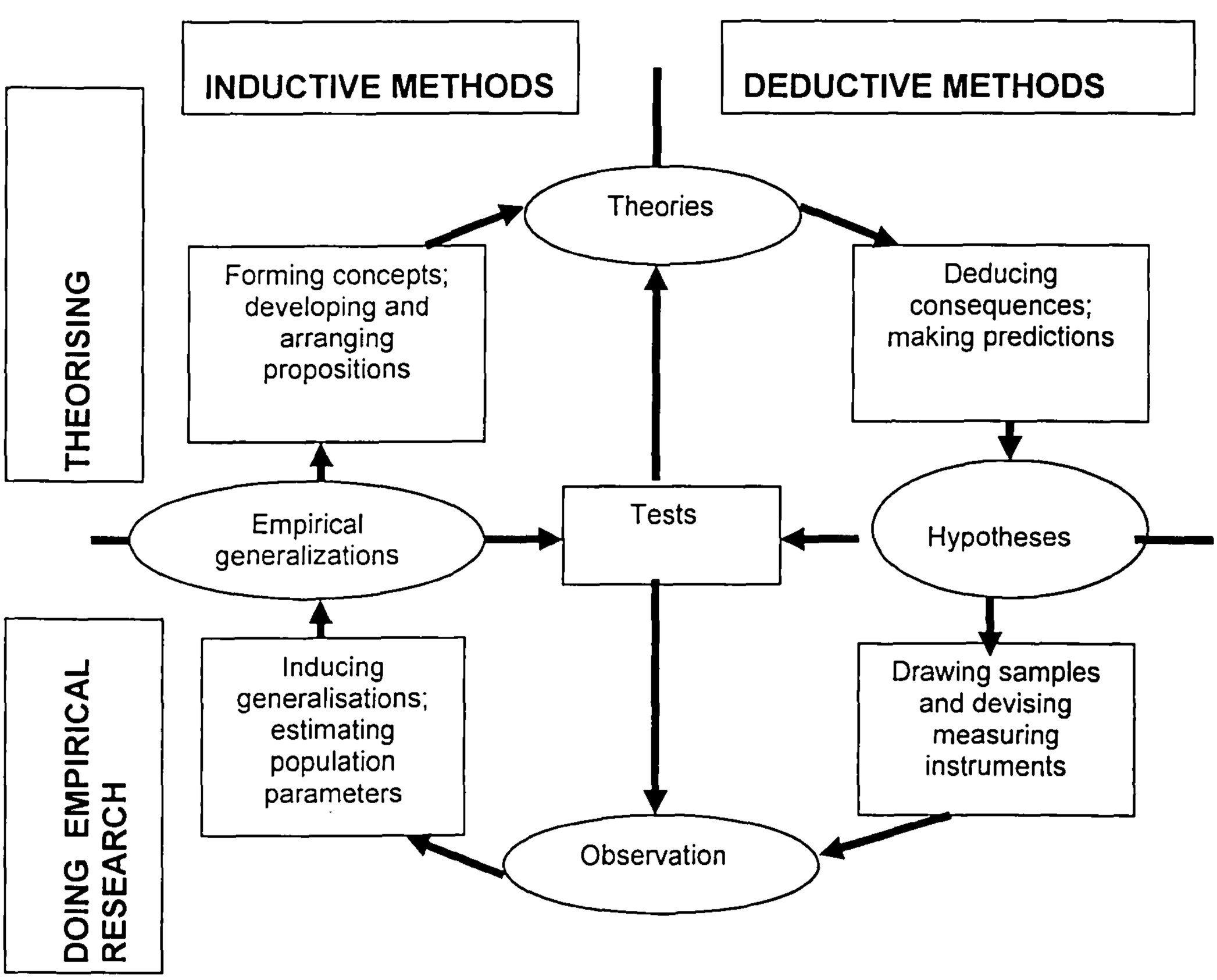

Figure 2.1: Combining Inductive and Deductive Research Strategies (Blaikie, 1993 p.157)

Harré, 1961; Keat & Urry, 1975 p.35 (cited in Blaikie, 1993 p.170) summarise the Retroductive research strategy as follows:

> *"In order to explain observable phenomena and the regularities that obtain between them, scientists must attempt to discover appropriate structures and mechanisms.*
>
> *Since these structures and mechanisms will typically be unavailable to observation, we first construct a model of them, often drawing on already familiar sources.*
>
> *The model is such that, were it to represent correctly these structures and mechanisms, the phenomena would then be causally explained.*
>
> *We then proceed to test the model as a hypothetical description of actually existing entities and their relations. To do so we work out further consequences of the model (that is, additional to the phenomena we are trying to explain), that can be stated in a manner open to empirical testing.*
>
> *If these tests are successful, this gives good reason to believe in the existence of these structures and mechanisms.*
>
> *It may be possible to obtain more direct confirmation of these existential claims by the development and use of suitable instruments.*
>
> *The whole process of model-building may then be repeated, in order to explain the structures and mechanisms already discovered."*

Table 2.1: Retroductive Research Strategy: Blaikie (1993 p.170)

The next chapters of this thesis follow the stages of this process; the existing literature is discussed and hypotheses derived from it. These hypotheses are tested in a research context, methods, methodology and design that are consistent with a Retroductive approach. A pilot study explores the hypotheses and the results are also tested on a larger study (with triangulation to manage issues with reported data). There is also congruence with three of the four key Campbellian ideas about scientific inquiry, further developed and integrated by McKelvey (1999b) and mentioned earlier in this chapter: a focus on selectionist evolutionary explanations of emergent order and differential survival; an evolutionary epistemology; multimethod triangulation perspectives, with experiments and quasi-experiments omitted.

2.6 Conclusions

Research projects require the researcher to understand the way that s/he perceives knowledge and the methods used to change the base-level knowledge-state. There is also a need to consider the destiny of the findings of the research and the way in which they will be incorporated into the overall corpus of existing knowledge and practice.

This research is based on a Realist epistemology. However, it also follows the tradition of the work of Donald Campbell and his adherents in seeking a more accurate representation of the real world rather than bi-polar. It uses a research strategy that combines a larger scale quantitative study (Normal Science) with a finer grained qualitative interview programme (Contra-Science) to enhance explanatory powers and a largely Retroductive strategy, through the postulation of a model to test and advance hypotheses. The philosophy and strategy are both congruent epistemologically and methodologically with previous work completed within the coevolutionary research approach embracing both Sociology-based and Economics-based research movements. This is discussed in further in the next Chapter.

CHAPTER 3: A REVIEW OF THE LITERATURE PERTAINING TO THIS RESEARCH

3.1 Summary

The chapter begins with a discussion of firm size and mechanisms that can be used to overcome small size for new entrants as a default explanation for firm survival. Next, the subject of evolution as a mechanism for survival is introduced and particularly its constructs of selection and adaptation. It looks at how evolution has come to be viewed in the Sociology and Economics based Strategic Management literatures, and especially the importance of adaptation through the dynamic capabilities associated with exploration and exploitation activities as determinants of survival. It moves on to discuss how evolution itself has evolved into coevolution. It considers other research on firm survival and the role of the industry in performance and thence implicitly in survival. Finally, it links government policy along with other literature-supported survival determinants and defines the literature gap examined in this research project.

3.2 Introduction

Survival is important to management researchers. Pfeffer & Salancik (1978, p.1) open their classic text thus: *"This book is about how organizations manage to survive".* Survival is attributed to effectiveness, defined as: *"Effectiveness derives from the management of demands, particularly the demands of interest groups upon which the organizations depend for resources and support."*

Firm survival can be viewed in a fashion parallel to organism survival in biology, but the caveats about the transfer of scientific methods mentioned in the last chapter hold for the transfer of biological mechanisms. As discussed there, the social system is not capable of closure in the same way that biological systems may be, so the scientific explanation may not be completely transferable to social science phenomena, leading to a change in the use of evolution to that of a metaphorical construct from a scientific theory. The existing literature on firm survival is spread inside the main literature groupings described below. These groupings follow the transfer and adoption of evolutionary ideas from biology to management research and support the grand theories developed about firm survival.

In the first section, size as the overriding determinant of survival is introduced as well as the possibility of building extensive intra-industry ties to overcome size issues. This is followed by an exposition of the use of the evolutionary theories from biology and the use of the evolutionary metaphor as pertaining to organization or firm survival in two of the key management literatures - sociology and economics. These are discussed in the context of the literature where they come together, in the strategy literature grouping. Following a brief discussion of the principal sociology-based theoretical frameworks, the population ecology view is examined, as well as the parallel economics–based literature on routines, competences and capabilities.

The development from evolution to coevolution as a unifying approach closes this discussion. In particular, the use of the constructs of exploration and exploitation in looking at coevolutionary research developments is highlighted as these are at the heart of this research project.

In the next section, the existing literature concerning firm survival is gathered to establish current research directions and discussions, set in the context of the strategy subject area.

A brief discussion of the role of the industry in performance as a proxy for survival follows with closing discussions on policy – this research is interested in survival as an aid to policy formation. The literature gap is also defined.

3.3 Size as the over-riding factor in survival?

Pfeffer & Salancik (1978) view resource control as a source of power and thence influence (p.44), and that *"size should affect the organization's dependence on the local community"* (p.171). The Resource-Based View of the firm, or RBV (discussed in a subsequent section of this chapter), looks at the combination of resources to form capabilities that can affect competitive advantage (Barney, 1991). Even in the evolutionary approach based on biology, size is important, *"large firms are economically dominant"* (Aldrich, 1999, p.10).

Firm size is important when considering survival, Mata & Portugal (2002) – but is it the only consideration? There is an assumption that larger organizations can survive because they are better able to compete as a result of economies of scale and scope (Porter, 1980, pp.7-9; Grant, 2001, pp.75, 458). Berndt (1991, pp.60-101) links economies of scale to learning and experience.

Bluedorn (1993) reviews the literature on organizational size and the environment. Size has been related to organizational ecology (discussed in the next section) through a model where individual organizations grow and contract, suggesting that *"the evolution of size distributions has potential value for linking change in organizational populations with change in macrostructures"* and that dynamics can be inferred *"when size distributions are available, but microdata is not"* (Hannan, Ranger-Moore & Banaszak-Holl, 1990, p.247). A firm's resources can sustain it, though too much slack (March & Simon, 1958) is to be discouraged. Linked to size are also issues relating to *de novo* firm entry (Mata, Portugal & Guimaräes, 1995; Mata & Portugal, 2002); both studies confirm size to be a key determinant of survival. Audretsch (1995) suggests survival, as opposed to financial performance, is likely to be industry specific and also linked to the innovative environment, with survival of over a decade less likely in lower innovative industries, but with a rider that higher growth rates are exhibited by those firms that do survive.

However, Aldrich (1999, p.9) also notes that *"most organizations are small"*.

One way that small new firms can try and acquire resources to overcome size limitations and to capitalise on the learning benefits from size is through partnering with other firms in an industry (Jarillo, 1988; Liedka, 1991; Ebers & Jarillo, 1997; Piskorski & Anand, 2003), though selecting the right partner is a contributor to the success of an organization's activities according to a number of authors (Buckley & Casson, 1976; Killing, 1983; Harrigan, 1985; Beamish & Banks, 1987; Beamish, 1987; Geringer, 1988; Contractor & Lorange, 1988). Some empirical evidence suggests firms are prepared to trade autonomy for survival (Donaldson, 1995, p.162). However, the partner selection may be sub-optimal (Chowdhury, 1992; Sherman, 1992; Bleeke & Ernst, 1993). Structural mechanisms exploring ways whereby actors, both individual and organizational, interact are reviewed in Gulati (1998) amongst others. Gulati (1995) examines the effects of repeated ties between organizations in a formal alliance setting. Dacin, Ventresca & Beal (1999, p.345) follow this in defining a need for more work on structure and content of inter-actor ties. Haveman & Nonnemaker (2000) looked at the impact of market structure on organizational growth and market entry, differentiating their study as *"more microscopic"* than Carroll (1985) and looking at a broader picture of firms' physical points of competition – a similar approach to that used in this thesis. They also looked at single market firms and found that multimarket contact strongly influences a firm's market entry and growth behaviour, similar to the findings about industry ties, exploration, exploitation and adaptation strategies in this study. This study was about large organizations, as compared with the smaller ones in the UK onshore oil and gas production industry.

Studies using size-related measures are often limited to larger firms as data on smaller firms is not always accessible, leading to bias issues in the study as failure of smaller firms are under-represented (Denrell, 2003).

3.4 The Evolution-based Strategy Literature on Firm Survival

In contrast to the *"size explains all"* perspective, and following the biological literature, firm survival can also be viewed as successful competition for resources and a place on the competitive landscape, as well as the outcome of responses to selection pressures and adaptation processes, all situated in an environment with punctuated equilibrium as the norm.

There are two major literature groupings underpinning the strategy literature concerning survival relevant to this research having roots in the biological theories of evolution (and to a lesser extent coevolution):

- The sociology based literatures including the ecology-evolutionary literature, looking at the external environment as the regulator of survival through selection and the organizational systematics literature which models competitive landscapes. This grouping includes the population ecology, organization ecology and corporate demography literature as well as the complementary organization evolution field;
- The economics based literature considering routines and competences/competencies /capabilities[10] as adaptation mechanisms and including the evolutionary economics literature as well as the Resource-Based View of the firm.

In both cases these have subsumed earlier literatures, which will be mentioned under each heading in a brief historical perspective. Both literature groups look back to Darwin (1859) for the key principles of variation, selection and inheritance or retention and also refer to Lamarck (1809) who suggested that acquired characteristics, the results of adaptation, can be inherited, and that variations in the population arise as response to local needs (adaptation) rather than through chance changes by external selection at the population level.

A map of the single lens theories informing the selection–adaptation discourse (Lewin & Volberda, 1999), is shown in Appendix A.

In a final section, the later integrating coevolution/new organizational forms literature is also briefly reviewed.

3.5 Evolution and survival in the sociology–based strategy literature

There are two closely linked groupings of research in the sociology–based strategy literature that use ideas taken from natural science to explain firm survival: ecology–based research and evolution–based research.

3.5.1 Ecology–based research

"Ecological models suggest that environmental contingencies allow some organizations to survive while others disappear, thus selecting organizations that fit the environment at the expense of others that fit less well." (Pfeffer & Salancik,1978, p.226).

The role of the environment and its effect on organizations and their survival can be seen in the work of Burns (1963) and the idea of an organismic (or organic) system, highly adapted to unstable conditions. It also occurs in Lawrence & Lorsch (1967) and structural contingency and Pugh, Hickson, Hinings & Turner (1969) and strategic contingency - the idea of different types

[10] The literature is inconsistent in the use of these terms.

of organizations performing well in different environments, as well as Pfeffer & Salancik (1978) and the idea of the enacted external environment of the organization and its institutions controlling access to valuable resources that affect survival. Miles & Snow (1984, p.12) also look at fit at the organizational level and suggesting tight fit both with the external environment and within the organization as the key to survival, *"...minimal fit (with the environment)*[11] *is required for organizational survival"* and though misfits may survive, ultimately they will perish if they fail to adapt. All of these studies look at environmental pressures inducing variation in organizations and the tension between the rational approach and natural system approaches (Thompson, 1967, p.xix).

Thompson (1967), whilst also taking a contingency approach, followed systems theorists, e.g. Parsons (1956), in taking a systems-based approach and saw three *"levels"* as explaining variation in organizations: all organizations are open to the environment; all organizations must adapt to their environment; organizations are differentiated and this spread of degrees of openness accounts for differential adaptation, both within and without the organization. *"Uncertainties pose major challenges to rationality and we will argue that technologies and environments are basic sources of uncertainty for organizations"* (Thompson, 1967, p.1).

In a development from this research agenda, in the late 1970s, a movement emerged that returned to an examination of the forces of selection on firms and firm populations, in contrast to the adaptation thrust of the research mentioned above. The ecological perspective suggests that not all firms can adapt to environmental change successfully and that environmental change may favour new organizational forms. The unit of analysis was the organization, defined as: *"goal–directed, boundary maintaining and socially constructed system(s) of human activity.."* (Aldrich, 1979). A map of the theoretical perspectives, evolutionary processes and outcomes from Aldrich (1999) is shown in Appendix B.

Hannan & Freeman (1977) began the first of a series of initiatives to explore the application models from the biological sciences to explain firm survival. They offered the view that selection effects arising from the environment (not adaptation at the firm level) are important when considering populations of firms observed over time. They stressed the importance of the level of analysis to their theory of population ecology and also clearly defined a *"selection-(structural)-inertia–adaptation continuum"* where inertia may well be path dependent or strategic legacy–driven, e.g. the fixed assets base of the organization. In the Hannan and Freeman population ecology manifesto, theory is transferred from a scientific context to an organizational one, following Hawley (1950), and using niche theory and isomorphism between organizational structure and environmental demands to develop explicit competition models. Population ecology is concerned with a population of all organizations competing for a specified pool of resources, and the dynamics of

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[11] My insertion.

that population with respect to organizational foundings, mortality rates, niches, etc., expressed at the population level. Hatch (1997, p.82) suggests that population ecology is: *"....an organizational version of Darwin's 'survival of the fittest' "*. There are three key evolutionary processes: variation, selection, and retention (survival) applied at the population level by the environment (Aldrich, 1999). These are often described as the V-S-R model, again following Darwin (1859).

While population ecology concentrates on the effects of the environment on a population of firms, the metaphor has been developed to cover other levels in the system: Organizational Ecology, defined as *"the investigation of how social environments shape rates of creation and death of organization forms, rates of organizational founding, mortality, and rates of change in organizational forms."* (Singh & Lumsden, 1990). In this paradigm, the definition of environment has narrowed to the social environment.

A further development has been the newer field of corporate demography, developing the population ecology perspective by looking at *"organizations in a special way; through the scientific examination of their vital rates of founding, growth/decline and mortality."* (Carroll & Hannan, 2000, p.3). Corporate demography develops the population ecology work further by offering the possibility of exploring the granularity at the sub–firm level as a unit of analysis, so branches of banks rather than just populations of banks. Carroll & Hannan (2000, p.xx) explain the difference thus *"organizational demography refers to processes that apply at the levels of populations of organizations, population ecology refers to interactions between localized sets of populations"*. The Darwinian concepts of selection and retention also feature greatly in the longitudinal studies that make up this literature (Swaminathan & Delacroix, 1991; Carroll, Preisendoerfer, Swaminathan & Wiedenmayer, 1993; Swaminathan, 1996; Dobbin & Dowd, 1997; Messallam, 1998; Carroll & Hannan, 2000; Dobrev, 2000; Lomi, 2000). Process is the key to understanding the population, and two classes of environmental processes are defined: exogenous processes shaping and changing the populations and endogenous processes, also termed population dynamics, where changes within the population reshape it, its response to and ultimately its environment (coevolution).

Corporate demography also includes a theory of Resource Partitioning, once more co-opted from biology (Roughgarden, 1976; Carroll, 1985; Peli & Nooteboom, 1999; Boone, Bröcheler & Carroll, 2000; Dobrev, 2000). Here, the large competitors fight over the resources leaving opportunistic niches for smaller specialist entities at the periphery. This model recognises the non-heterogeneity of response to competitive forces and has been applied to mortality rates, again using some sophisticated mathematical modelling techniques. It looks at how the number of organizations in a population changes over time and why there are so many different kinds of organizations, or organizational forms (Delacroix & Rao, 1994, p.255).

One reason advanced for this is *"density dependence"* (Hannan & Freeman, 1989; Hannan & Carroll, 1992; Carroll & Hannan, 2000; Boone, Brőcheler & Carroll, 2000; Lomi, 2000). Density (the number of organizations in the population), is related to foundings and disbandings in a curvilinear way – at the beginning of the life of an organizational form, there are more foundings, and the curve is convex; later there are more disbandings, so the curve is concave. Though the right hand part of each curve is accounted for by classic competition theory, the left is explained by legitimacy. Again, detailed mathematical modelling has gone on in this field, with long accounts justifying non-conformity. Additional research in this field has looked at age dependence and size dependence, as patterns governing growth and mortality rates for industries studied. Survival is also linked back to government policy (Dobbin & Dowd, 1997) which is discussed in a later section of this review.

However, population ecology as an independent field still has some champions (Boone & Van Witteloostuijn, 1995; Van Witteloostuijn, 1997; Van Witteloostuijn, 2000) who argue that the field itself is continuing to evolve as a response to its environment. In contrast, McKelvey (1994, p.326) muses *"But what does population ecology have to say about important populations today? And what would happen if strong operational measures were substituted for weak proxies?"*. In answer to this, the relatively new organizational systematics group of researchers, led by Bill McKelvey, is attempting to model competitive landscapes using an approach from biology (Kauffman, 1993) as a starting point and returning to evolutionary theory's systems-based roots. McKelvey is critical of the corporate demography school favouring the more scientific approach (Organization Science) discussed earlier in the previous chapter on the philosophical approach and rooted in Campbell's own work (Campbell, 1969) cited in Aldrich (1999, p.21) which identified four stages of evolution for organizations, adding to the V-S--R of the population ecologists:

- Variation – both intentional and blind changes in routines, competencies and forms;
- Selection – both external and internal variations;
- Retention – within and between organization preservation, duplication and reproduction;
- Struggle - for scarce resources e.g. capital or legitimacy.

Corporate infant mortality is not an issue for this study, as firms are viewed as either present or absent inside the industry boundary and their ability to manage a portfolio of interests to aid corporate survival is not of major relevance to a study on intra-industry firm survival.

3.5.2.Evolution-based research

Evolutionary Dynamics of Organizations (Baum & Singh, 1994a) marked an attempt to develop the ecology model and an extension of the biological

metaphor, whilst recognising, in the words of the authors, that *"the domain is still taking shape"* as an explanation for the lack of a coherent unifying theory. Again following ideas from Campbell, this research group has conceptualised organizational evolution as *"the complex interplays between two kinds of processes (interaction and replication), acting on two kinds of entities (ecological and genealogical), observed at the level of the organization"* (Baum & Singh, 1994c, p.4), thus offering the adaptation complement to the selection-based approach of population ecology. Baum & Singh recognise the limitations of the transfer of biological ideas, since organizational inheritance and biological inheritance are quite different, so they synthesise from the literature and assert that information is the link, so that theories about information asymmetry and its management and organizational learning become theories of evolution. They also broaden out the umbrella of organizational evolution to include evolutionary biology and its more controversial claims (Cosmides & Tooby, 1994) which are not discussed further here.

March (1994) offers a bridge between organizational theories of selection as described above and also organizational adaptation. He links evolution to path-dependence on rules and routines already formed and also to the idea of destiny fulfilment through an evolutionary process involving management action. March uses the concepts of historical processes encapsulating the past through a combination of exploitation and exploration. *"Exploration produces variety in experience (experimentation, variation and diversity). Exploitation produces reliability in experience (selection, consistency, unity). The engines of evolution include mechanisms for interpreting, retaining, transmitting and retrieving those lessons of the past."* (March, 1994, p.41). March stresses the importance of history - we study history in the hope that by looking at the past we can predict the future by offering causal links between events and outcomes. History, though perceived as efficient in the past, is found to be inefficient with consequences in both exogenous and endogenous environmental lagging, multiple equilibria, path dependency and networks of diffusion being characteristics of the former, and mutual adaptation, the role of other ecologies as complications and nested adaptation or multilevel adaptation of (say) sub-units of organizations and the organizations themselves at differential rates and in different ways as characteristics of the latter. In both cases, the *"meandering"* of history is dissonant with the functionalist approach of much research. March's view of the *"engineering"* of evolutionary history looks to three interventionist approaches: altering the possibilities of transmission, retention and retrieval of the lessons of history; altering the structure of interactions among units of evolution, and relevant to this research project, managing the exploration/exploitation balance.

The theme of exploration and exploitation has been developed further from its introduction in March (1991) through Levinthal & March (1993); March (1996) and papers in the area such as Holmqvist (2003) and this research theme links to the thesis research project as March suggests that *"maintaining an appropriate balance between exploration and exploitation is a primary factor in system survival and prosperity"* (March, 1991, p.71). However, Baldwin &

Rafiquzzaman (1995) examine entry cohorts and suggest that selection is a more important contributor to the growth of an entry cohort than evolutionary learning.

3.6 Evolution and survival in the economics-based strategy literature

"(Accordingly) to some degree, biological metaphors have always been present in the foreground or background of modern economic theory." (Hodgson, 1999b, p.87).

3.6.1. Evolutionary Economics

Just as researchers in sociology looked at the biological metaphor and the work of Darwin to explain the survival of organizations and firms, a parallel movement was taking a similar perspective in economics. Evolutionary economics, focusing on the firm as the unit of analysis, has roots in the Nineteenth Century, and the work of Marshall (1890): *"... Economics is a branch of biology, broadly considered"*, Marshall (1890, p.772) cited in Hunt (2000, p.18). Hodgson (1999a) reviews the early history of this metaphor. Marshall (1890, p.xii) states: *"the Mecca of the economist lies in economic biology"*. Three locations of economic research were actively using biological metaphors as the 19th Century closed: Germany, where Menger's challenge to the prevailing theories essentially discredited the biological metaphor as collateral damage, discussed in Hutter (1994); the UK, where evolution had moved on to encompass eugenics, and where work was dominated by Herbert Spencer (Hodgson, 1999b, p.93); and the US, where Veblen applied Darwin's methods including the V-S-R model to economics and began the development of the concept of routines as heritable trait (Veblen, 1899), also distinguishing the important role of creativity and evolutionary selection, (Hodgson, 1999b, p.99). A reaction to the apparent use of science to justify less ethically sound practices such as eugenics, together with the historically contemporaneous rise of fascism in Europe produced an inevitable backlash when Boas proposed a different explanation for human behaviour, that of culture (Hodgson, 1999b, p.100). Cultural explanations of social phenomena, increasing emphasis on a Reductionist philosophy and the rise of Positivism, coupled with a backlash against the perceived *"Social Darwinist"* movement[12] mentioned in the previous chapter, meant that evolutionary and biological metaphors in economics went into hibernation until the publication in 1950 of Alchian's paper. Alchian argued that firms that were *"fit"* would survive and prosper as a result of evolutionary processes, and that imitation was also possible (Alchian, 1950). Alchian's timing was critical, biologists had just made the connection between Mendelian genetics and evolution, and interest in biology was renewed. At this time too Boulding (1950) advanced *"population thinking"*, (an inspiration for Hannan & Freeman's work on population ecology), later developed into Boulding (1991) as a theory of evolutionary economics

[12] Hodgson takes issue with use of this term, explaining that it is misnamed and not about Darwin's ideas, referring instead to Bowler (1983).

Chronologically, the next key event was the publication of Nelson & Winter's (1982) *"Evolutionary Theory of Economic Change"*. This defined the construct of routines which *" represent the skills of an organization"* (Nelson & Winter, 1982, p.124), in sharp contrast with neo-classical contractual view of the firm. In this approach, routines are adaptations so the economic view is more Lamarckian in contrast with the more Darwinian approach of the population ecologist school described above, though Knudsen (2002) advocates an economic selection theory.

Nelson (2002) reviewed the evolutionary economics field twenty years on from the seminal 1982 paper with Winter and advocated closer links with institutional economics as a route for both disciplines to move forwards (analogous with work by researchers in the sociological tradition such as Oliver who combines an institutional approach with population ecology (Baum & Oliver, 1996). Nevertheless, despite much empirical progress, the evolutionary economics research stream is still open to attack in that routines are still perceived as largely behavioural and ignoring intentionality (Child, 1997, p.68), i.e. adhering strictly to the biological metaphor of non–discretionary adaptation - a view expressed earlier by Penrose (1952).

Two literature reviews from the 1990s track developments in evolutionary economics:

Witt (1992) identifies several ongoing research programmes:

1. The Schumpeterian stream focusing on technical progress, innovation, industrial development, business cycles and growth (Nelson & Winter, 1982; Dosi, Freeman, Nelson, Silverberg & Soite, 1988).

2. The Austrian Subjectivist works emphasising subjective knowledge and competition as a discovery process (Loasby, 1976; Hayek, 1978; Loasby, 1991; Foss, 1997).

3. The Institutionalist stream focusing on how routinised patterns of behaviour and habits of thought affect economic change (Hodgson, 1993).

4. The neo-Darwinists who rely on biological analogies to explain change (Hirshleifer, 1982; Boulding, 1991; Metcalfe & Saviotti, 1991).

As a contrast, Hodgson (1999b) offers a literature map using three criteria:

1. An ontological criterion – novelty;

2. A methodological criterion – reductionism;

3. A metaphorical criterion – biology.

These ideas are expanded and related to the work of different economists in Appendix C.

3.6.2 The Legacy of Nelson and Winter

Nelson and Winter (1982) were careful to signal the limitations of a full-scale adoption of the biological view of evolution in its application to the social sciences, and specifically economics. They began by dismissing general equilibrium theory and then rejected profit maximisation as the only *raison d'être* of a firm. Internal routines, which make up the organizational memory of the firm, play the part of genes in their view of evolution and act as repositories of knowledge and skills, being durable and replicable. Firms continually engage in a search across the intersection of the firm boundary and the environment, with routine modification and transmission if required, i.e. a Lamarckian approach. Economic selection, though not necessarily leading towards a single optimisation, is a selection mechanism by the environment manifested as market environment. These three activities correspond exactly to the V-S-R model used by Darwin and the model used in population ecology, though here it is used as a metaphor.

The relationship between Nelson and Winter and other strategy-located economic theories is shown in Figure 3.1:

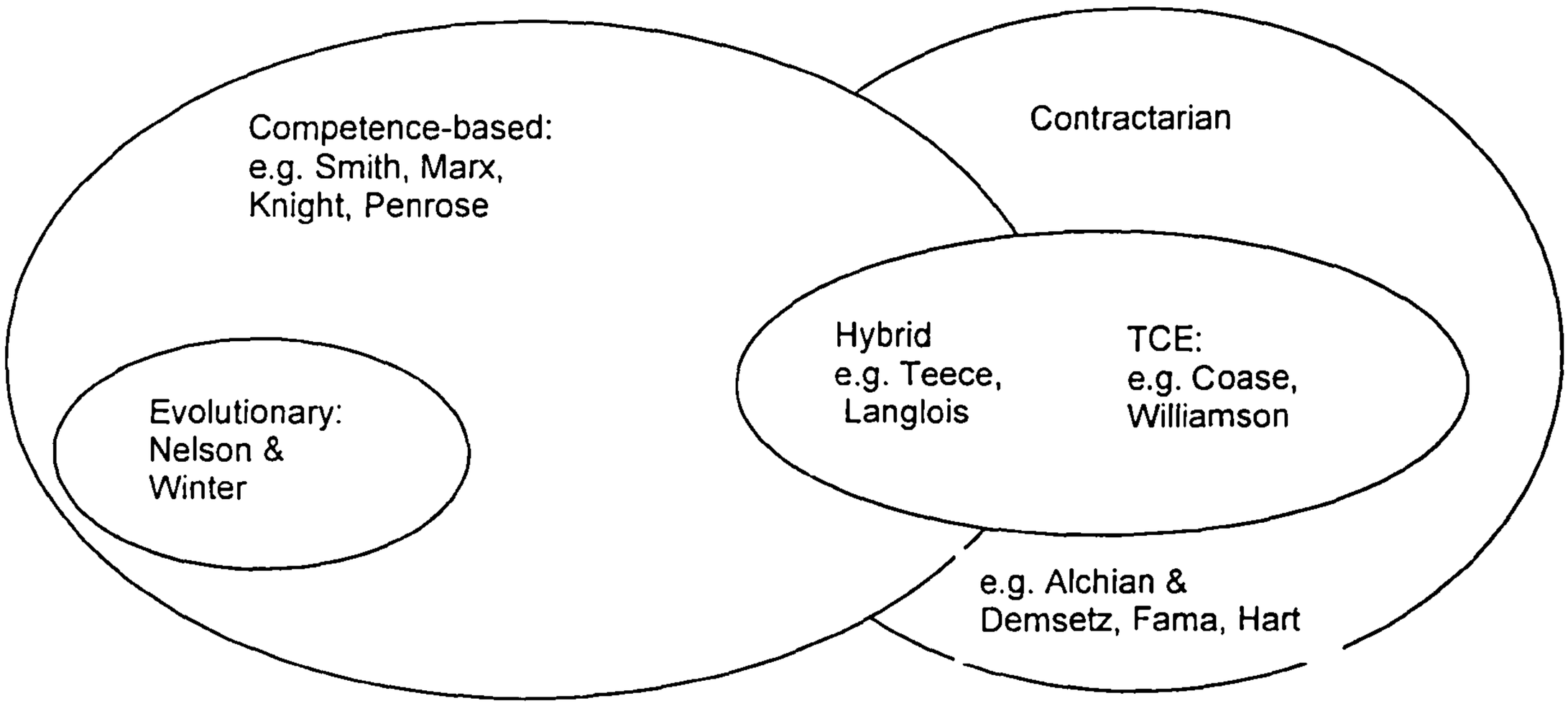

Figure 3.1: Relationships between Contractarian and Competence–based theories (Hodgson, 1999b, p.249).

Nelson and Winter's work is now linked with the general area of competence–based literature according to Hodgson, and also linked closely to the RBV of the firm, first proposed by Penrose (1959). The RBV is fast becoming the dominant paradigm for strategy research, and much effort has been directed to its progression. First articulated in the strategy literature as Wernerfelt (1984), it

has been extensively developed by champions such as Dierickx & Cool (1989); Barney (1991); Grant (1991); Peteraf (1993) and expanded to develop a complementary/competing research agenda, more closely allied to Nelson and Winter in the Knowledge–Based View (KBV) of the firm (Kogut & Zander,1993; Grant & Baden-Fuller,1995; Conner & Prahalad,1996; Foss,1996) with Barney (1996) synthesising the two approaches. More recently the two groups appear to have divided once more, with the KBV reclaiming roots in evolutionary economics (Loasby, 2001; Potts, 2001).

The key RBV and KBV models are essentially static and so evolutionary only in that they look at snapshots over time, thus a literature has developed to look at a dynamic approach to what are termed variously resources, capabilities, competences, competencies, etc. (though Jay Barney suggested the labels were of lesser importance to the research agenda when addressing fellow researchers at the Pre-Conference Workshop on the RBV at the Strategic Management Society conference in 2004). The RBV stresses the importance of the competitive advantage of a firm (the unit of analysis) and this, when combined with a presence in an attractive industry, contributes to superior economic rents (Grant, 1991). So this model is not, *prima facie*, sympathetic to organizations which are not profitable, or are embarking on a steep development curve post-initial founding. In a commentary on Barney (1991), Stinchcombe (2000) clarifies the importance of context when considering resources to be valuable.

In the Dynamic Capabilities approach proposed by Teece, Pisano & Shuen (1997), the market power is emphasised and as part of the literature review in this paper, competitive positioning (Porter,1980) and game theory as a contrasting dynamic analysis (Nalebuff & Brandenburger,1995) are used as comparative approaches to strategy. Competitive advantage is seen as *"exploiting existing external and internal firm–specific capabilities and developing new ones"* (Teece et al, 1997, p.515). Dynamic Capabilities are the *"firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.....thus reflect(ing) an organization's ability to achieve new and innovative forms of competitive advantage, given path dependencies and market positions"* (Leonard-Barton,1992). Here, the capabilities/competences are seen as also dependent on the assets a firm possesses (both internal and market) and the evolutionary trajectory it has either followed or inherited. Teece et al (1997) look to innovation and technological change drawing on Schumpeterian models of constant change (Schumpeter, 1934), (in contrast to Veblen) as a backdrop to explore firms, and an underlying emphasis away from markets and towards organization, knowledge and learning (Hodgson, 1999b, p.275).

The RBV, the Dynamic Capabilities approach and the KBV are all still relatively recent, developing theories with a need for empirical research to test and develop the largely theoretical work to date. In a later section of this chapter the existing literature on survival as a distinct topic will be considered and linked back to the approaches in this section.

3.7 From Evolution to Coevolution

Although the two literature bodies above use evolution as an explanatory theory or even as a metaphor, it should more correctly be termed coevolution as, consonant with systems theory, a change at one level will affect all levels. In the coevolutionary perspective, the interaction is multidirectional, making research design more problematic, but offering a closer reflection of systems theory.

Roughgarden (1976) defined co-evolution in an organization theory context as: *"Mutual causal change between a firm and competitors, or other elements of its niche that may have adaptive significance".* She later modified it to: *"a co-evolutionary approach requires that sets of coacting organizations and their environments be the object of study and changes in all interacting organizations be allowed to result not only from the direct interactions between pairs of organizations but also by indirect feedback through the rest of the system"* (Roughgarden, 1983 cited in Baum & Singh, 1994a).

From a practical point of view, the Campbellian/coevolutionary approach, which this research follows, seizes the selection/adaptation agenda but takes issue with the neo-classical view of economics and a general equilibrium, preferring the concept of *"punctuated equilibrium"* (Eldredge & Gould, 1972) or even the *"edge of chaos"* view supported by Kauffman (1993). The Prologomena to the Special Edition of Organization Science (Lewin & Volberda, 1999), advanced the use of coevolution based on organizational ecology and its concepts of adaptation, mutation and the emergence of new organizational forms as a way of bridging levels of analysis and including longitudinal studies to enrich our understanding of organizations and their strategies.

A map of coevolution's theoretical antecedents and the current literature, encouraging the use of a multidisciplinary approach, is shown as Figure 3.2, expanded in Appendices A, B, D.

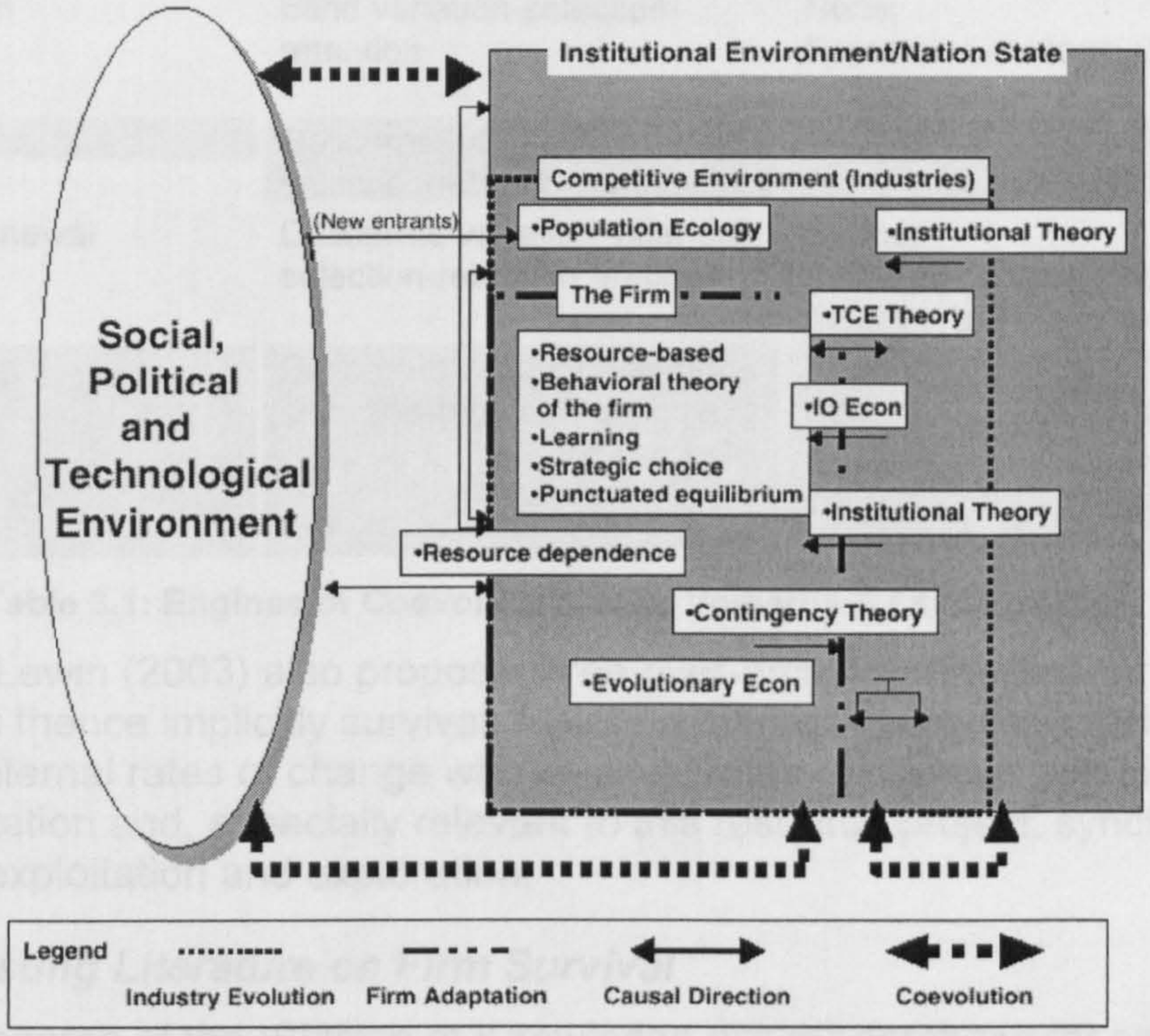

Figure 1. Theories of adaptation and selection

Source: Lewin et al. (2003).

Figure 3.2: Theories of Adaptation and Selection, Lewin et al (2003)

At the moment, coevolution remains very much *au courant* as an explanation for strategic and network alliances, management logics, relationships between various hierarchical levels in organization systems and for the emergence of new organizational forms. This links it back to the population ecologists and the evolutionary theorists under an integrating *"New Organizational Forms"* agenda. Papers were published using this approach (Baum & Singh, 1994b; Levinthal & Myatt, 1994; Haveman & Rao, 1995; Koza & Lewin, 1999; Dijksterhuis, Van den Bosch & Volberda, 1999; Van den Bosch, Volberda & de Boer, 1999; Lewin, Long & Carroll, 1999; Djelic & Ainamo, 1999; Sakano & Lewin, 1999; Djelic, Koza & Lewin, 2000) – see Appendix D for a taxonomy of research in this area. March (1991), referred to earlier, and his concepts of exploration and exploitation have also been used as evidence of coevolution (Koza & Lewin, 1998; Koza & Lewin, 1999).

A recent Special Issue of the Journal of Management Studies features an updated view from Volberda & Lewin (2003) developing the idea of four co-evolutionary *"engines":* naïve selection, managed selection, hierarchical renewal, and holistic renewal, applying them to multi-unit firms. These views are shown in Table 3.1:

Type of coevolutionary "Engine"	Characteristics on VSR continuum	Intentionality and other theories/ideas
Naïve selection	Blind variation-selection-retention	None; Population ecology; Organizational economics.
Managed selection	Deliberate variation-vicarious selection-retention engines	Limited; Anticipatory control; coevolution.
Hierarchical renewal	Deliberate variation-vicarious selection-retention engines	Strong; Strategic choice; administrative theories; top down direction.
Holistic renewal	Deliberate variation-vicarious selection-retention engines.	Strong; Collective sense making; single/double-loop learning; entrepreneurship; transformation; emergence.

Table 3.1: Engines of Coevolution, after Volberda & Lewin (2003)

Volberda & Lewin (2003) also propose three over-arching principles for self-renewal and thence implicitly survival: focus on managing requisite variety by regulating internal rates of change with external rates of change; optimising self–organization and, especially relevant to this research project, synchronising concurrent exploitation and exploration.

3.8 The Existing Literature on Firm Survival

A literature search of the ISI/Web of Knowledge (WOK) database for articles containing the terms *"firm survival", "organization survival"* and *"organizational survival"* produced some 94 distinct articles, many of which are covered in the analysis above. Of course it may be said that all research on firms looks at survival as a latent variable, i.e. performance assumes survival; examinations of particular strategies presume survival in order to execute the strategy. This section considers literature linked to an explicit espousal of firm survival.

In an updated WOK search on 2nd March 2004, using three sets of keywords, the following results were obtained:

Key Word	Count
Firm survival:	47 articles
Organizational survival:	1 article included in the firm survival search
Organization survival:	47 articles

In order to make sense of this literature, it is organized below in Table 3.2 and linked with the main theory supporting the findings of the authors.

Major Underlying Theory of the WOK Reference	Number of references	Addressed in the context of this study?	Selection/ Adaptation
1. Contracting/Economics	3	No	S
2. Ecology/Evolution/Complexity	3	Yes	S
3. Entry/Liability of Newness	6	Yes	S
4. Ethics	1	No	A
5. Financing	4	Yes	S
6. Industry Effects	2	Yes	S
7. Location/Geography	4	No	S
8. Marketing incl. Climate; TQM	2	No	A
9. Mortality/Exits	4	Yes	S
10. Oligopoly/Economics	2	No	S
11. Organizational Forms	3	Yes	A
12. Organizational Learning	6	Yes	A
13. Ownership/ Entrepreneurship/Leadership	10	No	A
14. Partnering/Merging	3	No	A
15. Public Policy including Taxation	19	Yes	S
16. Size	3	Yes	A
17. Technology	7	Yes	S
18. Time/Life-cycles	3	Yes	S
19. Unspecified Others	9	N/A	N/A

Table 3.2: Extant Literature Linked to Firm or Organizational Survival

Many of these categories are used in the quantitative study in this thesis (Chapters 7 and 9) as variables, or related to measures, and/or used in the qualitative study in this thesis (Chapter 8), though more specific references may be cited.

In addition to these studies and those mentioned in the previous section, a number of other key studies found in earlier searches of the ISI, IBSS and ProQuest databases explicitly address survival or focus on survival as a consistent theme. Many look at survival at the firm level, considering entry, exit and survival by foreign subsidiaries and strategic alliances into markets, such as the work of Pearce (1997); Delios & Beamish (2001) and Mata & Portugal (2002). Other researchers look at survival as duration for (say manufacturing plants), e.g. Disney, Haskel & Heden (1999); Chen (2002). However, some have specific relevance to this research project and are discussed next.

Willard & Cooper (1985) used a comparison of two groups, survivors and non-survivors, to look at a population of large TV manufacturers during a shakeout in the industry. The researchers attempted to compare the groups of survivors and non–survivors to see which characteristics separated them, using size of parent; financial strength of parent; strategic importance to parent; degree of relatedness of this business to parent; timing of entry decision; strategic group membership; market share; price; quality; value; relative advertising spend; vertical integration; research and development emphasis; breadth of product

line; strength of distribution system; relative direct cost; dependence on offshore facilities; competitive advantage emphasised, etc . Many of these variables were averaged out over a five-year period, thus losing some fine grained detail. However, they concluded there was no consistent survival strategy followed by the survivors.

Mata & Portugal (2002) link survival of foreign and locally owned firms to ownership advantages, size and growth strategies, the internal organization of firms, and by industry characteristics such as economies of scale, and industry entry and growth. After controlling for these characteristics, the firms in both groups showed little difference in response to survival determinants.

A recent prize-winning paper (Lien & Klein, 2003), presented at the Strategic Management Society conference in 2003, exposes the latent survivor principle found in the economics-based strategy literature on competitiveness and tests relatedness of diversification as an empirical test for firm survival. Using a large US database of all firms with over 20 employees and three chronological points, 1981, 1983, and 1985, the authors suggest that a derived relatedness factor can offer a good predictor of firm survival, though they recognise that the data has limited time points and there may also be other effects such as parenting; Wall Street business cycle, etc.

A significant group of papers which links the ecology-evolution approach, but concentrating on adaptation as the driver, look at survival linked to other independent variables as shown in Table 3.3:

Variable linked to survival	Paper	Conclusions
Clustering	(Pandit, Cook & Swann, 2001)	Physical clustering appears to lead to above average growth and thence post-entry survival.
Collaborative relationships	(Singh & Mitchell, 1996); (Mitchell & Singh, 1996)	Collaboration appears to enhance survival, providing there are no severe environmental shocks to the collaborative business.
Entry timing	(Mitchell, 1991)	Performance and survival of newcomers to a subfield is affected by entry order; New entrants affect industry incumbents.
	(Mascarenhas, 1992a)	Need to look at survivors and non-survivors to manage potential over estimation of performance.
Governance structures	(Kole & Lehn, 1997)*	Initial conditions not linked to survival, survivors adapted governance structures to deal with environmental changes, but small study – n= 21.
Innovation	(Mitchell & Banbury, 1995)	A business survival is most influenced by its ability to support rather than just introduce innovative products.
Embeddedness and institutional structures	(Baum & Oliver, 1991); (Baum & Oliver, 1992)	Institutional linkages improve organizational survival and population survival especially when competition increases.
Technology	(Suarez & Utterback, 1995)*;	Explicit inclusion of technology as a variable can enhance understanding of survival using a dominant design perspective.
	(Singh, 1997).	More complex technology leads to higher rate of failure, with collaboration not necessarily improving performance.

* = included in the WOK literature survey.

Table 3.3: Map of Other Key Strategy Research into Survival

For these researchers the firm survival is the important process variable, as opposed to entry or exit.

3.9 The Industry Effect – does it matter?

So far all the research examined has looked at firms or organizations, but does the industry factor affect survival chances, as suggested in the literature search? This section considers two possible ways of viewing the impact of

industry: the overall effect of membership by a firm or population of firms of a particular industry as compared with other industries, where the location of that industry's life-cycle relative to others may be critical; or the membership by a firm or population of firms of a distinctive industry where by controlling for industry effects, differential survival can be assessed and related to firm level characteristics.

The first grouping of literature began with an on-going debate between two significant pieces of research: Schmalensee (1985) and Rumelt (1991). In a US FTC line of business database cross-sectional study on variance in profit rates, Schmalensee found that corporate effects did not exist; market share accounted for a negligible fraction of the business units variance in returns; industry effects accounted for 20% of the variance in business unit returns, and industry effects accounted for at least 75% of the variance in industry returns. In contrast, Rumelt reused similar data, including some data taken out by Schmalensee relating to smaller firms, and also looking at a four-year longitudinal study. By contrast, Rumelt concluded that business unit effects outweigh industry and corporate membership as predictors of profitability; the dispersal of rates of return of Rumelt's business units is not explained solely by corporate effects; business units within industries differ from one another more than industries differ from one another. The studies have been replicated several times over using the Compustat database thus including service industries (McGahan & Porter, 1997). The most recent paper on this work (Hawawini, Subramanian & Verdin, 2003), used a ten-year period, and different financial metrics to show that industry effects dominate firm effects except for cases of the highest and lowest performers, possibly reconciling Rumelt and Schmalensee's findings.

Table 3.4 compares the outcomes of key studies:

Effects	Schmalensee, 1985	Rumelt, 1991 Sample A	Rumelt, 1991 Sample B	McGahan & Porter, 1997	Hawawini et al, 2003[13]
Industry effects	19.6	8.3	4.0	18.7	16.0
Firm effects[14]	0.6	47.2	45.8	36	16.7
Year effects	n/a	n/a	n/a	2.4	1.1
Industry/year effects	n/a	7.8	5.4	n/a	4.1
Error	80.4	36.9	44.8	48.4	62.1

Table 3.4: Comparison of the Findings of the Key Studies about the Dominance of Industry versus Firm Effects on Financial Performance, drawn from Tables 1 and 6 of Hawawini et al (2003)

In the Hawawini et al study, various industries were broken out and compared, including single industry firms (in contrast to Roquebert, Phillips & Westfall (1996), whom Hawawini et al argue overstate corporate results as an outcome

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[13] ROA is used here to replicate comparative measures - the study used an economic profit and total market value added metric as well, provided by Stern Stewart.
[14] Firm effects are both business level and corporate effects in earlier studies. These are the modified results shown in Hawawini et al (2003, p.13).

of this exclusion). Mauri & Michaels (1998) looked only at a sample of single-industry firms as compared with diversified ones and also articulated clearly the link between firm level effects and the RBV and industry-level effects and the Industrial Organization paradigm popularised by Porter (1980), concluding that industry-level effects also became less potent for longer observation periods of the firms.

The second way of looking at the industry effect is to consider the industry history itself over time, used in the dual clocks of Mitchell (1991). Studies using event history analysis methods, e.g. Barnett, Greve & Park (1994) can capture the entry and exits of firms and relate them to key milestones in the industry life-cycle. These studies are often linked to the evolution/coevolution literature as well as industry studies found in population ecology or organizational demography, and provide useful insights into the need to control for industry life-cycle effects, especially in the early period of a firm's presence in that industry.

In summary, therefore, the literature seems to be ambivalent about firm level effects as prevalent over industry effects, when considering financial performance. Longitudinal studies seem to lessen the importance of the industry effect too. However, industry has an impact in the sense that firm entry relative to the industry life-cycle or clock can affect survival.

3.10 Firm Survival and Government Policy

The most frequent drivers of survival in the literature search can be grouped under the broad heading of Government Policy. Dobbin & Dowd (1997) suggest that Government Policy can be examined using approaches from the longitudinal studies that characterise the ecological approach laid out in section 3.1. Natural-resource rich Sovereign States seek to optimise the balance of exploitation of resources and the transfer of technology to develop a viable sustainable local resource exploitation industry (Schachter, 1977, p.105)[15] composed of indigenous firms that survive and develop. This policy need is often achieved through partnerships with foreign investors. States may also have a political need to demonstrate so–called "*local-content*", i.e. to demonstrate that resources are not being exploited solely for the benefit of foreigners to their electorate or to foreign investors or donors. Schachter (1977, pp.124-134) addresses this[16]. Pandey (2002) suggests most countries have an economic policy model concerning the exploitation of resources, and there is a wealth of literature discussed in more detail under the individual research hypotheses pertaining to different economic factors as policy drivers. Policy, therefore, is another key selection influence on firm survival.

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[15] Schachter adds the restructuring of agriculture to his three fundamental remedies addressing a more equitable economic order, specifically just pricing between commodity producer countries and industrialized countries.

[16] As a former student of Schachter's, I was disappointed that almost 20 years since the book was published, the issue of local natural resource industry development remains a problem for many governments (Source: Personal discussions with Cabinet members of an anonymous African Government in 1996; Mani, 2003).

3.11 The Literature Gap

McKelvey (1994 p.326) looks at an acceleration of the Organization Science agenda described in Chapter 2 and related to the literature in sections 3.5.1, 3.5.2 and 3.7 by suggesting that (we): *"Move(d) on to the host of evolutionarily more relevant studies; (and) Weaned ourselves away from the frequently weak proxy measures and archival data based on what many observers believe are trivial populations... But what does population ecology have to say about important populations today? And what would happen if strong operational measures were substituted for weak proxies?"* The RBV and the Dynamic Capabilities approach are also looking for more empirical studies to support and develop their theories.

Many existing studies have used performance of one form or another as the dependent variable, and this automatically leads to exclusion of new small firms from studies, making the conclusions only applicable to larger firms. March & Sutton (1997) discuss some other issues relating to inferences made about performance from imperfect data, as does Denrell (2003) who emphasises that our learning is derived from studies of successful organizations and failure is under sampled. Small firms are often loss-making in early years and are thus omitted from studies using performance as the dependent variable. They also suffer from the liability of newness and are more likely to fail. Data on small firms is also often hard for researchers to access. Indeed, Mitchell (1991) uses survival as a proxy for performance when data may be unavailable.

This chapter opened with the premise that resource endowment, or size, can allow a firm to withstand the pressures on the competitive landscape. Although size as an absolute seems to be supported as a factor in the prevailing literature, this ignores another current both in the literature and in practice, that of network formation to compensate for resource gaps as a size compensatory move by firms, and also the use of networks for risk spreading (Liedka, 1991; Piskorski & Anand, 2003) as examples of adaptation mechanisms. Exploration and exploitation activities of the firm at the investment site level can also affect performance and thence survival and dynamic capabilities, specifically discretionary adaptation linking back to strategic choice are an under-researched area.

The tension between externally-driven selection pressures and firm level adaptation processes is captured in both the sociology-based and economics-based literatures that use evolutionary theory from biology (either as a direct transfer or as a metaphor) but data difficulties have impeded multilevel analysis on the significant populations described by McKelvey in the preceding paragraph. The developing body of literature on the coevolutionary perspective and new organizational forms attempts to address this. The literature suggests that survival is linked to the ability to resist selection pressures and also an ability to develop adaptive routines such as exploration and exploitation though the sequencing over time is still under-researched.

Other studies have looked at firm or organizational survival and identified various drivers – one can also make sense of these using the external selection and internal adaptation perspectives, discussed in the section on evolution-based research.

There is also the issue of the industry effect – does the industry under study appear to make a difference so conclusions cannot be generalised? The consensus seems to be that, provided the study is long-term in nature, firm level factors rather than industry level factors are the key drivers to performance (and thence implicitly to survival).

So the gap lies in the need for empirical longitudinal studies examining selection versus adaptation effects and specifically extending the exploitation and exploration metaphor to activity inside the firm boundary. The impact on firm survival of selection and adaptation influences can thus be extended alongside the multi-unit studies theorised in Volberda & Lewin (2003) and empirically described in Flier, Van den Bosch & Volberda (2003) which use a different level of analysis. However, organizational size, both absolutely and considering the network proxy as an adaptive mechanism to overcome size issues, must also be addressed as there is literature to suggest that size may over-rule adaptation by promoting the resistance of adverse selection forces as a result of the resource endowment of the firm.

From this we can postulate a model to examine factors affecting survival for policy-makers, and particularly contributing to the development of research into exploration and exploitation activity inside the firm or unit boundary. A longitudinal study looking at the use of this activity at the investment level, where that investment is not in a new organizational form, but rather in a primary rent-generating asset, as well as the impact of intra-industry ties would add to the literature on the contribution of dynamic capabilities to firm survival.

This is the gap addressed by this thesis.

3.12 Conclusions

This chapter has reviewed an extensive literature relating to the survival process of firms. It has examined how biology has inspired a scientific approach to the study of populations of organizations, and how the evolutionary approach has been adopted by the two major base disciplines of the strategy literature. It has also explored the history and development of some research themes that contribute to the literatures as they exist today. The selection-adaptation motif has been contextualised in the literature and other key survival papers have been reviewed. Key findings from the literature pertaining to industry and size as factors affecting survival have also been discussed. Finally, a research gap has been identified and will be developed in the next chapter.

CHAPTER 4: THE THEORETICAL FRAMEWORK AND HYPOTHESES.

4.1 Summary

In this chapter, using the research gap described at the end of the previous chapter, a research model is derived from the literatures of the preceding chapter, based on the ontological and epistemological frameworks set out in Chapter 2 and linked to the research question in Chapter 1. Seven main research hypotheses follow and are mapped on to the research model, using a similar approach to Willard & Cooper (1985). Finally, the linkages back to the evolution/coevolution literature, specifically the testing of the prevalence of selection over discretionary adaptation variables will be tested through a regression analysis to see if the findings of Barnett, Greve & Park (1994), notably the dominance of selection, is upheld.

This chapter opens with a brief introduction and then shows the research model underpinning the project and variable definitions. A section on the theoretical support for the seven hypotheses follows, foreshadowing the operationalisation in Chapter 6. Finally, conclusions are drawn.

4.2 Introduction

The previous chapter closed with a discussion of the research gap. This chapter opens with a discussion of the research model based on the process for a firm entering an industry. It then expands the hypotheses associated with this research project, linking them back to the literature gap and the preceding chapters.

The previous chapter suggests that the selection–adaptation tensions affect firm survival, and that the mechanisms used to optimise the outcome of this process (or dynamic capabilities, to use the language of one of the theoretical approaches) are of interest and relevant to the longitudinal study of firms. The munificence of the environment over time will affect selection, especially the naïve selection of Volberda & Lewin (2003). Entry and exit from an industry demarcate the survival period of firms, and the timing of entry may also affect survival chances (Mitchell, 1991). The ability of a firm to adjust its position on the competitive landscape using exploration and exploitation, in March (1991); Levinthal & March (1993); March (1994) and March (1996) will also affect its survival chances as it seeks additional rent-generating assets, but those capabilities will be moderated by the firm's experience within the industry (Fiol & Lyles, 1985) and its access to networks (Dacin, Ventresca & Beal, 1999). Firm survival is also of interest to policy-makers.

In the research design used in this thesis, a pilot study tests hypotheses and some issues about the population, which are then reviewed after triangulation with a qualitative informant interview programme to allow fine-tuning before the main study. A multiple regression model is tested to see if there is a potential

predictive model that can match the theoretical model shown earlier by linking survival to selection or adaptation and suggesting which drivers and thence which mechanism appears to dominate firm survival in this industry.

4.3 The Development of the Research Model

Child (1997) in a retrospective examination of his research on strategic choice (Child, 1972), recognises that it is impossible to separate the environment from the organization (and thence by inference, the industry). The existence of the environment automatically constrains selection and adaptation possibilities. Child & Smith (1987, p.56) link the firm and the environment via the sector, where they locate the *"legitimacy"* of Pfeffer & Salancik (1978, section 2.7), questioning *"how externalised the environment actually is"*[17].

Looking back to the previous chapter, and considering the next level down in the system hierarchy, i.e. the firm:

Individual Firm Survival (yrs) **=*fn* (Individual Firm, Key Selection Forces, Key Adaptation Forces)**

Where:

- Individual Firm Survival is the dependent variable, measured as presence or absence on an annual data capture date.

- Individual Firm is a unit representing the existing resource base of the individual firm.

- Key Selection Forces are selection pressures exogenous to the population attractiveness of the economy; supply of capital; governmental attitude and tax. The selection effects would be governed by resource dependency theory and also by the evolutionary theories discussed in the last chapter. The literature would predict the existence of possible groupings of similar firms (McGee & Thomas, 1986; Cool & Schendel, 1988; Mascarenhas, 1989; Bogner, Thomas & McGee, 1996).

- Key Adaptation Forces are endogenous to the firm and may be measured at the firm and even sub-firm level, e.g. changes in intra–industry networks, changes in firm experience. In this model some of these adaptation forces are discretionary in origin, firms choose to form partnerships, they can choose to complete exploitation and exploration events (provided they have opportunity and adequate resources to do so). This links back to the literatures on networks, organizational learning and dynamic capabilities. Again the literatures would predict several successful survival strategies.

Building on this, I derived the simple representational model shown in Figure 4.1:

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[17] This discussion appears again in the interview findings discussed in Chapter 8.

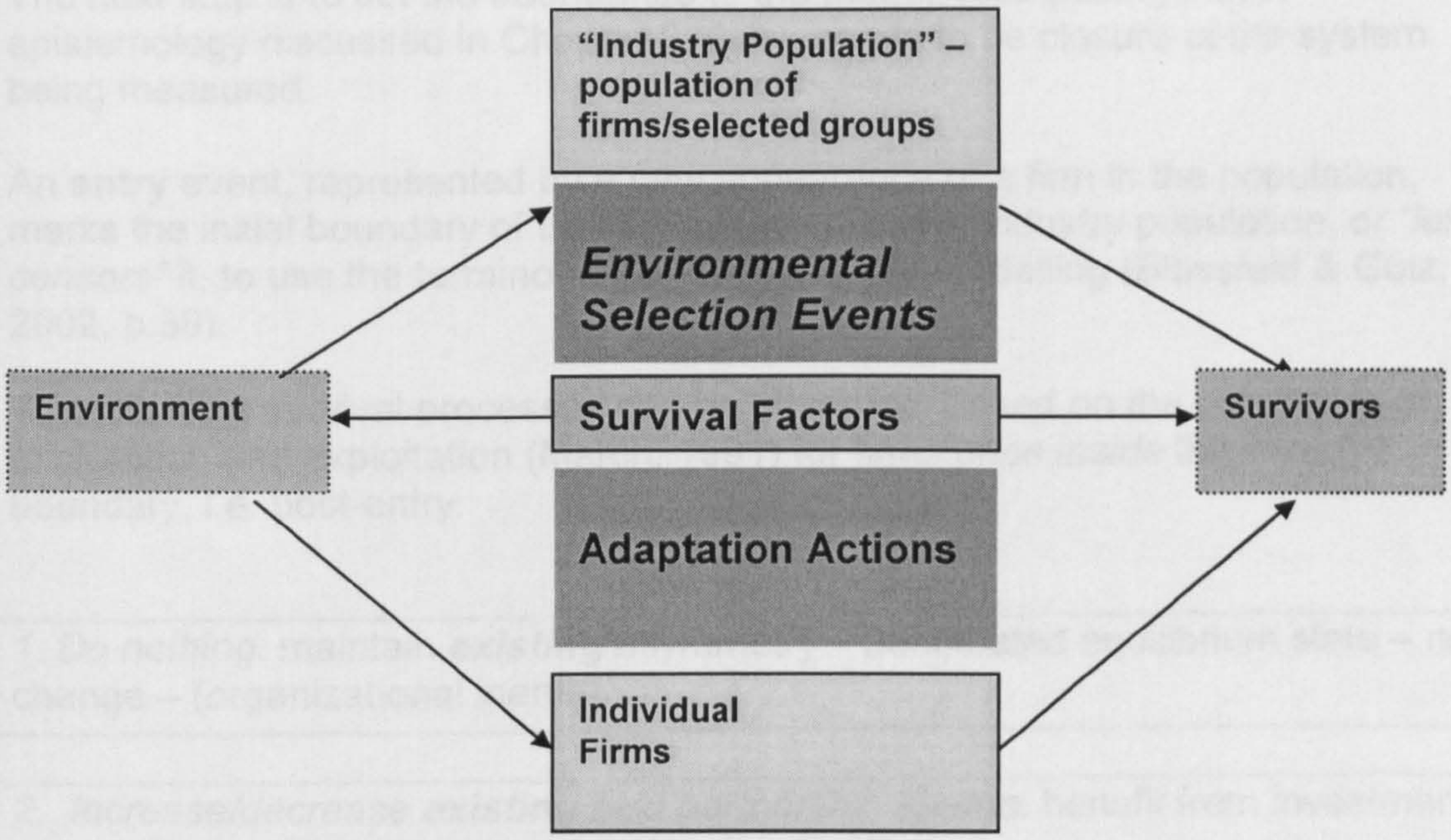

Figure 4.1: Research Model linking Survival, Selection and Adaptation

The four boxes represent the following:

Environment parallels the environment referred to in Pfeffer & Salancik (1978) as macro–economic and institutional. It is exogenous to each firm.

Industry or "population" of firms is the level of the aggregate of all firms recorded as being present in the industry.

Individual firms represents the level of those individual firms constituting the industry or population.

Survivors are those individual firms drawn from the population that survive for at least one year. A coevolutionary approach suggests that the survivors also re-create the environment.

The thickness of the arrows is not representative of the influences of those effects, since that balance is one of the expected outcomes of the research.

So from one perspective, the model suggests the environmental selection events affect firm survival either by filtering through the industry as a whole via selection of groups with specific properties or by impacting on individual firms with consequent differential adaptation. The converse view is that differential discretionary adaptation effects at the firm level may render certain firms better equipped to deal with selection pressures.

The next step is to set the boundaries to the model, recognising that in epistemology discussed in Chapter 2, there needs to be closure of the system being measured.

An **entry** event, represented by a new appearance of a firm in the population, marks the initial boundary of the firm's survival in the industry population, or *"left censors"* it, to use the terminology of event history modelling (Blossfeld & Götz, 2002, p.39).

The following survival processes can be observed, based on the constructs of exploration and exploitation (March, 1991) for firms *once inside* the industry boundary, i.e. post-entry:

1. Do nothing: maintain ***existing*** asymmetry – punctuated equilibrium state – no change – (organizational inertia).
2. *Increase/decrease **existing** field partnership shares*: benefit from investment site-level knowledge asymmetry – (exploitation).
3. *Increase/decrease **new** field partnership shares:* benefit from industry-level knowledge asymmetry – (exploration).

An **exit** event, represented by an absence of a firm previously present in the population signifies the termination of a firm's intra-industry survival and *"right censors"* the firm's survival in the industry population.

4.4 Variable Definitions

Survival is defined as post–entry presence of a firm in the industry population and measured in years.

A **Firm** is the aggregation of all producing onshore field interests with a similar corporate identity. The **Industry Population** is the sum of all firms in this study.

Discretionary Adaptation Events are defined as events completed by the firm over which it has varying degrees of control, so discretion is on a continuum. So at one end of the continuum, it would encompass the annually measured post-year of entry changes to either the size of an individual field investment (exploitation) or to the number of field investments (exploration) prior to exit, because those events are driven by adaptation decisions of the firm. In this instance, exploration and exploitation events are recorded both as annual event numbers by type and as an aggregate of exploration and exploitation taken together for each firm.

Intra-industry Firm ties between two firms are deemed to exist for each year that they are both recorded as present within an oil or gas field. A firm's intra-industry firm ties with another firm is the aggregate of all the times it is a partner

of that other firm in all the fields where they share interests. The aggregate of all intra-industry firm ties for each firm, is the sum of all ties with all other firms where they are partners, calculated annually.

Intra-industry Experience is calculated for each year a firm is present in an oil or gasfield and is measured annually as a firm's presence in a field for that year. A firm's annual experience is the aggregate of all its field interests in a given year, measured in years.

Industry Operator Experience is measured annually when the firm is reported as the field operator within this industry. A firm's annual industry operator experience is the aggregate of all its operatorships in a given year, measured in years. Operator experience has a symbolic meaning (Meyer & Rowan, 1977) discussed in the interview data as operatorships are approved by the governmental licensing body and are thus a mark of achievement by peers and by an important industry stakeholder, bestowing legitimacy (DiMaggio & Powell, 1983).

Intra –industry firm ties, intra-industry experience and operator experience also include some aspects of discretionary adaptation, but can be affected by decisions made by other firms.

4.5 Hypotheses

The next section looks at the hypotheses derived from the simple research model shown in Figure 4.1, notably that selection and adaptation forces are both important for post-entry survival within an industry. The literature reviews in the last chapter support a theoretical perspective that survival is the outcome of selection of firms or successful discretionary adaptation by the firm on the competitive landscape enabling it to withstand environmental selection pressures (or specific events). In the research model used here, the underlying driver for discretionary adaptation is the management of asymmetries, manifested primarily as changes to exploration and exploitation events but including changes to network size and changes in the learning leading to changed positions of a firm in the perceived hierarchy in the industry[18]. The following hypotheses are derived from the model and the literature analysis, relating to selection and adaptation at the firm and in one case at the population level.

H0: Within the industry, the larger the firm, the longer it survives.

The literature suggests large firms survive longer - Pfeffer & Salancik (1978, p.135) links firm survival to size. March & Simon (1958) discusses organizational slack or excess resources as important . Bluedorn (1993)

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[18] This is covered in more detail in later chapters, especially Chapter 5 on the industry context and Chapter 8 on the interview data. Essentially the license awarding authority (here, the UK Government) recognises a firm's ability to manage a resource development through the award of operator status; this is a significant legitimising event in a firm's history, confirmed by the interview data in Chapter 8.

reviews the literature on organizational size and the environment. An industry specialist (Lovegrove, 2000), concludes that smaller size is a disadvantage for independent oil firms in the competition for investors. Mata & Portugal (2002) consider size a key driver of survival. For some smaller firms, a paucity of resources will make them vulnerable to exit at times of adverse selection events in the environment (Said, 1976; Jarillo, 1988; Moore & Garnsey, 1993).

This hypothesis is not expected to be supported. However, it is indirectly linked to a later hypothesis on network size (Jarillo, 1988; Ebers & Jarillo, 1997; Piskorski & Anand, 2003).

H1: Within the industry, the more munificent the environment, the larger the number of firms that survive.

A munificent environment will have weak links with the organizations it encompasses as a result of organizational slack (March & Simon, 1958) and can affect the way that opportunities to exploit the environment may be effected.

This hypothesis is about resource dependency. It tests selection, and the applicability of the ecological-evolution approach, as described in the previous chapter. For larger firms, with other portfolio possibilities, the lower degree of embeddedness in this industry means that they are more vulnerable to selection events, as their investments are subject to internal screening based on *"materiality"*[19].

To describe environmental munificence, constructs related to survival derived from other literatures below are reviewed.

Most countries have an economic policy model concerning the exploitation of resources (Pandey, 2002). This includes macro-economic factors, taxation factors, technology and industry costs; as critical inputs – (Kemp & Stephen, 1999) find oil and gas activity levels sensitive to oil and gas prices, development costs and exploration effort. Sadorsky (2001, p.17) suggests *"exchange rates, crude oil prices and interest rates each have large and significant impacts on stock price returns."* Papapetrou (2001) suggests that: *"oil price changes affect real economic activity and employment. Oil prices are important in explaining stock price movements."* Both of these papers are looking at stock price returns, which in turn link to survival (Pfeffer & Salancik, 1978).

There are expected interactions between the metrics in this category (Kemp & Crichton, 1979). Doroodian & Boyd (2003) formally link oil prices to inflation.

Im (2002) looks at taxation as a way of managing resource depletion, and Kemp & Crichton (1979) look at tax as favouring capital-intensive schemes. Andrews-Speed & Rogers (1999) link taxation policies to resource price movements. Rutledge & Wright (2002) link tax to political economy through a

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[19] Materiality or relative importance compared with the rest of the investment portfolio is explored further in the interviews in Chapter 8.

study of the North Sea as a source of state revenues. Flåm & Stensland (1985) suggest taxation policy may influence the order of development of natural resource pools, and that the taxation policy may affect the development of natural resources with consequences for national economies.

Suarez & Utterback (1995) and Singh (1997) suggest technology has an impact on firm survival. Mani (2003) looks at international comparisons of Government policy, innovation and technology.

Support for this hypothesis is anticipated from key industry drivers such as oil price, environmental effects, tax, technology and costs consistent with the standard economic investment model for this industry (Nevitt, 1989; Pollio, 1999). The results discussed in Chapters 7 and 9 also test out the impact of the selection variables contrasted with the discretionary adaptation variables addressed in later hypotheses.

H2: Within the industry, early entrants are more likely to survive for longer than later entrants.

This hypothesis is about firm entry, addressed in the previous chapter in the literatures on population ecology and also in the other literature on survival as well as being popularised by the term, *"first mover advantage"* (Lieberman & Montgomery, 1988, 1998). Mascarenhas (1989, 1992a, 1992b); Bryman (1997); Rothermael (2001) and Vermeulen & Barkema (2001) suggest first mover advantage is real and tangible, though Mascarenhas (1989) also suggests later entrants are also likely to survive. However, Mitchell (1991) stresses the importance of the state of the industry, the sub-field that is being entered, and particularly the timing relating to the industry clock. In a parallel fashion (Agarwal & Gort, 1996) link entry, exit and survival with stages of market evolution. Baldwin & Rafiquzzaman (1995) suggest selection is important to the growth of an entry cohort.

In contrast, however, Willard & Cooper (1985) find no apparent relationship between survival and entry timing.

The year of entry represents the initial boundary of a firm's survival. However, if the firm has a short survival, entry and exit can occur in consecutive years with effects on the survival statistics. Disney, Haskel & Heden (1999) recommend the use of *"post-entry survival"* to manage this, and this study follows their approach.

The next three hypotheses look at pro-active adaptation strategies, derived from the dynamic capabilities approach (Teece, Pisano & Shuen, 1997):

- Exploration and exploitation are outcomes of discretionary choices within the control of the firm;
- Intra-industry ties are not completely within the control of the firm;
- Experience can be gained through inertia as well as discretionary choice.

All three are to some extent inter-linked; experience may be gained through exploration activity as well as inert incumbency and industry ties may be gained through exploration activity or through inertia as other firms evolve or disappear and new entrants take their place.

H3: Within the industry, the greater the total number of exploration plus exploitation activities executed by a firm at the investment level, the longer it survives inside the industry.

Exploration and exploitation as adaptive mechanisms derive from March (1991) and lie at the heart of this research project. They are viewed over time and an experience effect is anticipated here (Delios & Beamish, 2001). March (1991); Levinthal & March (1993); Lewin (1997) and Koza & Lewin (1998, 1999) use exploration and exploitation to explain changes in organizations to produce new organizational forms as adaptation strategies for new markets or territories.

In order to look at the balance between exploration and exploitation, this hypothesis is split into two:

H3 i: Within the industry, the greater the number of exploration activities executed by a firm at the investment level, the longer it survives inside the industry.

H3 ii: Within the industry, the greater the number of exploitation activities executed by a firm at the investment level, the longer it survives inside the industry.

These hypotheses examine pro-active adaptation, rather then passive inertia inside the industry boundary. March (1991, p.71) suggests that *"maintaining an appropriate balance between exploration and exploitation is a primary factor in system survival and prosperity"*. However, there is a need for clarification of the exploration/exploitation sequencing and prevalence in the literature. March (1991) suggests that exploration follows exploitation, and exploration is linked to survival, also postulated by Bierly & Chakabarti (1996). However, Proposition 1 of Koza & Lewin (1998) expects a preponderance of exploitation driven alliances and Flier, Van den Bosch & Volberda (2003) also favour exploitation as a driver for strategic renewal, and thence survival. Regner (2003) suggests

the location of decision-making dictates the prevalence of exploration or exploitation. Levinthal & March (1993) warn against competency traps from over-indulgence in either exploration or exploitation, and Levinthal (1997) suggests that the age of the firm has an impact too. Chang (1996) finds that firms tend to repeat exploration and exploitation activities, though Miller & Chen (1994) favour a view reflecting periods of firm activity followed by periods of inertia (albeit on a study of large firms).

H4: Within the industry, the greater the number of a firm's intra-industry ties, the longer it will survive inside the industry. Smaller firms will be predisposed to use large numbers of ties to enhance survival.

This hypothesis is about social networks and partnerships, that is the linkages between firms inside the industry. Burt (1978, 1982, 1997) suggests social capital is important to the individual manager. Thorelli (1986) looks at networks as an alternative to transaction costs. Benson (1975); Uzzi (1997); Rowley, Behrens & Krackhardt (2000) and Hite & Hesterley (2001) all find that stronger ties and denser networks promote better performance. Baum & Oliver (1992) suggest embeddedness is linked to the institutional environment. Singh & Mitchell (1996) link survival to collaboration.

Benson (1975) argues that inter-organizational relationships are complex and multilevel. The study uses the political-economy metaphor to explain why dominance by the larger resource rich firms should not apply because they have only limited power in the industry taken as a whole[20]. The high degree of information asymmetry in the industry and its importance to members mean that one way to acquire information is through an extensive organizational intra-industry network built up over time to permit development of trust, etc. (Granovetter, 1985). There is also an element of success by association (Padgett & Ansell, 1993) that is examined in aggregate through the individual organization's number of ties, but is not broken out by partner in the thesis. The latter is discussed as part of a future research agenda in Chapter 10. This hypothesis is also linked to H1 as small firms may use networks as a proxy for size.

H5: Within the industry, the greater a firm's intra-industry experience, the longer it will survive within the industry.

This hypothesis looks at organizational learning effects, as distinct from discretionary organizational adaptation (Fiol & Lyles, 1985), and survival; in other words, the benefits from incumbency in terms of progress along a learning curve coupled with the legitimacy derived from that incumbency. Progress in the institutional environment will also confer benefits that may lead to enhanced survival through preferred treatment by policy-makers and regulators as well as perceived legitimacy (Baum & Oliver, 1992). It is also about the longevity of a

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[20] Although BP could be thought to be a dominant player, the relative isolation of the Wytch Farm group from the rest of the industry suggests that this is not so. BP closed its onshore operations unit in the early 1990s and runs Wytch Farm as a separate entity, (Informant interview).

firm, discussed in Chapter 1 (de Geus, 1997), and the liability of newness of a firm, discussed briefly in the preceding chapter.

H6: Within the industry, the greater an adverse environmental shock, the more firms will exit from the industry.

This hypothesis is about resource dependency. Thompson (1967) discusses the concept of buffering, also referred to in Pfeffer & Salancik (1978, p.108); this provides a capability to withstand external shocks; adequate buffering should protect firms and enhance survival. Smaller firms are expected to leave the industry, in times of adverse environmental changes, e.g. fiscal policy changes and low oil price as they have smaller resources to withstand shocks. External shocks, however, can be survived if a firm has developed dynamic capabilities that may enable it to withstand adverse selection (Brown & Eisenhardt, 1997). Groups of firms are also expected to leave the industry as they are selected out over the period (Willard & Cooper, 1985; McGee & Thomas, 1986; Cool & Schendel, 1988). Pandit, Cook & Swann (2001) link survival to clusters.

Hypothesis	Synopsis	Construct	Main Literature
H0	Size is all	Resource Endowment	Size
H1	Environmental munificence	Selection	Resource Dependency
H2	Early entry/first movers	Selection	Population Ecology; Corporate Demography
H3 group	Exploration/ Exploitation activity	Discretionary Adaptation	Dynamic Capabilities; Organizational Learning
H4	Intra-industry ties	Discretionary/ no choice Adaptation	Size; Social Networks and Partnerships
H5	Intra-industry experience	Discretionary Adaptation	Organizational Learning
H6	Adverse environmental shocks and exits	Selection	Population Ecology; Corporate Demography; Resource Dependency; Strategic Groups

Table 4.1: Hypotheses Summary and Linkages to Literatures Referred to in Chapter 3

4.6 Conclusions

This chapter develops the model for this research from the literature discussed in the previous chapter, and then links it to the research question from Chapter 1 using the selection/adaptation metaphor and the dynamic capability/discretionary adaptation approach. It uses this model to form a framework for seven hypotheses concerning selection factors, entry, adaptation and survival enhancement and exit from the industry, together with a null hypothesis that firm size alone will determine survival. The adaptation hypotheses lie along a continuum from pro-active discretionary adaptation to inertia driven adaptation from incumbency. In particular, the hypotheses concerning exploration and exploitation seek to address one of the key literature gaps by looking at the pre-eminence of one adaptation mechanism over the other. The operationalisation of the hypotheses together with the research design forms the basis of the next chapter.

CHAPTER 5: THE RESEARCH CONTEXT

5.1 Summary

This chapter looks at the research context by examining the history of onshore oil and gas exploration and production in the UK. It reviews the process from license award to operation and the impact of two key influences, taxation and finance on the industry. The latter are included in the H1 hypothesis. It also discusses the terms used and the role of partnerships as a background to the operationalisation of the hypotheses in the next chapter, closing with some conclusions that link to the methodology, methods and design chapter that follows.

5.2 Introduction

This study is located in the context of the onshore oil and gas production industry in the UK. Though much smaller in size than the offshore industry, the more manageable number of firms and investment sites permits the investigation of theory and its development, which can then be tested in the offshore industry in a subsequent study. The oil industry is extremely secretive (Stanley & Morrison, 1989) and even public data disclosed in Government publications such as the *"Brown Book"* (Department of Energy, 1975-99), which was the major source for this research, needed to be extensively cross-checked for accuracy, as discussed in the methodology chapter which follows next. A time-line for the industry, including offshore events, is shown as Appendix E.

In this chapter, the history of the onshore industry is briefly discussed, followed by a longer section breaking down the stages in a firm's journey to reach onshore production.

This chapter is laid out as follows: The UK onshore oil and gas production industry context; the historical background to the UK oil and gas sector; how the oil and gas production process works; the investment decision, and conclusions.

5.3 The UK Onshore Oil and Gas Production Industry Context

In this study firm survival in an important but unusual industry context (that of a primary extractive industry with commodity outputs) is addressed. The oil and gas industry in the UK differs from the US industry in several key areas. Oil is owned by the State, and developed through licenses awarded in competitive bidding rounds by the State to pre-qualified firms. Firms need to demonstrate adequate technical and financial resources, and the award is based on the technical programme proposed. Firms collaborate in field partnerships, led by an operating firm, chosen to carry out the technical work on behalf of other parties. License interests may only be transferred with State approval, and existing partnership members have first right of refusal. Access to the oil on

land not owned by the State is mandatory but firms have had to resort to intricate deals with landowners to secure compliance. Oil or gas produced has to be moved to an offsite processing plant, via trucks or pipelines creating constraints to sales agreements[21].

All oil and gas industries share risks and resources through partnerships (Johnston, 1994). In the UK oil and gas exploration and production industry, many newly-created local firms were included as partners of major multinationals in the early licensing rounds. Hence in the 1960s, and early 70s, many small independent UK oil and gas exploration and production firms appear on the early lists of licensees (Department of Energy, 1975-99). However, as of December 1999, only 4 out of the 19 firms actively producing onshore in the UK were listed on the UK Stock Exchange – the others were reliant on private capital, or were non-UK firms. Firms listed in the 1970s and 1980s are gone: they have been taken over, or they have left onshore UK.

Firm entry is no more than the initial delineator for potential survival, with exit marking closure. The intervening period needs to be worthwhile for the firm through its collection for license interests. It can try to dispose of its licenses individually, but, as discussed later in this chapter, this may be subject to the pre-emptive rights of existing partners in the license, and thus impair the price. It can report its licenses on its balance sheet by capitalising expenditure (but there needs to be evidence that cashflow from oil or gas production is going to happen in the foreseeable future)[22]. This asset valuation is currently the subject of negotiations between the International Accounting Standards Board and interested stakeholders through Exposure Draft 6, which is recommending an annual reappraisal of the value of licenses with provisions taken immediately for any impairment of value, a development likely to change the profile of this industry drastically if enacted.

The disappearances of firms in the onshore research population suggest that the knowledge and the capabilities gained inside the industry impact on the perception of a firm such that:

1. Other firms are prepared to acquire the firm as a bundle of licenses and associated tax status plus knowledge with a possible bid premium;

2. The knowledge and capabilities may have greater value when applied elsewhere, e.g. offshore (possible exit reason);

3. They have not been effective in producing rents, and therefore the firm chooses to leave the industry and possibly sell off licenses and/or associated tax losses piecemeal.

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[21] All sales of onshore gas were the subject of a State-controlled monopsony agreement with the former State-owned BGC until the 1990s. As a result, gas fields were not developed as the price, dependent on quality and volume, was largely unattractive compared with large offshore gas fields.

[22] This issue is currently in the news concerning Shell.

These are entirely congruent with the view of a long-time industry expert (Lovegrove, 2000).

Bankruptcy has not been a feature on this competitive landscape. This has been largely due to the value of the tax losses to other firms. The firms in the study do not include any bankruptcies during the period, but one has subsequently entered a state of financial reconstruction.

Selection pressures in this industry arise from regulation, politics, tax[23]and technology[24]. However, an application for development and production involves agreement of a complex web of stakeholders, leading to agency costs and delays and the exit of many of the major companies prior to production.

This research treats the UK onshore oil and gas production companies as a separate population following McKelvey (1982); Baum & Singh (1994c) since it has relatively distinct services, client (and supplier) niches and configurations of natural, human and capital resources. It also has distinctive fiscal treatment. The separate nature of the industry is consistent with the informant interview data (see Chapter 8).

5.4 The Historical Background to the UK Oil and Gas Sector

Since 1965, the UK oil and gas industry has generated operating surpluses of over £250 billion, with some £105 billion reinvested in the UK oil industry. In 1999, the last year of the period under study, the UK oil and gas sector as a whole accounted for 1.8% of the UK Gross Value Added. It accounted for 13% of total industrial investment and provided £2.6bn in revenue to the UK treasury as receipts from tax and royalties. Peak receipts for 1984/5, the years at the start of the study, equated to £22.7bn in 1999 prices, some 16.5% of GNP in 1984 (Department of Energy, *"Brown Book"*, 1988, 2000). The oil and gas sector of the economy remains a significant contributor to the UK national wealth, and the member firms exert considerable power both in the UK and elsewhere in the world.

Onshore oil and gas forms a small part of this story, but has a longer history. Since the North Sea development, it has been the low cost (as compared with offshore) entry route for smaller firms to the oil sector. Many did not survive.

Highlights of the industry are captured in Appendix E, depicting a time line for the industry.

5.4.1. Early History up to 1960

The history of oil and gas exploration and production in the UK dates back to Roman times. Archaeologists found evidence that bitumen had been used in

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[23] Tax is a major driver in the offshore oil industry – with marginal tax at over 90% at one point – tax synergies and offset arrangements are critical to this expensive resource.
[24] Following economies of scale and scope, well costs have become cheaper, and production costs lower over time.

the camp at Wroxeter in Shropshire for waterproofing. This was almost certainly from a surface seepage, as was the feed for a primitive refinery at the village of Pitchford (note the name) which was recorded by a writer as early as in 1684 (Huxley, 1983, p.28).

However, the first serious oil production was from shale oil seepage in Alfreton in Derbyshire in 1847, from which paraffin was produced. James Young, who set up a company to develop shale processing, extraction and separation, is viewed as the father of the British oil industry, which started a more than a decade before that of the USA. Shale oil as a source peaked in the early 20th Century, and was suffering from competition from cheaper imported oil as the First World War broke out.

In the early years of the 20th Century, the Anglo-Persian Oil Company (APOC, now BP) had access to oil it was producing in the Middle East, but no market, and had difficulties funding its exploration and production. It was 97% owned by the Burmah Oil Company, which had interest even further afield. In 1914, APOC negotiated a complex agreement with the UK Government, whereby in return for a substantial cash injection, it had the sole concession to supply the Admiralty fleet with fuel oil, and granted the UK Government a majority shareholding and the right to appoint two directors (BP web-site, 2003). This supported the British war effort during the First World War.

Indeed the story of the UK's domestic oil and gas exploration is strongly linked to threats to overseas supply, and the desire for self-sufficiency in a crisis. Commercial exploitation in the UK itself can be said to have begun at the end of the First World War, when US oilmen and equipment came to England and drilled a well at Hardstoft, on the Chatsworth estate of the Duke of Devonshire. The Admiralty feared for security of oil supplies to the Navy, since its ships were increasingly oil powered, and used the Defence of the Realm Act (1914) to speed up exploration for alternative supplies. In all, 11 wells were drilled (Cranfield, 1985). The wells were drilled under the supervision of S. Pearson & Sons (forerunner of today's Pearson Group) under the urging of Sir John Cadman, then deputy chairman of APOC. A Petroleum Production Bill was introduced in 1917, vesting ownership of oil in the Crown or its licensees (i.e. the State and its licensees), with a clause that would offer compensation to landowners dropped from the Bill at the last minute. The matter of landowner compensation is an important differentiator for the UK regime from various regimes in the US (specifically the French legacy regime in Louisiana, and those followed by other oil producing US states). In the UK, ownership is now unambiguously vested in the State (Johnston, 1994).

By 1921 the exploration campaign was over. The Armistice had been signed and the threat had receded, leaving the question of what to do with the onshore oil discovered. The Hardstoft well had been a *"most remarkable oil well"* according to Arthur Wade, a surveyor (Huxley, 1983, p.41). It was unclear to whom the Hardstoft (Chatsworth) oil belonged. The Government was trespassing on the Duke's land, but had been protected by the Defence of the

Realm Act, which became invalid after the war ended. Official compensation was paid to the Duke of Devonshire who took over the only private oil production license. The well has now essentially run dry (Huxley, 1983).

As a result of the lack of clarity about oil ownership, Parliament enacted legislation to organize the issue of petroleum licenses in 1934. This Act remains the main authority for issuing licenses to prospect for, drill for or produce onshore (or landward) oil and gas in the United Kingdom. It confirms ownership of resources by the State, empowers the Board of Trade (and its successors) to regulate practice, including requirements for financial suitability and technical competence, and allows compulsory access to potential well sites for licensed firms, with provision for compensation payments if necessary. There are also safeguards against oil passing into foreign control, as well as clauses addressing concerns about the management of the environment and poor reservoir management, leading to poor recovery rates, or early depletion. Alongside this Act, tax incentives were granted to firms, in the hope that domestic production would be competitive with imports.

By 1937 four companies received licenses – D'Arcy (now BP); Steele Bros; Gulf Exploration (GB) (now Texaco) and Anglo–American Oil (now Esso or Exxon). In 1939, oil was discovered by D'Arcy at Formby in Lancashire, making this the first true onshore oil field. Within months war was declared again. During the Second World War, the UK Government, realising that its dependence on imported oil from the Middle East was a weakness, brought over experienced oilmen from the USA to assist D'Arcy leading to the discovery of the large East Midlands fields (Woodward & Woodward, 1973). Little public information was available on this top-secret project until comparatively recently. 249 wells were drilled between 1939 and 1944 in the East Midlands area, resulting in the discovery of four small oil fields.

Once the war was over, Anglo-American left the UK, believing there was insufficient oil, later returning in 1961 as Esso. D'Arcy also scaled down its operations, finding easier oil sources overseas, taking another look at the UK in the 1950s as expertise from Iranian fields was transferred to the UK. A dozen fields came on stream during 1953 and 1961 aided by a partnership between BP (as D'Arcy Exploration) and the State-owned monopoly, the British Gas Corporation (BGC) (through its 100% subsidiary, the Gas Council) signed in 1952. However, it was not until 1959, when Shell and Esso made the significant offshore gas find at Groningen in the Netherlands (Moreton, 1995, p.7) that interest in the UK was rekindled, as companies pondered the existence of large reserves offshore and the extensions of those potential offshore fields onshore.

5.4.2 The Sixties and Seventies

By the early 1960s, all domestically produced oil was refined in Scotland, at a single refinery in Pumpherston and received a duty concession, in essence a cost subsidy, for gasoline production (petrol for cars). However, in 1964, the UK Government removed this subsidy - low world oil prices, even with

transportation costs from the Arabian Gulf, meant domestic oil was uneconomic once more.

The Geneva Convention, ratified in 1958, delineated national territorial waters, and the UK Government became a signatory in 1964. By this time, Groningen had been discovered and oil firms were speculating on the existence of a possible series of similar fields offshore UK because the geology was so similar. A key meeting was organised by BP, mostly with companies from North America to discuss what the companies wanted from the licensing process (Colin Fothergill, quoted in Moreton (1995, pp.15-17). After due consideration of the representations made, offshore licenses were awarded and drilling began.

The fiscal system was addressed as issues surfaced, culminating in the Oil Tax Act of 1975, which is still the basis of the present tax system. More on the fiscal system is addressed in the later section on Taxation.

Following the success of the early formal offshore licensing rounds, further rounds were announced with so–called *"golden blocks"*, thought to have special potential, sold off by auction to the highest bidder in the 4th, 8th and 9th Offshore Rounds.

Licensing round awards were not uniformly successful. Offshore rounds depended on firms' views of the geology and economics of the blocks on offer, as well as the prevailing fiscal regime. The government also introduced State participation in 1976 through the creation of the British National Oil Company (BNOC) which had the right (though not the obligation) to purchase up to 50% of the oil produced, while all gas produced had to be sold to the State-owned monopoly supplier, British Gas Corporation (BGC).

As a result of successful offshore oil and gas discoveries, lower cost onshore oil and gas exploration was of interest to potential investor firms once more, especially in the littoral regions, as some companies guessed oil and gas bearing structures might extend from land out to the sub-sea areas. The lower funding and production costs associated with onshore also made these investments attractive. The onshore licensing regime had been overhauled in 1967, and by 1971 it looked as if a large gas field had been discovered at Lockton in Yorkshire by Home Oil and the Gas Council. With local opposition running high, a process to deal with impurities in the gas featured arsenic, with attendant disposal problems. A magnificent set of offices was commissioned, and production lasted barely *two weeks* after the official opening ceremony,

"after which the whole operation was shut down and the plant mothballed." (Moreton, 1995, p.100).

In 1975, a well drilled at Wytch Farm in Dorset by the BP/Gas Council joint venture marked the start of the UK's most prolific onshore oil field. Many in the oil and gas industry view Wytch Farm as an atypical onshore field

"an offshore field onshore"
(Informant interview)

"Wytch Farm moved from merely being the largest UK onshore field towards being the largest in a large part of Europe"
(Vic Colter, ex–Head of Exploration at BGC in Moreton, 1995, p.107)

The Wytch Farm discovery set off a major exploration programme, resulting in several other promising oil finds. Sadly none were of similar size to Wytch Farm, so in general onshore UK oil and gas production results have been disappointing.

Onshore oil and gas exploration, which contributes to the onshore oil and gas production industry by identifying economically viable fields, was also characterised by very limited access to onshore drilling rigs during the Sixties and Seventies. BP had its own rigs, but for smaller firms, there was a long wait for a rig; rig hire and well drilling costs were high and planning permission issues added further delays. Additionally, in the middle to late 1970s, the UK economy went through a very difficult time – the compulsory State participation in offshore fields was rumoured to be going to be extended onshore though there was nothing outside the State-sponsored Wytch Farm field of economic value. As a result the investment climate deteriorated and capital also became in short supply.

The decade closed with the start of production from Wytch Farm and a change of government from left–wing (Labour) to right–wing (Conservative).

5.4.3 The Eighties and Nineties

The 1980s was the decade of the Thatcher Administration, taking a free-market approach to business as opposed to the nominally socialist administrations of the late 1970s. Several key events happened almost simultaneously at the start of the period of study of this thesis, and serve to delineate it clearly from the preceding years:

1. In 1984, BGC was forced by the Government to divest its 50% Wytch Farm interest to other oil firms as part of the Conservative's privatization and fund-raising programme (Moreton, 1995; Hoopes, 1996).

2. A number of successful discovery wells suggested that there would be a series of new, prolific onshore fields replicating the Wytch Farm experience termed *"the string of pearls"* (Interview with informant).

3. Auctions by BP and Occidental of small parts of their interests in the mature Forties and Claymore offshore fields respectively allowed smaller

firms to offset accumulated tax losses including those from onshore fields against cash-generating, high-tax-paying, offshore production (de Nahlik, 1992, p.156).

4. Oil price forecasts were at $30-40 per barrel for future years. (Author's direct experience as bank participant in oil and gas financings approved at this time but see also McKechnie (1983, pp.116-7); Pollio (1999, p.60)).

5. BP became a private firm with the sale of the Government's shareholding, BGC began privatization, and the former entity set up to hold field participations under the previous regime (BNOC) split to produce two new sizeable UK privatized firms, Enterprise and Britoil (Hoopes, 1996).

The result was that in 1984, the number of onshore producing fields listed by the Department of Energy in their annual review of the UK Oil and Gas industry doubled from 1 to 2 and by 1985 rose again, with new players joining BP and BGC as producers.

Oil taxation was a major source of Government revenue and had steadily been increasing. With a maximum tax-take of a staggering 91.9% on offshore crude produced in 1982 and 1984 (Lovegrove, 1983), firms voted with their feet and declined to invest in licensing rounds, as can be seen in Table 5.1. Numbers of successful onshore producing firms began to increase until the UK government decided to change the tax system again in order to *"ring fence"* tax offsets from onshore activities against offshore activities within the UK oil and gas sector in 1985. This stopped a firm's ability to offset onshore exploration losses against offshore tax-paying production, diminishing the value of the assets at a stroke, especially those linked to the BP and Occidental disposals described earlier. The fall in oil price from almost $29/barrel in 1984 to $18 per barrel by 1989, coupled with these tax changes, resulted in a major exodus from the onshore industry. In particular firms, whose core activities were not oil-related, left. These firms had participated directly and indirectly as capital suppliers to the fledgling UK sector and included names such as RTZ (mining), Trafalgar House (shipping and property) and James Finlay (trading and tea plantations). Other oil firms, including both foreign national firms such as Elf and Total and maturing new UK firms with significant positions offshore and overseas such as LASMO, also left onshore UK in search of lower-cost, more certain returns. (The 1980s had seen the development of onshore provinces nearby, e.g. the Paris Basin, though success continued to elude those firms looking for oil and gas both onshore and offshore in Ireland). Majors such as Shell had already left for a number of reasons including the high costs of managing environmental issues. These departures offered possibilities for new entrants.

Onshore Round Number	Date	Number of Blocks Offered	Number of Licenses Awarded	Number of Firms Successful	Offshore Round Number	Date	Number of Blocks Offered	Number of Licenses Awarded	Number of Firms Successful
					1	1964	960	53	51
					2	1965	1102	37	44
					3	1970	157	37	61
					4	1971*	421/15	118	213
					5	1976	71	28	64
					6	1978	46	26	59
					7	1980	80	90	157
					8	1982*	169/15	48/7	81
					9	1984*	180/15	13	103
1	1986	n/a	74	91	10	1986	127	51	60
2	1987	n/a	60	73	11	1988	212	105	69
3	1989	n/a	22	30	12	1990	161	74	69
4	5/91	n/a	40	39	13	1990	117	6	17
5	11/91	n/a	26	27	14	1992	435	78	48
6	1992	n/a	22	24	14	1992	49	1	2
					15	1994	81	20	36
					16	1994	101	18	27
7	1995	n/a	22	17	16	1994	63	27	34
8	1996	n/a	35	27	17	1996	275	25	32
9	1999	n/a	37	21	18	1998	602	47	44

* These rounds included some additional attractive blocks awarded by auction and for which a premium was payable.

Table 5.1: Outcomes of UK Government Oil and Gas Licensing Rounds 1964-1999

Just as the Eighties were the decade of restructuring and privatization, the Nineties (characterised by a rise in oil price at the beginning and again in 1996) could be characterised as the decade of innovation.

As part of the continuing liberalisation programme of the Eighties, the UK state-owned gas and electricity monopolies had been broken up and in the case of electricity supply, production separated from distribution in 1990. Gas-producing fields no longer had to sell their gas to BGC, so independent gas–fired power stations were built to use smaller, less economic gas fields and meet specific power requirements. While this began with smaller offshore fields, it rapidly moved onshore where there were quantities of discovered gas which could not be produced because the quality was below BGC's standards, or pipeline construction was expensive or difficult.

Additionally, in 1992 the Government announced an initiative to produce coal bed methane (CBM), gas found above coal beds, and offered licenses to explorers as well as looking at ways to use trapped mine gas using Methane Drainage Licenses (MDLs). These initiatives attracted many new entrants, though few have come through to production as at 2003.

Exploration costs continued to fall as technology changes permitted horizontal drilling allowing many wells from a single site which also ameliorated the environmental disruption issues. Small-scale production rigs and use of tankers can now permit production from small fields. Seismic data capture moved from

2-D in the 1980s to 3-D and now 4-D, and seismic processing costs fell as computing power rose, also allowing better use and reinterpretation possibilities on older data. Oil or gas wells used improved technology to deal with problems such as high viscosity oil, sour gas, etc. in much more environmentally sound ways. The onshore industry also benefited from the investment by the major oil firms in good environmental management practice and from the relationships established with key stakeholders during the 1980s, since oil was becoming perceived as less environmentally rapacious than the gushers shown on television programmes such as *"Dallas"* and *"Dynasty"*.

As total UK oil and gas production reached peak production and decline, the rate of announcement of licensing rounds has been increased, in order to attract new firms. Yet another overhaul of the licensing system in the Nineties has left seven types of licenses in existence, with some dating back to the Sixties. An easing of the Government tax-take has stopped, and many larger firms are leaving the offshore industry. Although the number of new onshore fields has slowly risen, the field size remains very small especially compared with Wytch Farm and its satellite field Wareham. The fabled string of pearls fields, of which Wytch Farm and Humbly Grove were two, have yet to be found. The industry is now in a mature phase and about to enter a slow decline.

5.5 How the Oil and Gas Production Process works

5.5.1 Getting a License

Since all oil and gas in the UK belongs to the State, a firm wishing to find and develop oil and gas in the United Kingdom needs a license from what is now the Oil and Gas Directorate of the Department of Trade and Industry. Licenses are normally awarded in Licensing Rounds, announced by the Minister. Firms join together to bid for the right to explore for oil in that area, by submitting a work plan, and producing evidence of financial and technical ability to deliver the plan in a defined time horizon. The licensing body, the Oil and Gas Directorate (formerly the Department of Energy) approves all licensees using a combination of these criteria (Department of Energy, various).

It is worth noting that a firm does not have to have been a partner in a license from its initial award. It is possible to join a license by assuming or acquiring the rights of existing license holders. This is subject to the approval of the other partners, who usually enjoy pre-emptive rights (first refusal) and the State, represented by the Oil and Gas Directorate, which has a veto as well as a pre-qualification requirement. However, the paramount consideration is often the conservation of the tax status of the acquired or assumed entity. The impact on this study of the latter point cannot be over-emphasised. The records in the *"Brown Book"* (the data source used for this study) are often in the name of the original licensee despite changes of beneficial ownership[25].

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[25] An example is the firm called Candecca in *"Brown Book"*s 1986-1999. Candecca was actually sold to Trafalgar House in 1984. The assets changed beneficial ownership several more times throughout the period of study, but the assets were listed as still owned by

The onshore licensing process was largely emergent. It had been driven by demand from firms until the early 1980s when existing licensees were asked to reapply or ratify their holdings following the introduction of both a new scheme and the First Onshore Round. Subsequent Onshore Rounds have been announced at intervals, and the Government has intentions to make onshore licensing rounds annual events (Department of Energy & Oil and Gas Directorate, 1975-99).

However, the award of a license is not the end of the story as far as permissions to explore, drill for oil and gas or to produce it are concerned. A complex approval process recognises the rights of various stakeholders to be consulted and give approval, including (in no particular order): Department of Energy/Oil and Gas Directorate; Department of the Environment; Mineral Planning Authorities; Local landowners; Oil companies making up the License group; Local residents; Oil companies on adjacent licenses; Health and Safety Executive; Council for the Protection of Rural England; The Countryside Commission; Nature Conservancy Council; National Farmers Union; Royal Society for the Protection of Birds; Local Water Authority; Local Parish and District Councils; Civil Aviation Authority; Ministry of Defence; Ministry of Agriculture or equivalent; English Heritage; Local amenity societies; Ramblers Association; Country Landowners Association; Local Members of Parliament; Emergency services and The Council for British Archaeology and local archaeology groups (various industry sources). Thus, stakeholder management is a key issue and a significant expense for onshore oil and gas producing firms.

Onshore licensing round awards can be considered as real options in the oil and gas game but their value is controlled by the Government and by other stakeholders (Herath & Park, 1999). The cost of maintaining the option until cash is generated has proved too much for several major players. Shell left the UK onshore industry in the early 1980s, prior to getting to production, when a major planning decision went against them (Staff Writer, 1986).

In all of the following development stages, prior consultation with the Oil and Gas Directorate and all interested stakeholders is assumed before any action can be taken.

5.5.2 Seismic Surveys

Assuming that the license is a new one, the first stage is a geophysical evaluation of the area, usually including some seismic data acquisition in order to try to get a sense of the sub-soil geological structure. In the 1950s and 1960s seismic data used to involve the use of dynamite to produce a shock wave whose echo was measured as it passed differentially through the various rock layers. During the 1980s, the less environmentally disruptive vibroseis

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Candecca. On this basis there would be no apparent exit from the industry, despite several entries and exits by the beneficial owners.

techniques using truck mounted vibration sources revolutionised seismic data capture.

Seismic data offers a picture of the geological structures which are then evaluated by reference to known geological data, so a picture of the rock formations can be constructed. Certain rock types are known to be petroliferous, and their thickness, area and regularity are important considerations when considering where a good well site might be.

The licensing system has changed over the period 1984-99 and Specialist Seismic Licenses (SSLs) are now available for those firms that wish to undertake a seismic survey as a step out from an existing Petroleum Exploration and Development License (PEDL)[26] as opposed to the past where the seismic survey was an integral part of the exploration license.

5.5.3 Exploration, Appraisal and Development Drilling

The next stage is to drill an exploration well at the optimal site, often a balancing act between stakeholders external to the firm, geologists and geophysicists. Landowners are often reluctant to allow access across productive farmland, fearing pollution hazards or heavy traffic disruption, and drastic measures such as land purchases have been used in some cases to overcome this.

Oil has been found in several environmentally sensitive areas, and lack of local co-operation plus the high costs of local stakeholder issue management have meant that only the major firms such as BP can afford to manage this. Shell is said to have left the UK onshore industry as a result of an adverse planning decision concerning an area close to the New Forest (Staff Writer, 1986).

Appraisal drilling usually takes place in order to delineate the reservoir area or the oil field. It is the license that permits well testing by allowing prolonged production from a well or wells. The oil or gas produced needs to be transported somewhere, so there may be requirement for vehicle movements to take oil away to be refined.

Development testing is the drilling of more wells to allow water flooding or other mobilising methods to get the oil up to the surface and produce it. Most onshore UK oil is not produced by natural pressure of gas, so either gas is reinjected under pressure or water flooding is needed to move the oil out of the rock and then allow it to separate out.

The licensing system has been the subject of change over the period of study. Prior to 1973, both the production and exploration phases were covered by a Mining License (ML) or Production License (PL), examples of which are still currently valid. Changes to the regulations then introduced Exploration Licenses termed variously XLs (1973-1989) or EXLs (1986-date) or PEDLs

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[26] Which confusingly also applies to gas production.

(1996-date)[27]. Specialist Appraisal Licenses or ALs (1986-1999) and Development Licenses or DLs (1986-99) were also introduced. Licensees converted some of the old-style licenses to the newer frameworks as they came up for renewal, but not all. The result is that the various producing fields in this study are covered by a variety of license frameworks. A summary of the licenses is shown in Table 5.2 below. The numbers with a slash '/' indicate an initial licensing period and then periods of renewal.

Type of license	When in use	No awarded	Term (yrs)	Comments
ML	1965-99	32	75	Some still in use
XL	1973-89	216	3/3	Converted to EXLS
PL	1967-99	267	4/30	Some still in use
AL	1986-99	10	5	Some still in use
DL	1986-99	5	20	After AL or EXL
EXL	1986-99	295	6	Some EXLs didn't convert to PEDLs
SSL	1996-date	**5**	1	Supplementary to an existing PEDL for seismic only
PEDL	1996-date	57	6/5/20	Current format
MDL (methane drainage license)	1982-date	N/a	Case by case	Supplementary part of other licenses

Table 5.2: License Types in Use in Onshore UK (Source: DTI website and others)

5.5.4 Operation and the Role of the Operator

Every license has an operator – a primary point of liaison for all the stakeholders and a project manager. Operators are responsible for the workplan and getting it approved, and therefore must have a high degree of technical expertise. The Government department has the right of veto and can insist on joint operatorships to ensure that nothing goes wrong. The partnership is governed by a Joint Operating Agreement (JOA), a confidential legal document that sets out the rights and obligations of all partners in that license. The JOA is subject to approval by the Government department and delegates powers to the operator. A Joint Operating Committee (JOC) meets regularly to monitor progress and vote on any issues. The JOA provides for cash calls for expenses to be paid, as well as an operating fee, with the sanction that failure to pay may mean forfeiting the license interest in favour of other co-licensees.

Becoming an operator is a milestone in a firm's life as it means that it has been externally approved as competent to direct operations (various interviews – see Chapter 8). Operators tend to have larger technical teams, but still outsource some technical functions. For onshore work, they need to handle the complex stakeholder relationships described above. Though the actual drilling for oil may be less sophisticated than offshore in hostile weather conditions and deep waters, negotiations with the complex stakeholder groups require resources, patience and expertise. Firms may choose to be the operator for a license for

[27] Validity dates shown in brackets.

one of the phases, relinquishing the role to a more experienced firm at production.

5.6 The Investment Decision

The licensing process has been explored in the previous section, so this section looks at the other side of the dyad – the decision to invest in the license.

Pollio (1999) revisits the arguments about the investment decision in this industry by describing the option approach (Pollio, 1999, p.64) and developing the more traditional Net Present Value method (Pollio, 1999, Chapter 3). Pollio describes several critical variables in this chapter; oil price change rate, time lag of cash recovery and ultimate size of reserve additions. Cash recovery is in turn affected by resource price, costs, tax and other investments. Reserve additions are subject to drilling cost, rig availability, and the difference between the proved producing reserves or *"p90s"*[28] (as determined by industry experts) and the ultimately recoverable reserves. The latter are additionally dependent on how the production is operated (e.g. too high a well pressure can damage the reservoir and diminish recoverable oil).

Two areas are of particular idiosyncratic importance to the consideration of investments in this research context – taxation and finance.

5.6.1 Taxation

Taxation plays an important role in UK onshore oil exploitation in two ways: the direct tax revenues raised from production and the ability of firms to offset abortive exploration expenditure against other revenues for tax purposes. The historic tax regime has inextricably linked offshore and onshore operations of a firm.

The taxation of the UK oil sector can be characterised as both complex and inconsistent from its inception, (See Appendix E).

Alex Kemp (Kemp & Crichton, 1979; Kemp & Stephen, 1999) has followed the UK tax regime focusing on the offshore sector. Other commentators such as Martin Lovegrove (Lovegrove, 1983; Lovegrove, 2001) have also estimated the maximum tax-take by the UK government for offshore fields. Many, but not all, of the firms in the population have larger offshore investments, so the offshore taxation system is of importance when considering the onshore investment decision, changes to the firm's onshore profile and the decision to continue in this industry. Since taxation is such an idiosyncratic feature of each firm and difficult to calculate, the general types of taxation are outlined next. Maximum

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[28] P90s are the amount of oil or gas in place in the reservoir (i.e. reserves) which have a 90% + probability of production, essentially equivalent to the old "proved producing" reserve category. The variation in experts' opinions can be tens of millions of barrels of oil.

taxation rates[29] are used in this research as a selection measure with some relevance to industry attractiveness.

Taxation is in three principal layers[30] (Inland Revenue web-site, 2003) and applies to taxable petroleum and gas production. For the end of the period under study it consisted of a Royalty Payment calculated on the gross production, Petroleum Revenue Tax (PRT) relating to the volume of resource produced and including certain allowances and Corporation Tax, payable on all the firms' revenue generating activities.

As the time line in Appendix E shows, the taxation system began by ring-fencing oil and gas expenditures and revenues in the late 1960s, after which exploration expenditures were a permissible offset against PRT- paying production in the UK North Sea. A change in regulation affected many firms significantly when the offshore and onshore areas were in turn ring-fenced from each other in the mid-1980s, and retrospective set-offs of exploration and production were disallowed. Just as the sales of small pieces of PRT-paying production to smaller firms allowed onshore exploration offsets to lower the effective tax rate on revenues and increased the industry population, so the change in tax treatment caused industry exits (de Nahlik, 1992). Rutledge & Wright (2002) provides a review of the literature on the highlights of the UK oil taxation system.

5.6.2 Finance for the Oil Production Industry

McKechnie (1983, p.lvi) identifies three sources of historic funding for the petroleum industry. The first two, equity and internal generation of funds, remain the main sources of funds for exploration projects. The third source, debt, is split into corporate debt, borrowed against the firm's balance sheet and *"project"* or *"non-recourse"* financing. The latter, only available for producing oil and gas fields, is where financing is based solely against reserve-generated cashflows and was developed in the US. Relatively recently, *"limited recourse"* financing has appeared as a technique permitting the financing of a development project against guarantees from sponsors which then fall away once production is established and meets mutually agreed targets. At this point, known as completion, the financing becomes non-recourse or a true project financing (de Nahlik, 1992, pp.146-148).

Oil and gas financing techniques in the UK in general have largely been extensions of those project loans, or non-recourse loans used in the US (McKechnie, 1983; Nevitt, 1989) as opposed to the use of corporate debt or balance sheet lending where some of the funds raised are dedicated to specific onshore projects. In its simplest form, a non-recourse loan requires an

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[29] To calculate an individual tax rate for each firm for each year would be extremely difficult, given industry secrecy, so an industry maximum tax rate published every year is used to track changes.

[30] But has included others such as Special Petroleum Duty - however the only onshore field generating significant taxable revenue is Wytch Farm – other firms participating in the industry may be or have been PRT payers based on offshore production.

independent consultant to assess the oil and/or gas reserves in a field, and is a percentage of the Net Present Value of projected future revenues, usually provided by banks. There may be additional guarantees given to the lenders before production is well established as described above under the limited recourse financing category. Variations on the theme include financing against forward sales of oil or gas and carve-outs (Nevitt, 1989, pp.303-307). Nevitt and other oil finance commentators discuss cases such as the large offshore Forties field, and BP's interest in it. This is a very different matter to the smaller onshore firm looking to finance its interest in a small onshore field with additional planning and environmental issues to contend with. As a result, few onshore field interests other than Wytch Farm have been financed through non-recourse or limited recourse debt and by banks. Instead of loans, equity finance has paid the bills; so the firms relied on internal capital in the case of larger entities using a subsidiary to enter the UK onshore market, or their shareholders for Rights Issues for small firms listed on UK Stock Exchanges. The fortunes of the onshore sector members are therefore closely tied up with the Stock Exchanges. Indeed the reason so many small firms do not progress to production from exploration is that they are unable to continue to fund themselves and meet the larger payments or cash calls due as an oil or gas field development progresses. One industry informant said that there are now only 3 banks prepared to lend to onshore oil firms, and then only against reserves that are assessed as p90 – i.e. have a 90% or greater chance of being produced.

The cost of finance is a selection force and appears in the selection variables in this research several ways: Cost of funds for both US dollars (normal oil production-backed lending currency) and UK base rates (used by banks to price working capital in the UK) and the UK stockmarket capitalisation of the oil sector (with support service firms removed). The latter offers a measure of the overall pot of money available from institutions for equity investment in the sector (i.e. covering equity funding for the less than p90 reserves described above). The equally weighted betas of all firms in the stockmarket sector are also used as a measure as they offer a measure of the variability of oil investments relative to the overall stock market index. The betas are equally weighted to avoid the significant impact of majors such as Shell and BP. These drivers of investment have been included as measures for H1.

5.7 The Research Context as a Milieu to Test the Research Model.

Survival is dependent on a portfolio management approach to attractive investments sites, where attractiveness is a function of the positive macro-economic variables discussed in 5.6, such as oil price, costs, tax regime, country economic variables, etc. over some of which management has little discretionary control other than to enter or leave; and over others such as field interest size, its ability to exercise choice is dependent on access to stockmarkets, funding costs, in turn related to the financial markets' perception of the industry relative to other investments (captured as sector capitalisation and stock market betas mentioned in the next chapter). Technological variables such as drilling methods can also positively enhance the field economics and

insensitive environmental management can negatively impact on the economics. Permutations of all of these factors coupled with maturity in the industry produce levels of diversity inside the population that allow deterministic factors to be analysed.

The traditional view expressed by Industrial Organization scholars, (Porter, 1980, pp.7-9; Grant, 2001, pp.75, 458) suggests that economies of scale at the industry level should lead to larger firms dominating any population over time. Although this is true of the population including Wytch Farm, those firms have grown because they have been participants in a very attractive asset, for which they had paid a premium price back in 1984. The attractiveness of this investment had improved as a result of better technology, both from the viewpoint of assessment of the oil reserves (3D seismic) and also from the viewpoint of being able to extract it in a n environmentally sensitive area (horizontal drilling). However for the non-Wytch Farm population, there is no dominant group of firms. Contrary to the literature discussed in 3.3, size does not seem to be other over riding consideration for survival - the onshore oil and gas production industry has a range of firm sizes at any given point in its history – these are essentially normally distributed as shown in Table 5.3 for the non Wytch Farm population, and there is no evidence of a gradual drift to a population composed of larger firms over time to support the scale dominance aspect of theory. Indeed the structural variables observed are also not constant over time – one example being ownership- which shows a spread of values both within and across the years and across years, support in the conclusion that there is no evidence of concentration in this study for the non –Wytch Farm population, and supporting a conclusion that the null hypothesis will be disproved.

no WF	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Mean	0.71	0.22	0.26	0.36	0.70	0.75	0.48	0.38	0.29	0.53	0.61	0.23	0.51	0.72	0.11
Standard Error	0.00	0.08	0.13	0.21	0.42	0.35	0.18	0.14	0.11	0.24	0.28	0.13	0.27	0.31	0.03

Table 5.3: Descriptive Statistics for the non –Wytch Farm population

Economies of scale are only evident at the firm level through observations of the discretionary exploitation strategy. Economies of scope, as a distinctive firm level strategy, are manifested as firms diversify their portfolio through an expansion of the number of oil or gas fields in which they have interests, using an exploration strategy. Berndt (1991, pp.60-101) links economies of scale to learning and experience. Both exploration and exploitation at the intra-firm level are discussed in 3.7 and elaborated further in both Chapter 4 and Chapter 6.

In Chapter 3, the literature analysis suggested that certain other factors contributed to firm survival. This thesis argues that these factors may be extraneous to the firm, or may be the products of managerial discretion and thus linked to an adaptive response to selection pressures. Managerial discretion is limited in the UK onshore oil and gas production industry, as a result of the finite types of investment possibilities described in Chapter 4 – maintaining the status quo, exploration, exploitation and the options at the firm

level –maintaining the status quo, acquisition, divestment or exit. Natural resources markets are finite, unlike business or consumer markets where both supply and demand can theoretically expand till equilibrium is reached. Natural resource extraction has supply constraints, as not all investment sites are of equal value and the relative worth is largely pre-determined by the underlying geological resource. Thus individual managers are limited in their ability to exercise the (relatively) unconstrained strategic choice described in Child (1972). Are there discernable patterns in the data? How do firms deal with this level of complexity?

Dijksterhuis, Van den Bosch & Volberda (1999) discuss the relationship between management logics and the emergence of new organizational forms. Dijksterhuis et al. (1999) p.576 use shared managerial schemas (as opposed to dominant logics) which they suggest are a 'function of both firm–level factors and macro-economic variables'. In this industry, the only discernable stated pre-eminent schema is that of initial partnering followed by a desire to *'go it alone'* in order to qualify for the institutional legitimisation by the UK licence awarding body of the operator status discussed in 5.5.4. This is prompted by economies of scale and scope in technology, production economics and the constraints on capital supply described in section 5.6,

This is surprising as the level of complexity in the factors that appear to contribute to survival coupled with linkages between them suggest that some form of sensemaking tools should exist. It also foreshadows the possibility that there may be differences between espoused (overt) schemas or logics and schemas/logics in use (covert) logics and a learning relationship between them, following Argyris & Schőn (1974). It prompts for a research design that would include both quantitative analysis of the archival data and qualitative interviews to examine what factors industry participants really believe drive survival, discussed further in the next chapter and again in the three succeeding chapters dealing with findings.

5.8 Conclusions

Onshore UK oil and gas production has a long history. The process of getting from a license award to oil production is complex and dependent on assessment of reserves, operation and partnerships. Taxation and capital supply favour larger firms with other oil and gas assets and other sources of income or large balance sheets. Although there is therefore an inherent bias in the system against smaller firms progressing to production from the exploration phase, especially for offshore firms active in the UK as they lack the absorptive capacity with respect to tax synergies, data from the onshore production industry allows us to examine a population containing many of these small firms. The onshore oil and gas production industry context also allows us to build and test a model supported by theory that includes some of the key factors for the investment decision such as taxation, oil prices, etc. It looks at some of the idiosyncratic features of the industry as well, such as the importance of partnerships. The research methods and methodology used to do this are discussed in the next chapter.

CHAPTER 6: RESEARCH METHODOLOGY, METHODS AND DESIGN

6.1 Summary

This chapter discusses the research methodology, methods and design used in the thesis. Methodology has already been briefly discussed in Chapter 2 as a consequence of epistemology, and will be further developed in this chapter. The key methods used, the research design and the triangulation between the quantitative and qualitative data is also discussed. The chapter is divided into the following sections: introduction, methodology and methods looking at choices made therein, so the choice of methodology, the choice of methods, the choice of an archival data approach and data collection methods, the choice of quantitative data analysis methods, the choice of semi-structured interviews and analysis techniques and the choice of research design, observations and measures, hypotheses and initial research design, data issues, triangulation, tests for design validity and conclusions.

6.2 Introduction

The choice of methodological approach mirrors the Organization Science-based approach described in Chapter 2, so this is a quantitative cross-sectional and longitudinal study, using secondary data. The quantitative data is discussed further in Chapters 7 and 9. However, in order to support and triangulate findings, some further data was gathered by a series of semi-structured interviews. The latter data is largely qualitative in nature, and has been analysed and included as Chapter 8.

This research is very much an exploratory study that uses different forms of analysis. It seeks information about the factors that impact on the survival patterns of firms and what appears to drive the survival process. The chapter reviews research design choices and the design chosen for this study, with observations and measures supporting the design choice and triangulation addressed. Using archival industry data and interviews with industry informants, the operationalisation of the research to test the hypotheses supporting the research model is also examined. Finally, the research design is tested for validity. The research process used was a quantitative pilot study, a qualitative interview programme to triangulate data/variable choices and findings and then a quantitative main study using the findings from the previous studies to improve the design.

6.3 Methodology and Methods

6.3.1 A Distinction between Methodology and Methods

Blaikie (1993, p.7) summarizes the difference between methodology and methods thus:

"Methodology refers to the analysis of how the research should or does proceed including generation of theories, testing of theories and the logic used; criteria satisfied; the theories themselves; how particular theoretical perspectives can be related to particular research problems…

Methods are the actual techniques or procedures used to gather and analyse data relating to some research or hypothesis."

Easterby-Smith, Thorpe & Lowe (1999, p.33) discuss the role of the researcher and the research using the taxonomy shown in Table 6.1:

Researcher is independent	Researcher is involved
Large samples	Small numbers
Testing theories	Generating theories
Experimental design	Fieldwork methods
Verification	Falsification

Table 6.1: Role of the Researcher

The authors proceed to identify three motives informing the choice of methodology and methods in terms of the personal preference of the researcher, the aims or context of the research to be carried out and ask *"will the research withstand third party scrutiny and be credible?"*

In the research in this thesis, the role of the researcher lies between the two axes but essentially on the left-hand side congruent with the Organization Science approach discussed in Chapter 2.

6.4 The Research Process

A map of the research process is shown in Figure 6.1 below. The following sections address the different choices made in order to arrive at the research methodology, methods, context and measures.

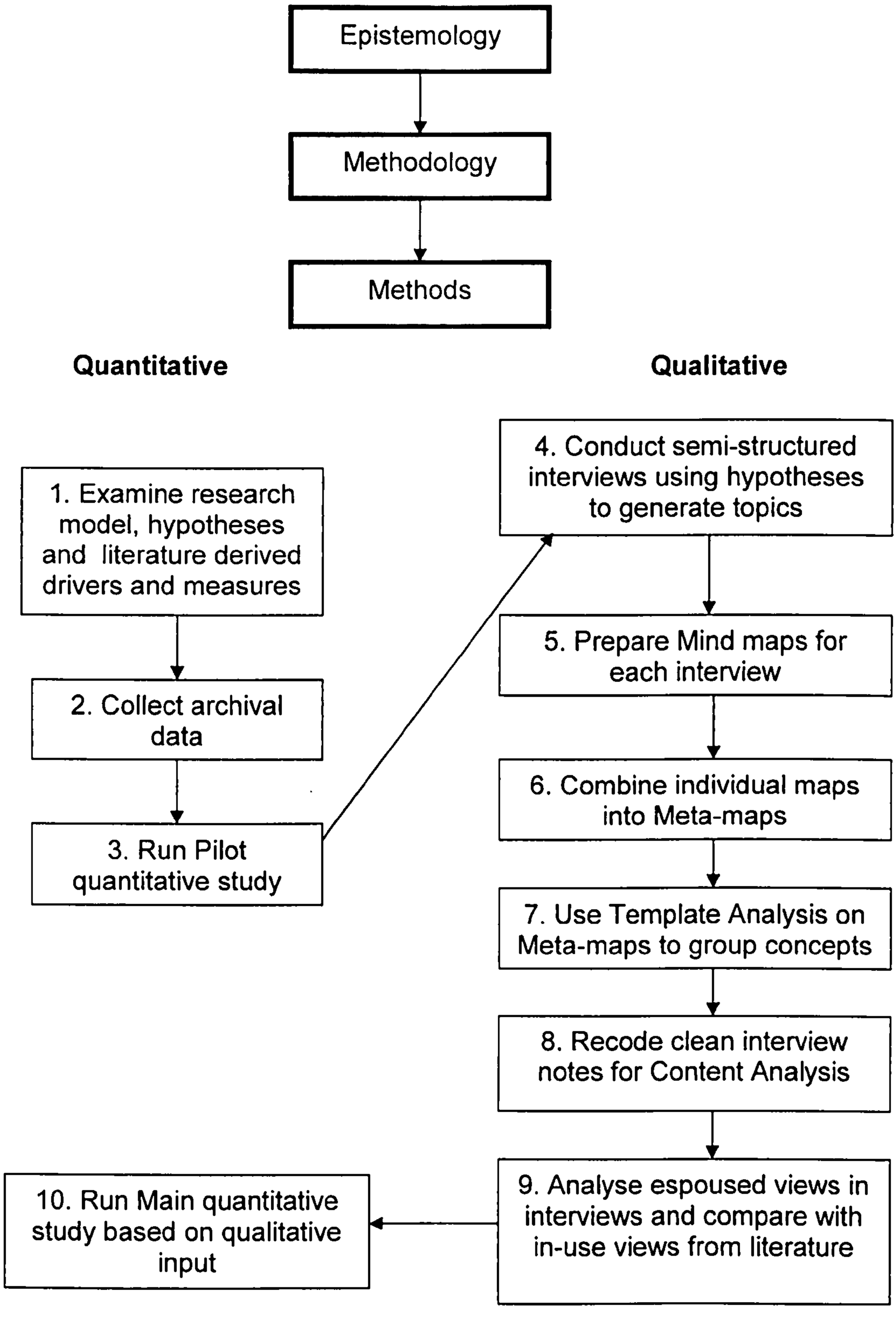

Figure 6.1: Map of The Research Process.

6.4.1 Choice of Research Methodology

The methodology used in this thesis is quasi-Empiricist rather than the Realist discussed in Chapter 2, accepting the distinction between theoretical and empirical domains of discovery. It recognises distinct models as abstract theoretical descriptions of reality developed through an exhaustive process of refinement and validation. It links observational data to theory through a linking language (Ryan, Scapens & Theobald, 2002, p.24). It also *"represents a universal generalisation representing along a single vector, extreme behaviour"* (Ryan et al, 2002, p.27).

Thus this follows Popper (1959); Popper (1972); Kuhn (1970) and Lakatos (1970). Ryan et al (2002, p.28) continue in the tradition of Lakatos to claim that:

- A research model should generate theoretical implications from which observational predictions can be drawn;
- Assumptions in the model should be internally consistent in the logical sense and as simple as the logical integrity of the model will allow;
- The model should be commensurate with any known empirical facts within its domain;
- The model's theoretical scope is defined by the model and its attendant set of explanatory and predictive variables;
- The combination of a set of related models (covering the same empirical domain) form with the relevant observation reports, the literary domain of a particular research programme.

(The model derived in Chapter 4 meets all of these tests).

As previously discussed in Chapter 2, Empiricism is not Realism and there are some nuances to Ryan et al's list. Realists focus on the conditions of the real world, not just existing knowledge, i.e. accepting that there are areas of ignorance or yet-to-be-discovered knowledge. Realists also view causality as being independent in existence from experimental conditions. Finally, Realists see reality as having three levels: empirical, actual and real or deep (Smith, 1998, p.298). So in the Realists' eyes, all is contextual. Campbell's Organization Science view of Realism is, of course, much closer to the scientific Empiricist view, hence it is possible to accept Ryan's criteria even though this study purports to be in the Realist tradition.

In the field of complex systems, the extension to the hard and soft systems approaches discussed briefly in Chapters 1 and 2, Allen claims that though the mechanical model of scientific understanding supporting Kuhn (Prigogine & Stengers, 1987; Allen, 1988), has been adopted by other disciplines, e.g. Economics (Arrow & Debreu, 1954; Debreu, 1959), its assumptions do not hold.

Living systems are not equilibrium structures, but rather engage in constant dialogue with their environment, maintaining the *capacity* to evolve and change, even when not visibly evolving (Allen, 1992, p.105). So, unlike thermodynamic systems, there is no single solution, and there is difficulty in isolating the system being considered from all its interactions. This is the paradox and challenge of empirical research into evolution, coevolution and multi-level models and explains its paucity.

One way to manage this practically is to take the following simplistic view for operationalisation purposes, supported by the literature reviewed:

- Selection operates at the population level and discretionary adaptation at the individual firm level;

- Simplify inter-actions between firms and between levels in the system.

However, this ignores the coevolutionary reciprocal effects, and essentially replicates the concerns about performance as a dependent variable expressed in March & Sutton (1997) and the difference between espoused and in-use research measures in a different context.

6.4.2 Choice of Research Methods

The study used two contrasting yet complementary methods:

1. Quantitative methods

Many of the organization ecology/corporate demography studies on firm survival have used Event History techniques (Allison, 1984; Yamaguchi, 1991; Webb & Pettigrew, 1999; Blossfeld & Gőtz, 2002) to build a model based on secondary data that explains the phenomenon studied. Thus, mediating factors on firm foundations, mortality rates, etc. have been modelled. Alternatively, some cross sectional studies have also looked at survival. All of these studies have been able to use clearly bounded phenomena to research.

This review differs by using simpler statistical techniques and extensive data coding to monitor multi-level changes over the time scale (16 years in this thesis). It links these changes to firm survival via entry and exit in the industry (population level) and changes at the micro-level of individual firm field investments to build up a picture at the firm level. It therefore attempts to combine the larger scale quantitative data from what is essentially a survey design based on archival data with more of a case study approach at the firm level. It follows the presence of the total population of 53 firms in the onshore oil and gas industry, who have survived to the production phase, viewed through their participations in 36 producing oil fields.

Simple correlation analysis and multiple regressions from the SPSS suite of programs were used to examine the statistical relationships between the

dependent variable and various independent variables, all measured numerically. Cluster analysis (Jain, Murty & Flynn, 1999) was also used in deriving a generic strategy model from groupings within this data.

2. Qualitative methods

   A series of semi-structured interviews with expert industry informants was completed with two purposes in mind: to test out early conclusions from the pilot data analysis and to see if the *"espoused"* view of the oil and gas industry matched the *"in-use"* version gleaned from the data (Argyris & Schőn, 1974). The interview programme also added to industry knowledge and offered some triangulation and support to the quantitative data. This path has been used by a number of researchers in the Organizational Ecology area, e.g. Dobrev (2000).

   The research uses an innovative systematic approach to the examination of concepts in qualitative data by adopting tools used for systematically mapping individual interviews and then compiling composite maps from interviewee maps addressing various key data points such as entry, survival and exit. The composite maps also cover some of the hypotheses. The composite maps are then used systematically to group coding into a coding tree for use with a standard content analysis program, NVivo™, on clean copies of the interviews. The coding tree links back to the different drivers of survival discussed in Chapter 3, paragraph 3.8. This approach offers triangulation of the choice of independent variables in H1, and support for the other hypotheses and an insight into the industry participant's view of the balance between selection and adaptation variables.

6.4.3 Choice of an Archival Data Approach and Data Collection Methods

The oil and gas industry is a very secretive one, and information in the public domain is severely restricted. This strongly indicates archival data research as a key option. Bryman (1989, Chapter 7) describes archival research and uses as exemplars some of the studies that make up the sociology–based literature described earlier, e.g. Carroll (1985). To complete a longitudinal study of this scale in this research context, archival data is the **only** option.

The annual UK State publication, *"Oil and Gas Resources of the United Kingdom"*, or more familiarly, the *"Brown Book"*[31], was used to compile the histories of 36 onshore oil fields and the histories of 53 firms as field participants. These are listed in Appendices F and G.

Though the *"Brown Book"* follows the industry from 1973, onshore information is unavailable for the early years. The only onshore production was from those fields discovered and brought into production in World War II and totalled less than 100,000 tonnes per annum in the 1970s. The first records of onshore

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[31] Thanks to Charles Henderson, UK CEO of TotalElfFina and Richard Milton-Worsell at the DTI Oil and Gas Directorate for the gift of copies of the *"Brown Book"*.

production begin with the development of the Wytch Farm field by BP and the Gas Council (British Gas).

Pre-production information is not available in the public domain, nor are licensee details (Stanley & Morrison, 1989) so producing onshore firms were chosen as the research context. Firms were followed as entrants and leavers in the individual producing oil or gas fields. A firm is defined as a collection of onshore field interests for the purposes of this research, and the focus is on the ultimate ownership and not the legal entity.

From knowledge of the industry, it became apparent that it was also necessary to supplement this information and crosscheck some of it. Secondary data has a number of problems (Atkinson & Brandolini, 2001). Foremost among these is the issue of accuracy of the data, also raised in Bryman (1989). Several firms reported as present, could not have been as they had been taken over – indeed I had been involved as an advising or lending banker in some of these deals. What had happened was that the legal entities had persisted to conserve a tax position, while the beneficial ownership had changed. This resulted in a need for a laborious check of all firms through the Lexis-Nexis Press Releases database, Fame database, other industry sources and even some industry informants, as detailed data on dissolved firms at the early end of the research time period is now unavailable from free public records to confirm the ownership of the field interest. One research standpoint is to use the legal entity as the unit of analysis. However, because in many cases firms are very small, if acquired, it is unlikely they would continue to operate as a stand-alone unit. Consequently, this research takes the viewpoint that policy is set by the ultimate holding company owning the interests, and therefore this entity becomes the entry in the data.

The variables were also derived from archival sources. The Fame database was originally used to collect financial data on the firms, but this was abandoned as it became clear it was impossible to get complete data for the population. Other variable data was provided as follows:

The LBS Risk Measurement Service:	Stock market measures to derive sector's relative volatility and sector equity valuations;
The Office for National Statistics:	Nominal GDP rates;
IMF:	Comparative cost data;
BP website:	Crude oil prices for Brent UK crude oil;
Chicago Federal Reserve:	Eurodollar rates;
Bank of England:	UK interest rates;
The Oil and Gas Directorate:	Well data, Well cost data, Field data, etc.

A summary of compiled data for the period 1984-99, and cleaning operations are shown in Table 6.2 and described below:

	Firm numbers	Field numbers	Firm field histories	Data points
Initial raw data: 1983-99	65	39	218	805
Initially right censor raw data and remove Wytch Farm for pilot	53	36	109	612
Remove duplicate fields from raw data	65	30	178	645
Right censor and adjust for post-entry survival of all firms, 1984-99	54	30	140	519
Take out Wytch Farm data, left with non--Wytch Farm population for 1985-99	45	29	127	429

Table 6.2: Firm Numbers and Data Operations

The research then proceeded in the following manner:

Pilot study: Right censor data, removing all firms that entered in 1999, remove Wytch Farm and its satellite field, Wareham, use entry years as well as survival years.

Main study: Revert to original data; remove duplicate fields shown in Appendix H as otherwise some firms are over-represented. Right censor data and adjust for post–entry survival, i.e. take out all firms that are present for year of entry only.

65 firms were initially identified with 218 firm field histories and 805 firm-level field-participation data-points. A closer examination of the data after the pilot study revealed that there were some issues with duplication of fields in the same license areas, leading to overrepresentation in the population (see Appendix H). This led to the removal of a further seven fields to prevent double counting: Arns Farm, Marishes, Malton, Rempstone, Scampton, Scampton North and Stainton. In order to ensure the data capture of at least one complete year of post-entry survival for each firm, the population of surviving firms was right-censored. All firms with zero years of survival, those entering in the last year of study, and one field entering in the last year, Saltfleetby (containing only one of the newly entering firms - ROC), were removed.

New fields, as entrants to the populations including and excluding Wytch Farm, are being added at non-linear rates. Exogenous factors include GDP, oil price, technological developments (e.g. the development of technology for producing

electricity from small gas fields, and a second innovation in the form of fields producing methane from old coal mines).

There are statistical issues in terms of the population size – the numbers of years studied (i.e. years of population) at 14 in the case of the main population excluding Wytch Farm and the number of firms present each year, as low as 6 in one year, are very small - leading to caution in interpreting and generalising some of the statistical results. Since this is the entire industry population for each year, there is little that can be done to enhance this.

6.4.4 Choice of Quantitative Data Analysis Methods

The dependent variable was measured as the number of survival years of a firm in the population. Measures of independent variables were derived from the literature coupled with discussions with industry participants, observers and triangulated using the interview programme. The financial measures for H1 were especially difficult to find, as archival information is not readily available for the complete population over the complete period, and in the case of large firms not broken out separately. Hence this study, like many others, relies on proxy variables.

The sixteen years of data modelled trends over time to give a longitudinal perspective. Coding mechanisms were used to mark micro-level changes at the sub-field (investment) level inside the individual resource development partnerships of each firm. This permitted generation of data to compare similarity or dissimilarity of strategies over time within each firm within each year and across the population.

The longitudinal nature of the study and nature of the industry mean that the data is not homogenous across the time period. It would be very difficult to demonstrate clear causality, given the model shown in Chapter 4, and the complex time–line shown in Appendix E. Simple correlation analysis, therefore, can substantiate most of the hypotheses, with a multivariate regression used to bring the selection and adaptation factors together.

A decision tree program, AnswerTree™, was used to show groupings in the data (Bierly & Chakrabarti, 1996) for a practitioner model using an exhaustive Chi-squared Automatic Interaction Detection technique (CHAID) (Carlin & Hocking,1999; Jain, Murty & Flynn, 1999) by growing a decision tree from the variables.

Once more, the data analysis can be challenged as a result of the parsimonious datasets.

6.4.5 Choice of Semi-structured Interviews and Analysis Techniques

In order to ensure that there were no critical factors absent from the external environment model, a series of semi-structured interviews with expert decision-makers was conducted. Hambrick (1980) suggests that self-reporting is a good method for identifying intended strategies, and that the data is reliable (Pearce,

Robbins & Robinson, 1987). I am extending this argument to factors that inform the decision-makers. March & Sutton (1997) mentions three major problems in reviewing the measurement of organizational performance,:

1. *"Information about determinants of differences in performance diffuses through a population of competitors tending to eliminate variation in both the determinants and their effects.*

2. *The theoretical and analytical models used ignore feedback loops that are likely to be important.*

3. *Data used to recall organizational histories often rely on retrospective recall of informants, recall that is likely to reconstruct the past to make it consistent with subsequent story lines and current beliefs."*

The last in particular could be a cause for concern, if the interviews were the only source of data. However, given that the interviews are used to triangulate the statistical findings, which are based on variables derived from theory, it is less of a problem, though the risk must be acknowledged. Validity is addressed in the later sections of this chapter on triangulation and validity tests.

A programme of 10 semi-structured interviews was conducted. The interviews were arranged in part by choosing as informants ten key decision-makers actively involved in the industry for most of the period of study (1984-99). Informants included former board-level members of firms in the 1967-99 industry population, and a board level member of a firm still in the industry (in the right-censored group) as well as one whose firm was taken over prior to 1984. Several other important informants have agreed to participate in subsequent interview studies but were not included here.

Contact was made with informants by either e-mail or telephone, with a confirmation letter following up as shown in Chapter 8. An interview protocol was developed and tested, and also reviewed by a non-participant who is a key industry figure. The interviews, which used the protocol as a discussion document, lasted about 0.5-1.5 hours, allowing for interruptions, and notes were made and written up within 24 hours of each interview. Based on my judgement as a former industry insider, and a conversation with the informant who reviewed the interview protocols for content, a request to record the interviews would have met with a refusal to participate. There is some recorded material available as part of an oral history of the UK oil project based at the University of Stirling, but a conversation with the researcher just after the first round of interviews revealed that onshore oil was not covered at that point.

The next stage was to use mind maps (Buzan, 1982; Buzan, 1995) to represent the content of each interview. Mind maps are a sense-making, or organizing tool, and are also an artefact of the map maker, causing them to lie more towards a Subjectivist approach as compared with the Objectivist view traditionally associated with a natural science-based epistemology described in

Chapter 2. Positivists claim that *"objective knowledge can be achieved through the pure use observation"* (Blaikie, 1993, p.212). Realists try to mitigate against such an extreme view and its limitations by separating the tools of explanation of reality from reality itself, thus permitting the falsification and multiple paradigmatic philosophies of Popper and Kuhn discussed in Chapter 2.

The use of maps as representational tools in researching cognition and causality is well documented, e.g. Laukkanen (1998), who discusses the use of causal maps (CMs) as descriptors of systems or phenomena. Whereas conventionally CMs are used interactively or iteratively, in this study, this was not possible because of access issues. While this research follows Laukkanen's approach to interviews and to deriving a map for each, based on the process of survival and its links with previously identified drivers, it moves away from his Cognitive Causal Mapping (CCM) process, or *"standardisation"* for CMs to allow comparison (Laukannen, 1998, p.182). This research requires a mechanism to combine the maps, to offer the possibility of exploring multiple perceptions and data enrichment. In addressing map combination, Eden & Ackermann (1998, p.196-7) suggest the need for homogeneity in cultural background of informants and also prior acquaintance of the researcher (though this could also lead to bias) as starting points. By clustering areas of the maps together that addressed common topics, in a manner similar to that described by Eden and Ackermann (1998), a stable combined or *"meta- map"* can be elicited on the basis of shared meanings and understandings.

In this study, the individual interview mind maps were searched for concepts which were assembled into a list, and then grouped again in meta-maps for each question in the questionnaire using the Ishikawa *"fishbone"* causal analysis technique (Majaro, 1988; Kawakita, 1991) to link and arrange them. These secondary sense-making maps were then used to generate a coding tree for the interviews for use with a content analysis program. The coding tree was then applied to clean copies of the interviews to generate a detailed content analysis (Weber, 1985). The process is shown below in Figure 6.1. The logic behind this complicated process was to produce a systematic, explicit and replicable analysis technique, developing the Template Analysis technique described in King (1998).

Template Analysis (TA), also known as thematic coding (Crabtree & Miller,1992; King, 1994), lies between a formal content analysis approach with a predetermined list of codes applied to interview transcripts (Weber, 1985) and a grounded theory approach (Glaser & Strauss, 1967), where the interview transcripts are used to derive the coding. In TA, the process is iterative – a template or list of codes is produced before coding begins, and this is modified as a result of interaction with the data, as described above. The analysis of the interviews is discussed in more detail in Chapter 8.

Issues with this research approach lie in the unwillingness of the informants to be recorded and thence the quality of any notes taken. The usual approach of sending interview transcripts was rejected to try to maintain the material

collected, rather than conformity with an institutionalised picture of the industry and any concerns about perceived indiscreet remarks that would compromise the study. Instead, the findings were discussed with other informants at a Poster Session at the Petex industry conference and exhibition in 2002. The feedback was universally positive and produced several further informants for the follow-up studies discussed in Chapter 10. A synopsis of the thesis findings will be sent to informants.

The meta-maps and the formal derivation process can be challenged by cognitive mapping purists, not least surrounding their ownership. However, the meta-maps have no independent purpose other than as a transient stage to produce the coding tree, and thus no claims are being made for them. Their purpose is limited to a function in a systematic derivation of a coding tree, and they owe their existence to the absence of material on a formal process for data transfer explaining the processual bridge between collection from interviews and inclusion in models tested. The Template Analysis technique cited was the closest approximation in the literature. Outcomes of the assembly of constructs are referred to in Hitt & Middlemist (1979) when discussing the policy capture model for decision-making, but there appears to have been little written on how to produce this systematically, other than through group techniques, e.g. Nominal Group Technique (NGT) (Delbecq, Van de Ven & Gustafson, 1975), which is quite different in nature.

6.4.6 Choice of Research Design

The research question is: What factors, in particular the impact of environmental events (uncontrollable by firms) and the impact of adaptive actions (controllable by firms) appear to drive firm survival within an industry and why?

In this research, the generation of the operationalised version of the research model shown in Chapter 4 begins by reconstructing a *"firm"* from its industry assets, so a firm is the sum of its producing oilfield interests. This is congruent with a common fiscal definition of the firm in this research context. Oil and gas production firms are defined inside the industry boundary as the sum of their oil and gas investments, because of the unusual tax structure in the industry. This administrative convenience allows points of common comparison across all firms. Data on the corporate entity is not used because corporate records for all firms for the complete study period were not available for this project[32]. The research design uses the collection of archival annual data to produce a survey of a population, creating a cross-sectional, time-series database. Data is collected at the firm and at the investment site level and aggregated to the annual population level.

The research treats the UK onshore oil and gas production companies as a separate population following McKelvey (1982) and Baum & Singh (1994b),

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[32] This data is now very expensive to obtain, as compared with simply inconvenient when I completed my MBA dissertation on non-food retailing 1950-1975 as a part of a study that eventually formed part of Channon (1979). In those days it was still possible to physically inspect copies of old annual company returns in London.

since it has relatively distinct services, client (and supplier) niches and configurations of natural, human and capital resources. The level of analysis is the industry level. The primary units of analysis will be the firm and its activities as a member of the industry population.

6.5 Observations and Measures

Cleaned data from the *"Brown Book"* was collected into Excel™ spreadsheets on an annual, individual firm and individual oil field level and then moved into the SPSS™ v11.0 statistics package for the statistical analysis discussed in Chapters 7 and 9. Decision tree analysis was also carried out using AnswerTree™, a software product from SPSS to look for groupings in the data discussed in Chapters 7 and 9. The interviews discussed in Chapter 8 were analysed using the MindManager™ mind mapping software and NVivo™ content analysis of text software. All of these packages have been extensively used in other published research.

The analysis initially followed firm and field data for the 17 years from 1983-1999. Coding was used to mark entry, exit and micro-level changes by firms inside the individual fields in order to allow comparison of consistency of firm strategies over time and across the population.

Survival was coded as commencing one year after the year of entry for the main study, a major difference from the pilot and from other literature studies, following Disney et al (1999). This *"normalised"* survival takes out the linked effects of the entry trajectory. This approach also eliminates noise from those firms that entered and left the population in the following year.

Table 6.3 shows the theoretical states for organizations in the population, the observable actions and the links to the hypotheses in Chapter 4 of this thesis:

Organization action	Theoretical state/Hypothesis link
1. Organization maintains existing asymmetry – punctuated equilibrium state.	1. Do nothing, (H1).
2. Organization acts at intra-field level asymmetry - (exploitation).	2. Increase/decrease oil-field level investment holding, (H3).
3. Organization acts at inter-field level asymmetry - (exploration).	3. Enter/exit from oil-field level investments new to organization, (H3).
4. Organization acts at inter-firm level asymmetry to remove asymmetries.	4. Firm Tie formation, (H0, H4) Organizational Learning, (H5)
5. Boundary states for this study.	5. Entry/Exit from industry, (H2, H6).

Table 6.3: Theoretical states and Hypothesis links

Table 6.4 lists all the variables used in the study described by concept, relevant hypothesis, operational constructs and measurements. All measures have associated code books to track detailed data treatment issues. Exogenous

factors are assumed to equate to selection forces and endogenous factors to adaptation responses.

Concept	Hypothesis number	Operational construct	Measurement
EXOGENOUS INDEPENDENT VARIABLES			
Economic environment	H1	Economic activity in the UK	UK GDP – constant prices.
	H1	UK cost base	IMF cost index 1999 =100.
Financial environment	H1	Cost of capital: USA/oil industry UK	6 month Eurodollar borrowing rates. Sterling base rates. Spot US$/£ exchange rates.
ENDOGENOUS INDUSTRY but EXOGENOUS FIRM INDEPENDENT VARIABLES			
Overall Resource attractiveness	H1	Attractiveness of all oil investments	Brent spot oil price in US Dollars.
UK Industry attractiveness	H1	Asymmetry of industry information flows	Number of onshore wells drilled before the start of that year. Number of onshore oil wells drilled during each specified year.
UK Government Environment	H1	UK Industry Fiscal policy	Max tax-take for all oilfields per year as %age.
Economics	H1	UK Economic governance	Market capitalisation of oil and gas sector.
	H1	Attractiveness of UK onshore oil investments	Stock market beta of oil sector. Onshore annual production figures in tonnes for oil and gas as equivalent. Number of onshore fields in production.
	H1	Rent potential	Number of firms producing (generating cashflow) in industry.
	H1	Industry costs	Annual onshore well costs.
Industry attractiveness	H1	Population density	Number of onshore oil producing firms in industry.
Socio-Technological environment	H1	Environmental sensitivity	Annual number of onshore deviated wells drilled/all onshore wells drilled each year.
	H1	Industry Supply Measure	Annual number of available onshore rigs each year.
	H1	Technology Innovation	Number of deviated wells to vertical wells drilled each year for the whole onshore industry.

ENDOGENOUS FIRM INDEPENDENT VARIABLES			
	H0	Size (Legacy)	This is a proxy variable measured as the firm's annual equivalent oil production. There are also codes for different governance forms - state or public firms may have better access to funds.
	H3	Discretionary Adaptation Exploration/ Exploitation	Number of exploration and exploitation events each firm completes each year, measured post year of entry.
	H4	Embeddedness (Intra-Industry Ties)	Number of intra-industry ties each firm has with all other firms in all fields in each year.
	H5	Organizational Learning (Intra-Industry Experience)	Number of fields each firm participates in measured each year. Number of fields each firm operates measured each year.
DEPENDENT VARIABLE			
		Survival	Number of years firm is present in population measured post-entry.
OTHER MEASURES/ BOUNDARY STATES	H2	Entry as delineator of survival period	Entry year - year of first record of firm in population. Entry mode - coded.
	H6	Exit as delineator of survival period	Exit year - year of last record of firm in population. Exit mode – coded.

Table 6.4: Variables and Measures for the Thesis

6.6 Hypotheses and Initial Research Design

Table 6.5 shows how the hypotheses link back to the literatures discussed in Chapter 3.

Hypothesis	Synopsis	Construct	Main Literature
H0	Size is all	Resource Endowment	Size
H1	Environmental munificence	Selection	Resource Dependency
H2	Entry/exits	Selection	Population Ecology; Corporate Demography
H3 grouping	Exploration/ Exploitation activity	Discretionary Adaptation	Dynamic Capabilities; Organizational Learning
H4	Intra-Industry Ties	Discretionary/ No Choice Adaptation	Size; Networks and Partnerships
H5	Intra-industry experience	Discretionary Adaptation	Organizational Learning
H6	Adverse Environmental shocks and exits	Selection	Population Ecology; Corporate Demography; Resource Dependency; Strategic Groups

Table 6.5: How the Hypotheses Fit with the Literature

H0: Within the industry, the larger the firm, the longer it survives.

The strategic legacy of a firm may mean that active adaptation is spurious – survival may be pre-determined by the resource endowment a firm possesses.

Measurement: Volume of oil and gas produced by each firm each year in this industry, calculated from oil and gas field production numbers. Correlation of firm governance type coded as public, private, state, etc., with number of observed survival years of that firm and cross tabulation of the total annual population of firms with the composition by coded firm type.

H1: Within the industry, the more munificent the environment, the larger the number of firms that survive.

This hypothesis is about the firm in its context and its ability to attract resources and manage change in macro-economic variables. It looks at simple correlation between key extra-industry derived variables, e.g. macro-economic variables (GDP, oil price, exchange rates, stockmarket effects, cost of funds); taxation rate; costs; and technology, and the aggregate numbers of firms surviving post-entry each year - variables derived from the other relevant literatures on this topic reviewed in Chapter 5 and shown in Table 6.6.

Literature source	Construct/Variable	Metric
Papapetrou (2001)	Attractiveness of all oil investments	Brent spot oil price in US $.
Pandey (2002)	UK Govt attitude to industry	Code for political party in power and for energy minister.
Kemp (1999); Im (2002)	UK Fiscal policy	Maximum tax-take for all oilfields per year as %age.
Pandey (2002)	Economic activity in the UK	UK GDP – constant prices.
Nevitt (1989) Pollio (1999)	UK cost base	IMF cost index 1999=100.
Sadorsky (2001)	Cost of capital: UK USA	6 month Euro $ borrowing rates; Sterling Base rates; Spot US$/£ exchange rates.
Porter (1990)	UK Economic governance	Market capitalisation of oil and gas sector.
Staff Writer (1986) Interview data	Environmental pressures	Annual number of deviated wells drilled/all wells drilled.
Nevitt (1989; Pollio (1999).	Supply/Resource conversion	Annual number of available rigs .
Coase (repr. 1990); Simon (1960); Akerlof (1970)	Industry Information	No of wells drilled before the start of that year. Number of onshore oil wells drilled in a year .
Porter (1990)	Attractiveness of UK Onshore oil investments	UK stockmarket oil sector βs; Onshore annual production figures in tonnes for oil and gas as equivalent; Number of onshore fields in production.
Hannan & Carroll (1992)	Population Density	Number of firms in industry.
Nevitt (1989); Pollio (1999)	Rent Potential	Number of firms producing (generating cashflow) in industry.
Suarez & Utterback (1995); Singh (1997)	Rate of Innovation	Number of deviated wells to vertical wells drilled each year .
Nevitt (1989); Pollio (1999)	Industry costs	Annual well costs - DTI figures.

Table 6.6: Literature, Variables and Operationalisation for H1

The key variables impacting on survival are expected to be oil price; taxation rate (possibly lagged); industry costs, industry information and environmental concerns.

Measurement: Correlation of various exogenous variables shown in Table 6.6 above against total number of surviving firms in each year of the study.

H2: Within the industry, early entrants are more likely to survive for longer than later entrants.

This hypothesis explores a link between timing of entry and survival. Incumbency in assets in short supply outweighs the *"penalty of taking the lead"* suggested by Veblen (1904) in contrast to the *"first-mover advantage"* strategy model (Lieberman & Montgomery, 1988; Lieberman & Montgomery, 1998).

Measurement: For this hypothesis, the year of firm entry is compared with firm survival over the period under study. As a subsequent refinement, the initial 16 year period from 1984-99 (subsequently modified to 1985-99) was split into smaller periods or waves matched to specific events on the time line. For each period, the number of firms that survived was counted, and the number that survived into subsequent periods was also counted. This is discussed further in Chapter 9 reviewing the main study. Years of survival were also correlated with year of entry measured from the end of the study period in the main study.

H3: Within the industry, the greater the total number of exploration plus exploitation activities executed by a firm at the investment level, the longer it survives inside the industry.

This hypothesis is split into two:

H3 i: Within the industry, the greater the number of exploration activities executed by a firm at the investment level, the longer it survives inside the industry.

H3 ii: Within the industry, the greater the number of exploitation activities executed by a firm at the investment level, the longer it survives inside the industry.

This group of hypotheses is concerned with the balance of the number of exploration and exploitation events completed by firms and their propensity to repeat the activity as a link with survival. This hypothesis is expected to be supported (March, 1991), with exploration dominating exploitation activity and firms establishing a capability, and thus repeating the activity.

Measurement: The number of new field interests, post-entry, are summarised annually to the firm level as exploration events. The number of times each firm expanded or contracted its interest in each oilfield investment is examined and summarised annually to the firm level as exploitation events. The annual number of observed exploration and exploitation events, and the total of both types of events collected for each firm over the period of study were correlated with the number of survival years.

H4: Within the industry, the greater the number of a firm's intra-industry ties, the longer it will survive inside the industry. Smaller firms will be predisposed to use large numbers of ties to enhance survival.

Ties between firms are an expression of relationships that can transfer knowledge and share risks and resources, especially when repeated many times. They can also partially substitute for size disadvantages.

Measurement: This research defines intra-industry ties as the total of number of records where two firms are present in each field in the study for each year . The total intra-industry tie figure for each firm is correlated with the survivor years for that firm over the study period, and the aggregate number of industry ties and number of survival years at the firm level are also correlated annually.

H5: Within the industry, the greater a firm's intra-industry experience, the longer it will survive within the industry.

The experience curve is a widely discussed phenomenon in the strategy literature. In this hypothesis, the benefits from incumbency in terms of progress along a learning curve coupled with a perceived industry legitimacy derived from that incumbency are tested. Recent literature suggests that experience arises from inter-firm and intra-firm activities (Holmqvist, 2003) linked to the exploration and exploitation discussed in H3. This hypothesis takes a simpler approach, viewing the presence of a firm in the industry as an annual opportunity to accrue years of industry experience and producing a capability linked to survival.

Legitimacy in the industry manifested as an increased number of operator years is also important as it enhances a firm's status as a field operator, thus legitimising the smaller firm and enhancing its status to its peers in turn affecting its ability to be considered in future partnerships and new licenses.

Measurement: Every year a firm is recorded as present in an oil field in the data, it counts as one year of intra-industry experience. This is then aggregated for all fields for each firm for each year to give an annual total number of years of intra-industry experience and, similarly, an annual total number of years of intra-industry operator experience for each firm present in the population.

H6: Within the industry, the greater an adverse environmental shock, the more firms will exit from the industry.

Certain external adverse environmental shocks may displace numbers of firms that have not developed capabilities to probe for and plan for future developments, (Brown & Eisenhardt, 1997; Teece et al, 1997) or do not have the resources to withstand adverse change. This hypothesis is expected to be supported for those few shock events, probably taxation related.

Measurement: Simple annual frequency count of number of firms that exit in any given year of study. This also links to the time line shown in Chapter 5, with the interviews in Chapter 8 supporting this.

The data was initially analysed using simple correlation analysis for a pilot group of partly censored firms from 1983-99 (see below) ignoring post-entry survival and including firms that entered in one year and exited the following year. It was then analysed in a main study for censored firms, looking at the period 1984-1999 for a population including Wytch Farm firms[33] and 1985-99 for a population excluding Wytch Farm firms. Both populations exclude the year of entry to use normalised survival data, following Disney et al (1999). The pilot study served to explore the data and consider implications for the main study, and as a result several changes to the data analysis were made.

6.7 Data Issues

1. Left Censoring:

   The industry had just two participants for the period from 1975 to 1984 posing some distortion problems for statistical analysis, hence one year of this tail, 1984, is included in the main study discussed in Chapter 9. The industry is generally regarded as having experienced a renaissance with the Government-forced sale of its interest in Wytch Farm by one of these incumbent organizations in 1984 so this is a logical start point. This event also represented a significant change of ownership of the industry as the two incumbents, BP and British Gas, were subject to the Government's privatization programme (Hoopes, 1996). The non-Wytch Farm population 1985-99 excludes the Wytch Farm tail and begins in 1984, so the first year of post-entry survival is 1985.

2. Right Censoring:

   Pilot study: In the pilot study, all firms that entered in the final year of the study, i.e. entered in 1999, were removed as well as one field that started production in 1999 and only contained one of the firms that entered in 1999.

   Main study: In order to look at surviving organizations, all firms that failed to survive inside the population for more than one year after their year of entry, and all entry year data were removed. Additionally, all firms that entered in the final year of the study, i.e. entered in 1999, and the field that started production in 1999 and contained one of the firms that entered in 1999, mentioned above, were removed. Finally, all duplicate fields contained in identical license area with the same field partners were removed.

3. Anomalies:

   When organizations have possession of 100% of a field, they cease engaging in exploitation activities relating to that field. Some organizations

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[33] These firms, forming a distinctive grouping, are discussed in the next section and caused some anomalies in the results. They are also discussed in the chapters on quantitative data and qualitative data.

are coded at zero for this variable because they entered the population with a 100% interest in a particular oil or gas field. There are three firms that have engaged in no further exploitation activity because they have entered the population with 100% interests in their fields: Caribe (1 field), Coalbed Methane Ltd (1 field) and IPC (2 fields). There are also others that have either entered with some 100% interests or have exploited to gain 100% of a field and then ceased exploitation in that field as well as engaging in exploration and exploitation in other fields: Blackland (1 field); Cairn (1 field); Edinburgh (2 fields); Independent Energy (1 field); MMR (3 fields); Pentex (6 fields); SOCO (1 field) and Ultramar (1 field).

The results of the data censoring are shown in Table 6.7 and Table 6.8.

	Firm numbers	Field numbers	Firm field histories	Data points
Raw data 1983-99	65	39	218	805
Initially right censor raw data and remove Wytch Farm for pilot	53	36	109	612

Table 6.7: Data Censoring Activities for the Pilot Study

	Firm numbers	Field numbers	Firm field histories	Data points
Raw data	65	39	218	805
Remove duplicate fields	65	30	178	645
Right censor and adjust for post-entry survival, 1984-99	54	30	140	519
Take out Wytch Farm data, 1985-99	45	29	127	429

Table 6.8: Data Censoring Activities for the Main Study

6.8 Triangulation

Triangulation, the use of multiple but independent measures, takes four forms according to Smith (1975):

- Theoretical: using theories from other disciplines to explain observed phenomena;
- Data: data is collected over different time frames or from different sources;
- Investigator: different people collect data on the same situation and compare results;
- Methodology: the use of qualitative and quantitative methods (Jick, 1979).

This research includes triangulation in two of the areas described above (it excludes the theoretical and investigator categories although the former applies to the evolutionary theory discussed in Chapter 3).

- It uses longitudinal and cross sectional data for a complete industry population;

- It uses qualitative data to triangulate quantitative findings.

Thus the research design is triangulated across two areas and hence the findings should be well supported.

6.9 Tests for Design Validity

The design, methodology and methods are consistent with the ontology and epistemology laid out in Chapter 2 and also with the ontology and epistemology associated with various literature bodies used in the thesis to support the research model and the research hypotheses. Kirk & Miller (1986) in Easterby-Smith, Thorpe & Lowe (1991, p.41) consider a positivist–phenomenologist divide to provide tests for validity, reliability and generalisability: Table 6.9 shows the conclusions about the validity and reliability of this research design using their test and shows how the conclusions about this study from both viewpoints compare with each other:

	Positivist Viewpoint	**Phenomenological Viewpoint**
Validity	Does an instrument measure that which it is supposed to? √ **Yes**	Has the researcher gained full access to the knowledge and meaning of informants? **No, since this did not use a phenomenological viewpoint, but rather a semi-positivistic viewpoint as discussed in Chapter 2.**
Reliability	Will the measures yield the same results on different occasions (assuming no real change in what is supposed or intended to be measured)? √ **Yes**	Will similar observations be made by different researchers on different occasions? **It would be expected that for identical time periods and industry, the study should be replicable.**
Generalisability	What is the probability that patterns observed in a sample will also be present in the wider population from which the sample is drawn? **? Uncertain - possibly true of other extractive industries**	How likely is it that ideas and theories generated in one setting will also apply in other settings? √ **Possibly**

Table 6.9: Tests of Research Design for the Positivist and Phenomenological Viewpoints (Easterby-Smith et al, 1991)

Though validity and reliability are confirmed, generalisability is possibly restricted. Another potential issue is that I cannot claim to have gained access to the full knowledge and meaning of informants, however, I have attempted to gain access to their understanding, knowledge and meaning relating to my research questions and I have used multiple informants and tested the results

of my findings on other informants, so I feel this has some internal and external consistency and validity.

Yin (1994, p.33) looks at case study tactics for four research design tests, which are adapted for the two methods I am using, in Table 6.10:

Tests	Research Tactic	Phase of research in which tactic occurs
Construct validity	Multiple sources of evidence √ Chain of evidence √ Review of case study drafts - Multiple comparisons for consistency and results discussed informally inside industry community with other informants.	Data collection Data collection Composition
Internal validity	Pattern matching √ Explanation building √ Time series analysis √	Data analysis Data analysis Data analysis
External validity	Replication logic for multiple cases √	Research Design
Reliability	Case data protocols √ Case study databases √	Data Collection Data Collection

Table 6.10: Four Design Tests for this Research (after Yin, 1994, p.33)

These are also all confirmed, so the design is robust and valid.

6.10 Conclusions

In this chapter, methodology and methods have been defined and explained and some of the problems identified in the literature relating to these areas are raised and responded to. The quantitative and qualitative studies offer triangulation and augmentation of data and the approaches are detailed, especially the novel qualitative data analysis method. All of the choices concerning design and methods are systematically explored. The observations and measures for the study are linked back to the research question and the research model, and then to each hypothesis. Triangulation of theory, methods, data and the research design are formally evaluated and found to be satisfactory for the research project. The next chapter looks at the quantitative study, in particular the pilot study and its results, which were then used to refine the approach used in the main study and its findings.

CHAPTER 7: THE QUANTITATIVE PILOT STUDY

7.1 Summary

This chapter details the quantitative pilot study and its results. Following the pilot, the interview programme was completed and some important data issues were found that were addressed in the main study (these have already been mentioned in Chapter 6). The pilot was a valuable learning opportunity therefore, from which a refinement of the approach, increased development of the understanding of the data and an exploration of various analytical techniques emerged. It also has produced several of the ideas for early follow-up papers. Following cluster analysis, a model of survival strategies is postulated, based on pilot data.

This chapter is laid out as follows: introduction, data manipulation, pilot results and conclusions.

7.2 Introduction

The pilot study was designed to probe the robustness of the data, to identify relevant statistical tests and to seek early feedback on the use of this data to test the hypotheses. From its findings, a number of important issues emerged that needed some attention prior to a full statistical analysis of the data to prove/disprove the hypotheses. These are discussed at some length in Chapter 9. The main study, which took place after the interviews were completed, was thus enhanced by some of the feedback from that programme. Both the pilot and the main study look at each hypothesis in turn (including modifications to the measurement for H1 and the breakdown of H3 into two further sub hypotheses), using simple statistical techniques such as correlation, and then look at the overall balance between selection and adaptation for all firms and for each firm measured for each year of its presence in the industry population. The tension between selection and adaptation, viewed through the quantitative data is examined. From the data, and the findings, a model defining distinctive survival strategies is inferred, which was then *"tested"* on industry participants at a poster session at the PETEX biennial industry gathering. The narrative hints at some of the iterative processes necessitated by the flaws in the reported data, which was a long, slow process.

7.3 Data Manipulation

As outlined in the preceding chapters, data was compiled from the *"Brown Book"*, the annual UK Government publication of data compiled from self–reported returns from oil firms, and then cleaned up using industry sources and the Lexis-Nexis Press database.

Again, an example may clarify this. A firm, which we shall call ABC, was listed in the *"Brown Book"* as being present in one field. Despite searches of Press, legal and financial databases, specialist libraries and the Internet, nothing could be found on this firm. Its presence in the population was transient, only for one

year, but considering the approach explained in section 6.7 it was important to see if it linked to other interests either through a common parent, or was a distinct presence in the population. During the interview programme, I idly remarked to one of the informants, following a question on how the work was going, that I had had many problems finding out about this firm - could this informant shed any light on it? Peals of laughter that followed, with comments about secretive industries - this informant knew all about it – it was a little known low level subsidiary of another population member that should never have appeared in the reported data, and was still around, albeit in another form. The data was promptly recoded and the statistics re-run.

The data from each annual *"Brown Book"* was entered into Excel spread sheets for each oil or gas field and each firm, this was then manipulated to compile cumulative spread-sheets for the population for the following areas amongst others:

- Year of entry
- Survival years and post-entry survival years
- Year of exit
- Total number of years of industry experience
- Year of first field operatorship
- Total number of operator years
- Total number of years as a partner in UK onshore oil and gas fields
- Number of intra–industry ties
- Details of exploration/exploitation activity

The data was collected at the individual field level, developing a firm history in each field and coding it for entry, change in interest, change in number of interests, etc. and then aggregated at the industry level for each year, at the firm level cumulatively and at the field level though the latter data was not used in this study. The data was then imported to the SPSS™ v11.0 statistics package for statistical analysis.

7.3.1 Selection factors:

Data was collected separately to cover the selection factors deriving from the literature review in Chapter 3, as described in Chapter 6. Initial correlation analysis was conducted for each of the selection factors with the total right–censored population data for entry, exit and survival for each of the 17 years. Indeed, the original intent was to go back to 1973 and the origins of the current wave of onshore production but, with only two firms in the population from 1973-1984, the statistics were distorted, so the data was left-censored to 1983 on the basis that Hoopes (1996) and other industry commentators agree that the growth of the onshore industry began at this time.

7.3.2 Adaptation factors:

Correlation analyses were repeated for adaptation factors at the individual firm level, correlating individual firm survival times and endogenous firm variables

such as number and type of exploration/exploitation events completed, intra-industry ties and intra-industry experience.

7.4 Pilot Results

The results are shown in Table 7.1. The strongest findings relate to H3, H4 and H5, and suggest that exploration/exploitation strategies, firm ties and industry experience are linked to survival. There is limited correlation with exogenous factors, suggesting selection is less important than adaptation for survival in this industry.

Paraphrased Hypothesis	Results	Correlations/Comments
H0: Access to resources matters above all	Inconsistent with hypothesis	Publicly listed firms often inert/short-lived.
H1: Environment/selection influences survival	Four variables consistent with hypothesis	Oil price r= -0.766**, due to materiality issues. Eurodollar rates r= -0.744**, due to oil price and investment model decisions. Existing field numbers r= 0.533*. Technology innovation rate, r= -0.644**.
H2: Early birds survive longer	Inconsistent with hypothesis	Entry in first five years confers some advantage.
H3: Explorers and/or exploiters survive longer	Consistent with hypothesis	r= 0.737** overall, mostly linked to exploiters at r= 0.668**, grouping in data supports model.
H4: Large numbers of intra-industry ties support survival	Consistent with hypothesis	r= 0.769**, follows literature.
H5: Longer intra-industry experience promotes survival, as does legitimising behaviour	Consistent with hypothesis	r= 0.679** for firm experience r= 0.536 for operator experience linked to legitimacy.
H5: Major external shocks shake out firms	Possibly consistent with hypothesis	Cluster exits linked to negative events on the time line but take place over several years .

** = Correlations are significant at the 0.01 level.* = Correlations are significant at the 0.05 level.

Table 7.1: Summary of Findings from the Pilot Study

In all the following cases, *"industry"* refers to the onshore oil and gas production industry.

H0: Within the industry, the larger the firm, the longer it survives.

In the pilot study, data to calculate a size measure for a firm was not available, so governance structure as a measure of access to financial resources was used as a proxy. There was no apparent link between the governance structure of firms as a measure of their access to resources and the number of survival years measured at the firm level. This can be explained by the concept of materiality, a phrase commonly used in the oil industry and referred to again in the interviews in Chapter 8. Although larger firms might be expected to survive longer from the literature, e.g. Pfeffer & Salancik (1978); Mata & Portugal (2002), larger firms are more likely to be subject to different external selection pressures, so will be driven by factors relating to their asset and competence bundles. Among these is the relative size of producing assets compared with

their high centralised administration costs, so smaller fields become less attractive as the high overhead burden decreases profits further and so *"oil provinces"* such as onshore UK become less attractive as investments and the firms leave, i.e. do not survive.

H1: Within the industry, the more munificent the environment, the larger the number of firms that survive.

This hypothesis tests key selection factors for survival. The correlation matrix is shown in Appendix I. Numbers of firm survivors in each year were examined against the following exogenous variables shown in Table 7.2:

Variable	Measurement
Macro-economic:	UK GDP;
Finance:	Eurodollar rates; UK base rates; market capitalisation of the oil sector;
Industry climate:	Oil price; Onshore production; Onshore field numbers; new field entries;
Environmental sensitivity:	Number of deviated wells drilled/all wells drilled;
Technology innovation rate:	Proportion of vertical to deviated wells drilled each year.

Table 7.2: Variables and Measures for H1 for the Pilot Study

There were four significant correlations with the number of surviving firms:

- Oil price r= –0.766
- Eurodollar rates r= –0.744
- Existing field numbers r= 0.533
- Technology innovation rate r= –0.644

This implies that a rise in oil price, the cost of funds, a density dependence effect or technological changes can select firms in or out.

The first case, contra-intuitive at first glance, is linked to the concept of *"materiality"* mentioned in H0, Chapter 5 and in the interview data. When prices fall, large firms review their investments in less attractive areas. Using option theory, they might discreetly sell down interests to smaller firms already in industry. An examination of the detailed data suggests that this is certainly true for the year preceding the maximum differences. There were also sharp upward spikes in oil prices as a result of exogenous events, adding to the distortion. After 1988, there is a positive correlation between the survivor population and the previous year's oil price, but the number of observations is too small to be conclusive. This needs to be examined further in the main study.

The negative relationship with Eurodollar rates needs to be viewed in the light of the correlation between survival years and UK base rates (r= -0.353), and also in the correlation between Eurodollar rates and oil price (r= 0.593 and significant at the 0.05 level). This suggests that a part of the explanation is already captured in the oil price and the interest rates are of lesser importance, though it is consonant with Pollio (1999) and Sadorsky (2001).

The positive relationship with the number of existing producing oil fields suggests a weak density dependence effect, though the low number of years (n= 16), suggests caution about this. It could link to information flows, and the perceived attractiveness of the industry as an investment opportunity especially if viewed together with the findings of H5. This is reviewed further in the main study and regressions in Chapter 9.

The technological change rate measure links to cost, as deviated wells are more expensive but also less environmentally demanding, so it indirectly links additionally to environmental issues. The latter may be linked to exit as firms withdraw as a result of environmentalist pressures. This is partially confirmed by a correlation between the environmental factor and exiting numbers at –0.521, as well as by the interview data.

This hypothesis is partially supported.

H2: Within the industry, early entrants are more likely to survive for longer than later entrants.

At first glance, being an early entrant seems to confer no advantage - indeed there is a strong negative correlation (r= –0.334)[34] between year of entry and number of survivor years when calculated for each of the firms. However, if the population is split into three five-year periods[35] (of 24, 16, 13 firms each), firms entering in the first five-year period, 1984-88, survive for an average 4.38 years, compared with an average of 3.88 years for those entering in 1989-93 and an average of 2.77 years for 1994-98. Indeed, the 24 firms entering before 1990, survived for an average 4.38 years, compared with 3.38 for the 29 firms entering in the last 10 years. The higher average in the beginning could be because attractive investment sites (fields) were colonised early, but the larger firms were then shaken out by the shocks discussed in H6. The data in the last five-year period should be treated with caution as late entrants have limited opportunity for longer survival.

This finding appears to support the literature on early entry in that first mover advantage expressed as longer survival is linked with entry in the first five years. However, the averages are distorted by numbers of firms that enter and leave very quickly (within a year) in the early years of the study. Having begun production and generated cashflow, either the asset or the firm may become an attractive target for other firms, and leave after a short time. In the main study, this *"noise"* phenomenon was controlled by using post-entry survival years as the dependent variable thus taking out all firms only present for one year.

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[34] Significant at the 0.05 level.
[35] No entrants in 1999 as zero years survival.

H3: Within the industry, the greater the total number of exploration plus exploitation activities executed by a firm at the investment level, the longer it survives inside the industry.

A firm's ability to engage in exploration or exploitation events post year of entry is strongly correlated with the number of years of survival at 0.737. The spread of events is from zero to 32 for the longest survivor, mentioned in several interviews as an exemplar in the onshore industry. There may be an experience curve effect here.

Exploration strategies tended to predominate in the earlier years of a firm's life, with exploiters a rarer group, though exploitation is strongly correlated with survival at 0.668. Firms that engage in exploration or exploitation activity have built up this distinctive dynamic capability quickly after entry, completing several of these activities in a year, albeit possibly as a package of oil field interests through purchase of an exiting firm's interests.

There is a major dislocation in the data suggesting that for this industry a transition occurs at over eight events; this delineates four distinct groupings based on a typology such as Miles & Snow (1984); Bierly & Chakrabarti (1996). It is shown in Table 7.3 and essentially confirmed by an AnswerTree grouping run as an exhaustive CHAID analysis, shown in Appendix O. This uses the total number of exploration/exploitation events completed by a firm and the total number of firm intra-industry ties as grouping variables and is shown in Appendix O. This model is very tentative: there are issues with distortion from entrants who exit promptly and over-representation of fields. There is also an argument about the exclusion of the Wytch Farm firms who are long lived and have little interaction with the rest of the industry. Nevertheless, it supports the view that discretionary adaptation, evidenced by groupings based on exploration/exploitation activity (and intra-industry ties for the CHAID analysis), seems to confer some sort of capability or competence that enables firms to survive adverse selection.

It could be that by engaging in discretionary adaptive activities and reporting them to stakeholders (or members of legitimising coalitions), firms acquire enhanced legitimacy and are rewarded with continued support in the form of shareholder support. Shareholders are the major financial stakeholders in many of the firms in this population, and offer support either by not selling shares, or by supporting Rights Issues, since most of the firms that are not subsidiaries of larger groups have had problems raising significant debt. (The financing issue also surfaces in the interviews in the next chapter.) The CHAID analysis suggests five groupings, but based on exploration/exploitation activity, four were used in this simple model.

Strategy	Numbers in population	Number of Exploration/ Exploitation events completed	Discussion points
Sheep	25 (47%)	0	Probably a follower strategy – presence is selection driven, survival maybe legacy dependent.
Specialist	11 (21%)	1	Either early or late entrants. Mostly explorers – exit on adverse selection – short-term player.
Seeker	12 (23%)	2-7	Mainly explorers with small exploitation activity - short-term player.
Sorcerer	5 (9%)	11-31	Active explorer/exploiter. High levels of exploration and exploitation activity. Consistently initiates and/or adapts to events. Long-term player.

Table 7.3: Generic Strategies derived from the Pilot Study

Four of the five active explorers/exploiters used several rarer exploitation strategies. The longest survivor used exploitation to an outstanding degree, on 20 occasions, and almost 2.5 times as much as the next large exploiter, which overextended itself and was forced to exit. Of the five successful explorer/exploiters, only one is still present in the industry, two have exited, and two were acquired.

The sub-hypotheses mentioned in Chapter 3 and Chapter 6 were not tested in the pilot study and were developed from its conclusions.

H4: Within the industry, the greater the number of a firm's intra-industry ties, the longer it will survive inside the industry. Smaller firms will be predisposed to use large numbers of ties to enhance survival.

Total number of industry ties and the number of survival years of a firm are significantly correlated at 0.769, at the firm level. Indeed, exemplar firms mentioned in the interviews, e.g. Edinburgh Oil, are heavily embedded in the industry with multiple industry ties. Linking back to the theory on organizational ties, partnerships and networks, considering the high degree of information asymmetry in the industry and the small size of many firms, coalitions between firms would be expected (Said, 1976; Gulati, 1995).

The secondary part of this hypothesis was not tested for the pilot as size data was unavailable at that point in the study.

H5: Within the industry, the greater a firm's intra-industry experience, the longer it will survive within the industry.

Correlations are significant at the 0.01 level for the firm experience measure (r= 0.679) and the number of operator years (progression and legitimacy) (r= 0.536) with survival years for the firms. This confirms the hypothesis that experience and legitimacy inside the industry support survival, which would be expected. It is also consistent with the interview data suggesting *a "rite of passage"* through onshore – discussed by informants in interviews as the *"onshore as a nursery"* metaphor.

H6: Within the industry, the greater an adverse environmental shock, the more firms will exit from the industry.

At the firm level, year of exit has a low correlation with the number of firm survival years (r= 0.216). However, groups of firms exited at certain periods, e.g. 1989, 1990, following major tax changes. This suggests that exogenous factors may select out certain firm groups unable to manage changes at a system level exogenous to the firm. For these groups, legacy effects appear to dominate adaptation, or the discretionary adaptation capability of these firms is underdeveloped.

7.5 Conclusions from the Pilot Study

Firm survival would appear to be linked to a firm's active completion of discretionary adaptation events, its total number of industry ties and total experience. Some advantage appears to be conferred by early entry. Exits appear to be by cluster and linked to adverse environmental variable changes. Key environmental variables have a limited impact on the overall firm population – oil price, interest rates, number of existing producing fields and technological innovation/environmental pressures being the key drivers.

In summary, therefore, the pilot research suggested that firm level adaptation factors, especially exploration/exploitation activity, intra-industry ties and experience (i.e. those linked to the routines and competences discussed in Chapter 3) appear to be the dominant factors in determining firm survival inside the industry boundary *together* with information about the industry shown by the wells drilled to date. However, small firm effects and industry effects forewarn a need for care about generalising from the conclusions.

The next chapter reviews the qualitative findings and the differences between perceptions of the industry and the quantitative data.

CHAPTER 8: THE INTERVIEW DATA

8.1 Summary

In this chapter, the procedures adopted for the semi-structured interviews mentioned in Chapter 6 are discussed. The methods for concept elicitation from the interviews using mapping techniques are described, as well as the results of using this coding via the NVivo™ software to examine the text of the interviews. Finally, the results of the informant interviews and the validity of the approach are reported.

This chapter includes the following sections: introduction, the literature background to the interviews, the interviews, the informants, data from the interviews and data analysis techniques, initial summary findings from the interview data, summary findings from the informant maps, detailed re-analysis using a coding schema derived from the meta-maps and content analysis, discussion and conclusions.

8.2 Introduction

To illuminate the archival data, and indeed to interpret findings from it, 10 brief confidential interviews were conducted with key industry informants, invited by the letter in Appendix J, and using the semi-structured interview schedule (Appendix K). The interviews were conducted between the pilot and the main studies, over a two month period between 25th March and 8th May 2002. The schedule focused on the survival process and asked about entry, survival, exit, experience, partnerships, density dependence, and license awards. The interviews were written up and analysed using a systematic process to group constructs. The results were then linked to the pilot study findings.

8.3 The Literature Background to the Interviews

In order to avoid omissions in critical factors absent from the external environment model, a series of semi-structured interviews with expert decision-maker informants in the onshore oil industry were conducted. The interviews also served to triangulate findings from the pilot study. The use of experts is congruent with approaches used in three different literatures: clinical judgement and decision-making literatures (Einhorn, 1972; Dawes & Corrigan, 1974; Einhorn, 1974; Camerer & Johnson, 1999); forecasting literature (Armstrong, 2001) and the strategy literature (Hitt & Middlemist, 1979; Hitt & Tyler, 1991) all of which share the same roots. This research uses expert judges and their analysis of situations to provide background information about a secretive industry and firm dynamics, but stops at the point of elicitation of judgement factors that would then be used to build the decision-making model, thus following Shanteau (1992) in looking at the reported information base used to make key decisions.

Hambrick (1980) suggests that self-reporting is a good method for identifying intended strategies, and Pearce, Robbins & Robinson (1987) assert that the

data is reliable, though Podsakoff & Organ (1986) have reservations, as do March & Sutton (1997).

The qualitative data was only used for triangulation purposes to enable progress from the pilot study to the main study. Its richness was not explored, nor was the data sidetracked or used interactively with informants, because its variability as a result of collection issues would have rendered the validity of such analysis open to question if used on a stand-alone basis to form conclusions about survival.

8.4 The Interviews

The oil industry, as has already been said, is very secretive and the interviews were conducted in that climate. Many interviewees are still active in the industry and are directors of significant public companies as well as important industry figures. To handle concerns about the potential sensitivity of the questionnaire, it was reviewed by a senior figure in an industry body, who is also a lawyer, and was verbally approved by him for content. The interviews were conducted between March and May 2002 and ranged in length from about 30 minutes to about 90 minutes. Anonymity was offered to manage industry secrecy considerations. Interviews were not tape-recorded, as this would not have been permitted by the interviewees, so as near verbatim notes as practicable were taken and written up as computer notes within 24 hours of completion. Digressions from questions were permitted, as they added richness to the industry picture, and explained some linkages and practices.

There are inevitable limitations: the interviews were of varying length, so if all had been of the same length, the comparative approach could have been different. The unequal times would also make it difficult to justify the interviews as a stand-alone set of scientific measures, so its purpose was to gain a sense of priorities for triangulation of the archival data. Counts of topic mentions were used, but their limitations are recognised.

The interviews supported the choice of selection drivers for quantitative data analysis. They also stressed the unrepresentative nature of the successful Wytch Farm field. This serves as a sobering reminder of the dangers of basing research only on archival data, itself biased in terms of what is recorded, and what is omitted (Blaikie, 1993, p.198).

8.5 The Informants

As the interview programme was developed, several criteria to ensure representativeness for informants were considered:

- They needed to have been involved with onshore production or near production for most of the 15/16 year period under consideration;
- They needed to have been in a key decision-making role over that time;
- There needed to be a spread of management functions across the sample;

- There needed to be a spread of survival times and entry years for firms represented by the informants in the sample.
- The additional anticipated criterion of *"Being prepared to be interviewed by me"* turned out to be no problem at all, which was unexpected, as access to this industry is not easy[36].

Informants were chosen as the quantitative data for the pilot study was analysed, and after an initial telephone contact, a letter was written to each informant suggesting an interview and explaining the project (see Appendix J). There were no refusals. In all cases except one, the informants were known to me in the past, even if almost 20 years ago, when as part of my previous non–academic life, they had been either clients or potential clients of the bank I worked for. Undoubtedly this could be argued to have some bias, but as the chart below shows, I consider the group to be representative.

The breakdown of informants by these criteria is shown in Table 8.1.

Informant	Total number of years Onshore Production Industry Experience[37]	Number of firms worked for in industry population	Primary function	Worked for onshore operating firm in producing population?	Offshore UK before onshore?	Total Intra-industry ties of firms that Informant worked for
A	9	2	Finance	No	Yes	94
B	9	1	Engineer	Yes	Yes	78
C	5	1	Geologist	No	Yes	76
D	3	1	Finance	No	Yes	20
E	11	2	General manager	Yes	No	23
F	6	1	Finance	No	Yes	15
G	0	0	Finance	No	Yes	0
H	16	1	General Manager	No	Yes	80
I	0	0	Geologist	No	No	0
J	0	0	Engineer	Yes	No	0

Table 8.1: Informant Profiles

The number of firms covered by these informants is 10 out of a total of 65 (15.4%).

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[36] A former PhD student colleague of mine had enormous problems gaining access to informants inside an oil firm, probably because she was perceived as an outsider. Certainly, in the beginning of my work with the oil industry, I had to overcome similar barriers over time. So access issues were likely to be critical, and bias though recognised, was a secondary consideration.

[37] There would be some dissent about these numbers from the informants, as some may have had experience of test production prior to the grant of a long term production license.

There was one Wytch Farm firm informant. Although the finance function appears to be over represented, those informants also fulfil/fulfilled other roles as well as a finance primary role. In order to complete a balanced picture, informant I was chosen as someone who had managed a firm that was present in an onshore field prior to production and who had a long history with firms with onshore involvement, albeit not as producers. Informants G and J were in firms covered in the pilot but which had a life of less than one year in the study, so were censored out in the main study.

Informants were not told of the hypotheses being tested, nor of any preliminary findings from the pilot study to prevent *"anchoring and adjusting"* taking place (Slovic, Fischhoff & Lichtenstein, 1982; Tversky & Kahneman, 1985).

8.6 Data from the Interviews and Data Analysis Techniques

Possibly because of the prior acquaintance, the interviews spent little time on social niceties and focused on the research issues. If requested, the interview protocol was shared.

Areas of interest focused around the initial hypotheses of the research:

- perceptions of the reasons for industry entry, especially the decision and the mode; perceptions of the reasons for exit, especially the decision and the mode;
- perceptions of population density effects on firm foundings and firm entries and exits;
- perceived factors affecting within-industry firm longevity;
- perceptions of the role of partners;
- perceptions of the role of the operator;
- perceptions of the importance of being in a license group from its original award as compared with farming-in or acquisition;
- perceptions of key industry figures re-emerging in new firms to maintain industry knowledge.

Initially the interview notes were transformed into individual mind maps for each informant through content analysis and key words and phrases analysis, using the MindManager™ mind mapping software as shown in Figure 8.1.

The process has already been described in Chapter 6.

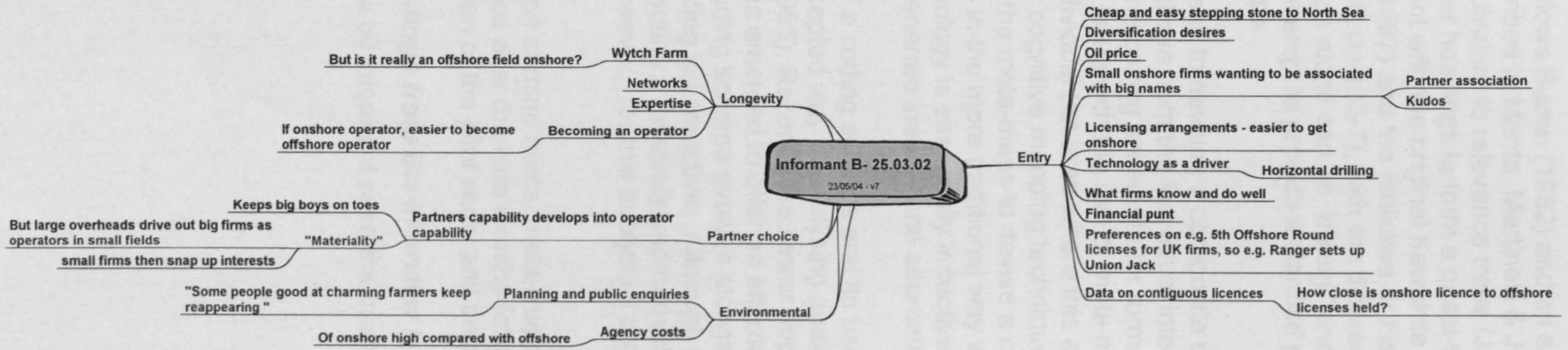

Figure 8.1: Informant B Mind-map

The use of mind maps follows Buzan (1982) and an example of the mind mapping process is described in Mento, Martinelli & Jones (1999). The mind maps are functionally equivalent to relevance trees (Jantsch, 1967) and consist of grouped concepts under headings to form a quasi-taxonomic hierarchy. This approach is also congruent with the original Kawakita method (Kawakita, 1991) as discussed in Scupin (1997) and the Ishikawa or Fishbone technique, discussed in Majaro (1988, pp.133-7), with the differences lying in the representation. Mind maps alone can be *"messy"* and hard to follow, whereas all of these approaches attempt to provide a clarified picture of the concepts and their inter-relationships.

The software was then used to develop a composite picture or meta-map of each of the areas listed above from the individual interviews. These meta-maps were then used to build the coding schemata for formal content analysis of the interviews. One potential issue with the use of meta-maps is the lack of ownership by a single individual (an area where this approach differs fundamentally from other cognitive mapping techniques). This has been addressed by only using the meta-maps to devise a coding scheme in order to re-analyse the interviews in the more traditional way with a content analysis package. So the methodology is essentially inductive at this point. The mind maps were not used to generate ideas – one alternative use of this tool.

The initial construction of a coding scheme and its use in a content analysis of interviews is a widely accepted way of analysing qualitative data (Glaser & Strauss, 1967; Weber, 1985). Recently the newer approach of Template Analysis (King, 1998), has emerged to offer an alternative methodology. In Template Analysis the coding schema evolves alongside the substrate data, so the template used for coding is interactive. Although this offers a more flexible approach to coding, it remains a relatively underdeveloped tool with a lack of supporting literature. However, for this analysis it proved to be a very useful technique.

The process of compilation of mind maps, meta-maps, coding schema and interview coding took place over the nine months following completion of the interviews, after completion of the pilot study and before the main study.

8.7 Initial Summary Findings from the Interview Data

The individual mind maps by informant were the basis of the meta-maps shown as Figures 8.2–8.8.

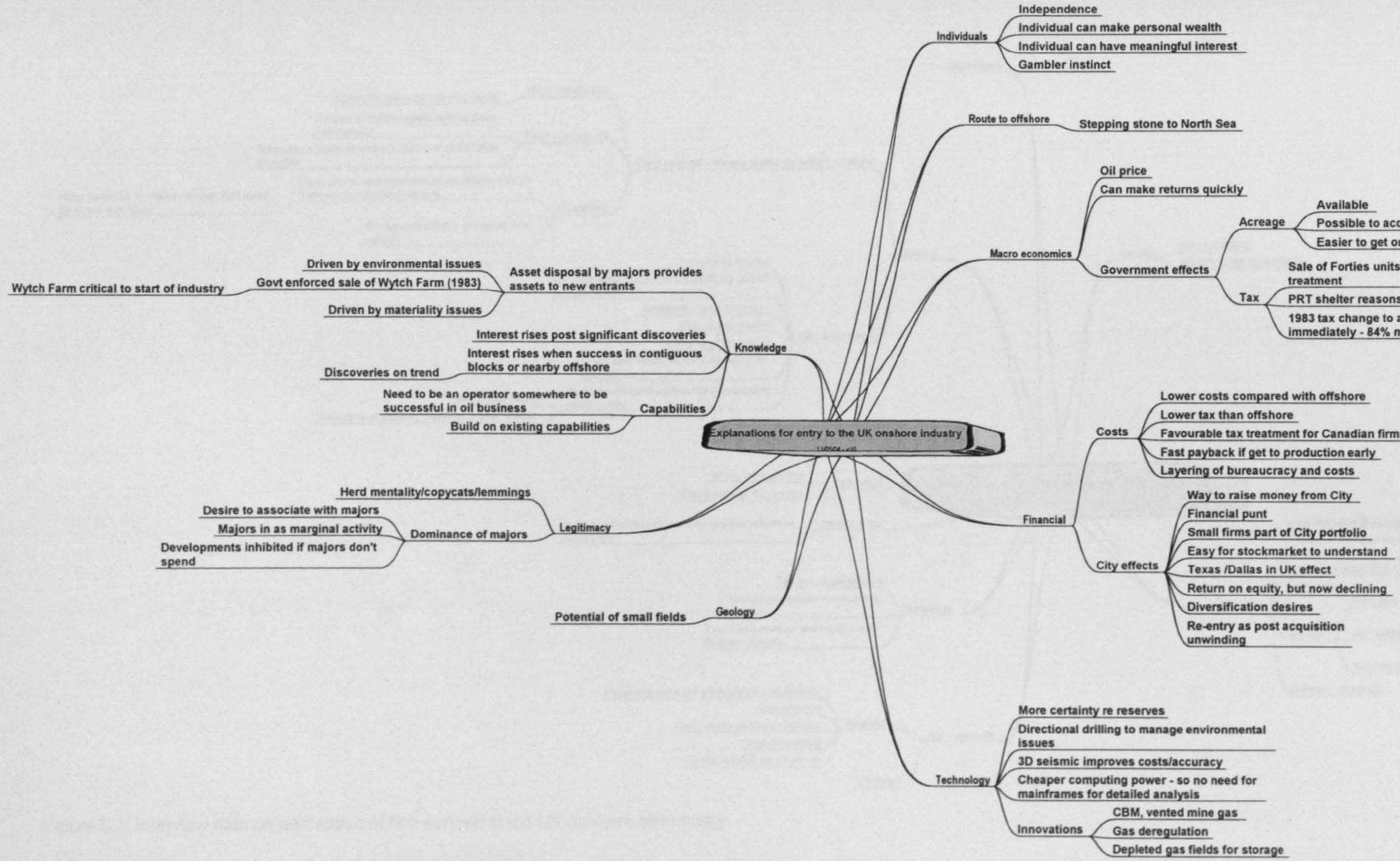

Figure 8.2: Interview data on perceptions of firm entry in the UK onshore oil industry

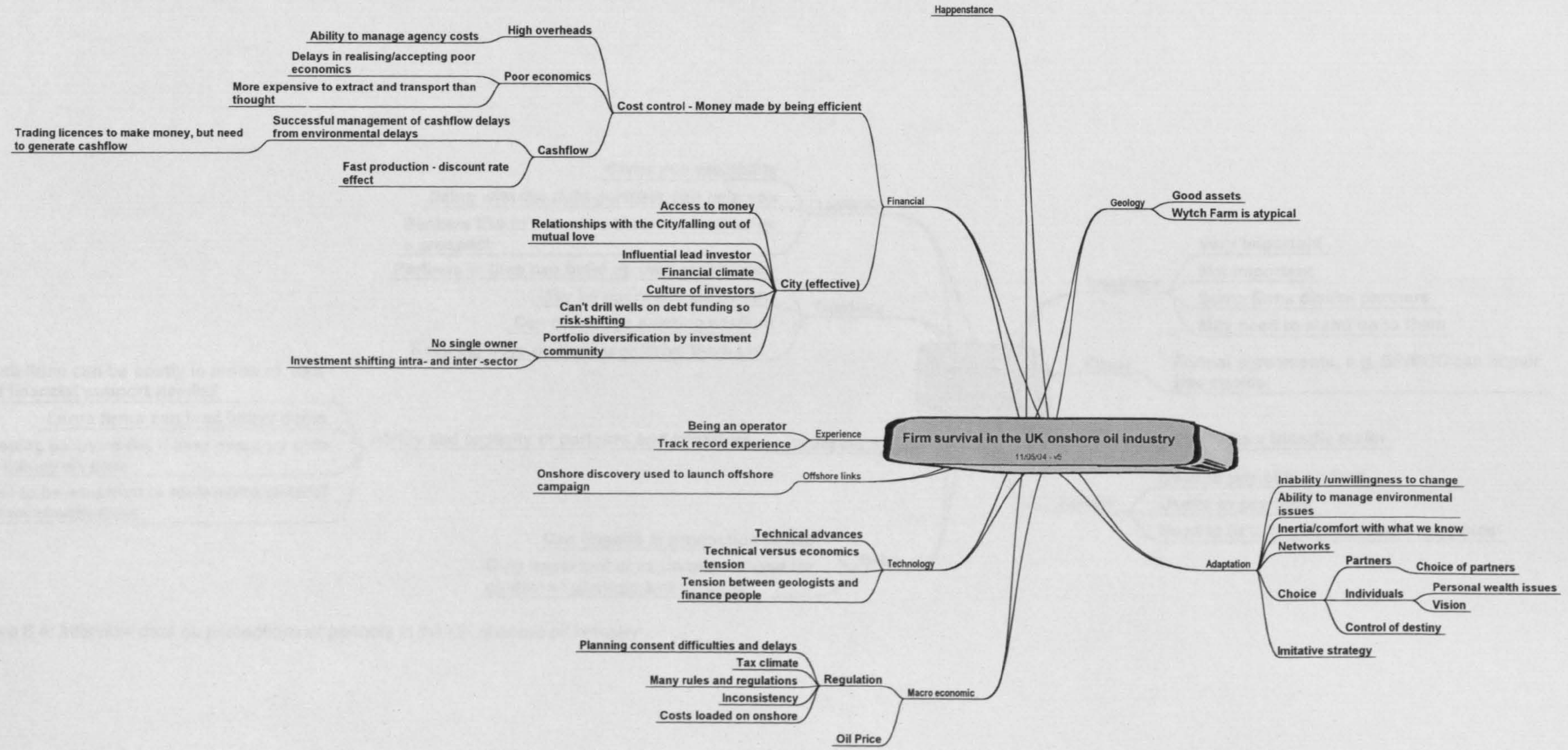

Figure 8.3: Interview data on perception of firm survival in the UK onshore oil industry

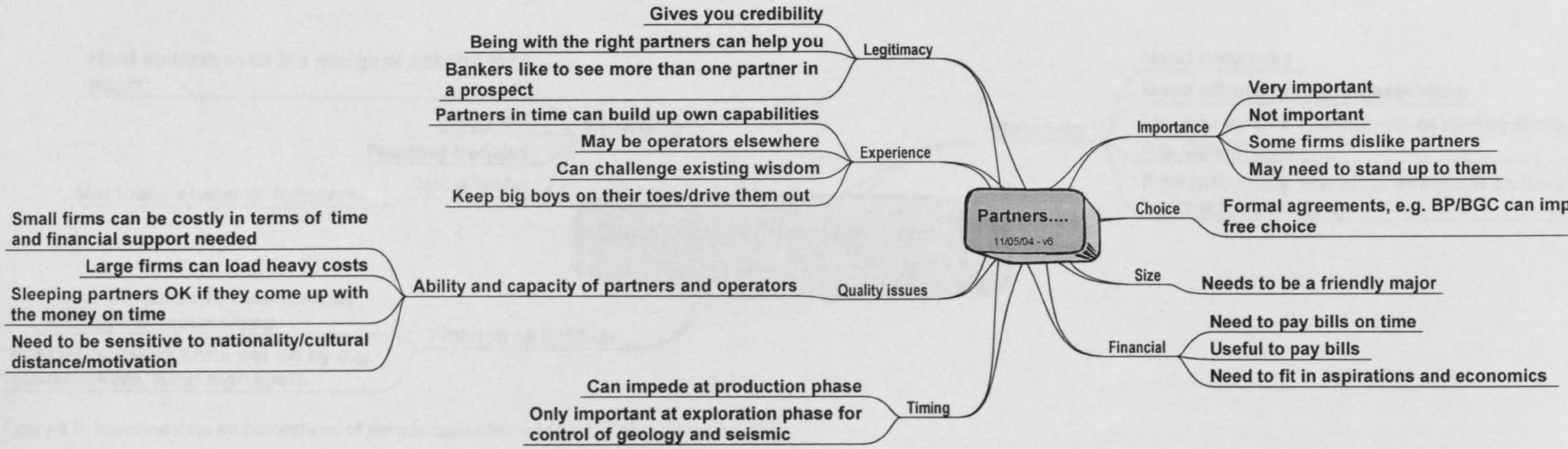

Figure 8.4: Interview data on perceptions of partners in the UK onshore oil industry

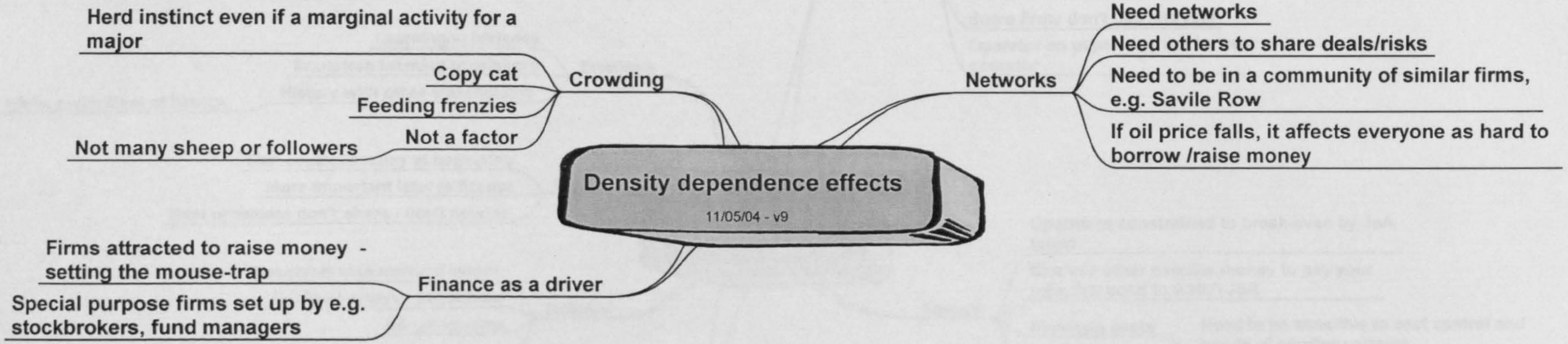

Figure 8.5: Interview data on perceptions of density dependence in the UK onshore oil industry

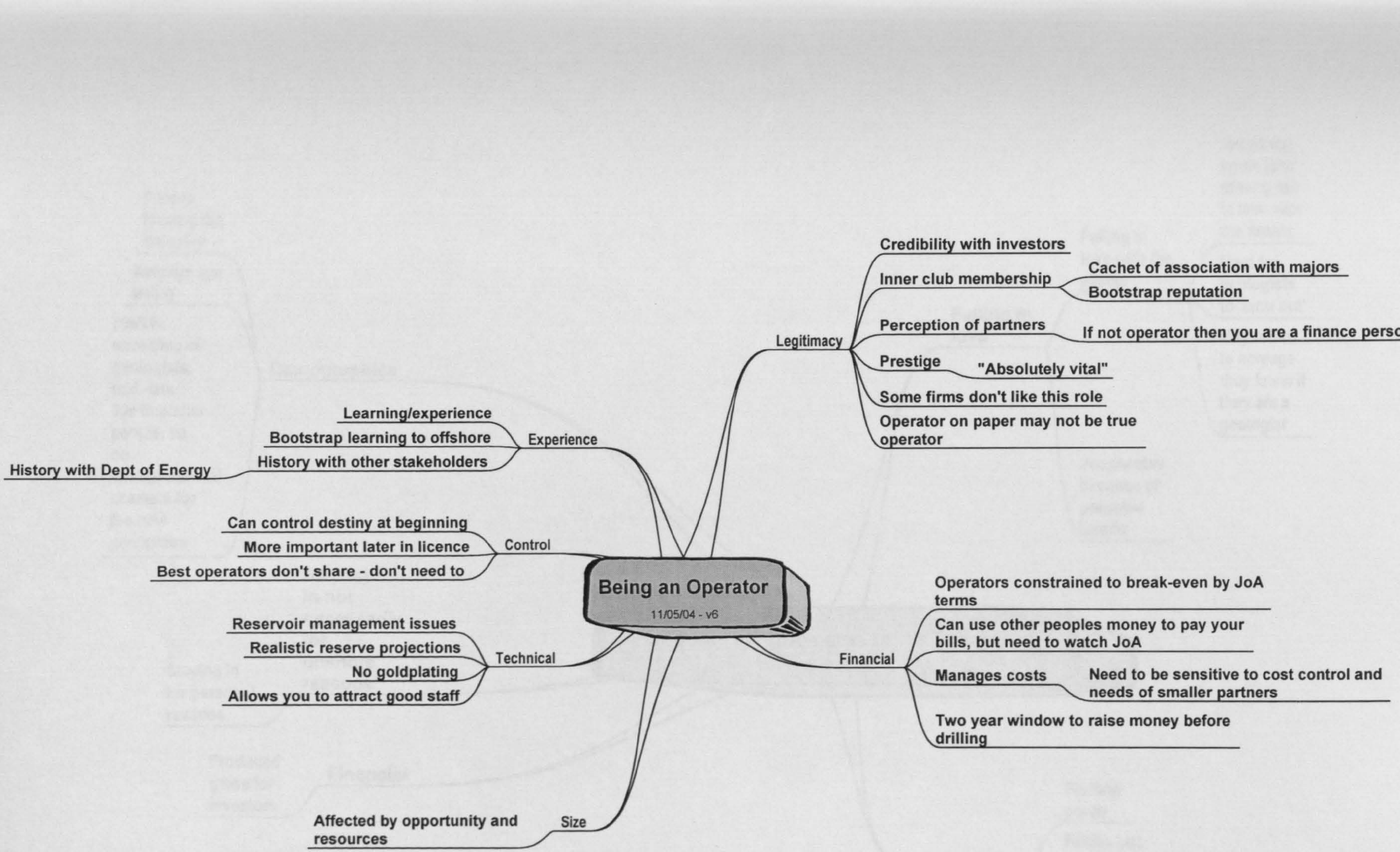

Figure 8.6: Interview data on perceptions of the operator role in the UK onshore oil industry

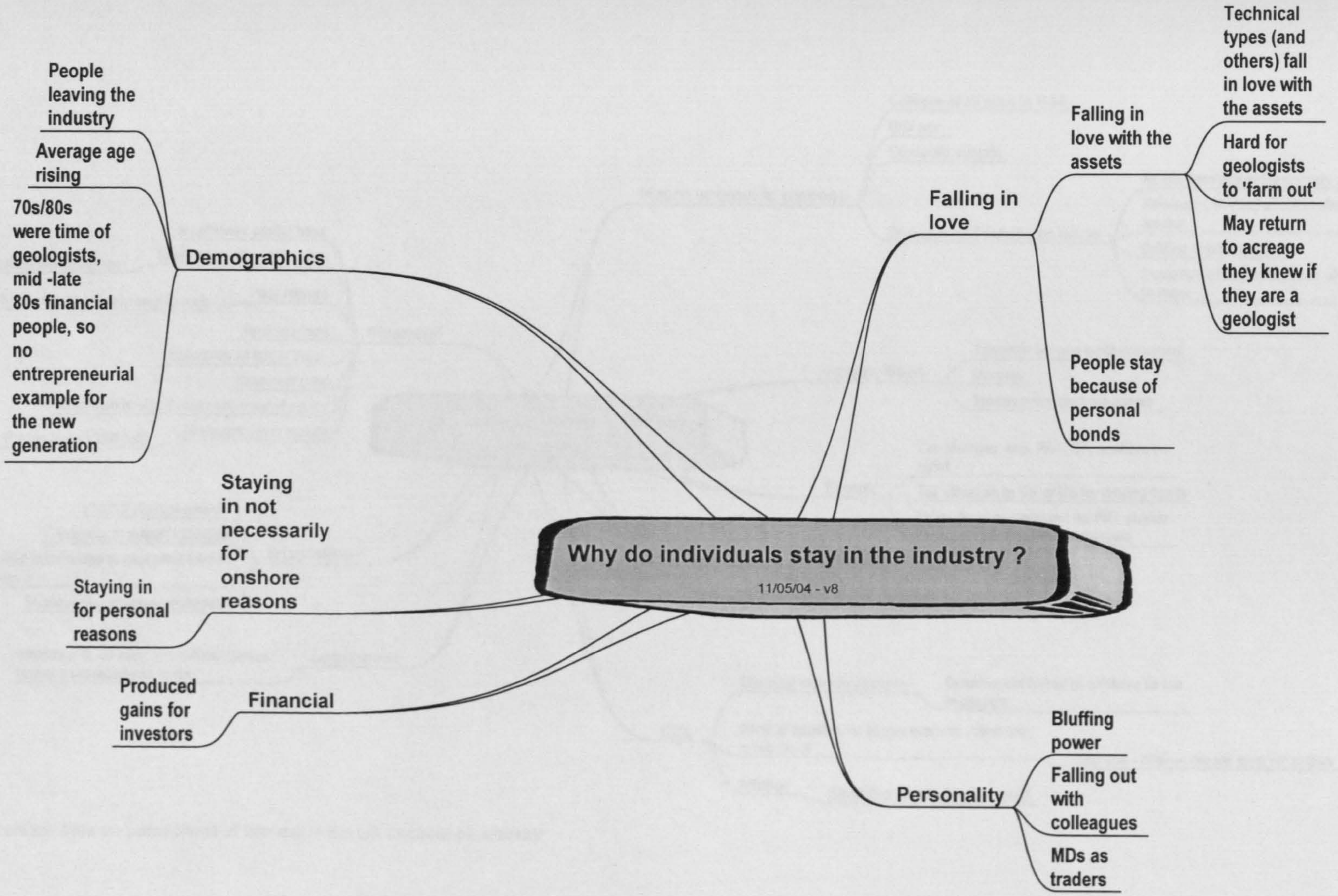

Figure 8.7: Interview data on perceptions of why individuals stay on post firm acquisition or firm exit in the UK onshore oil industry

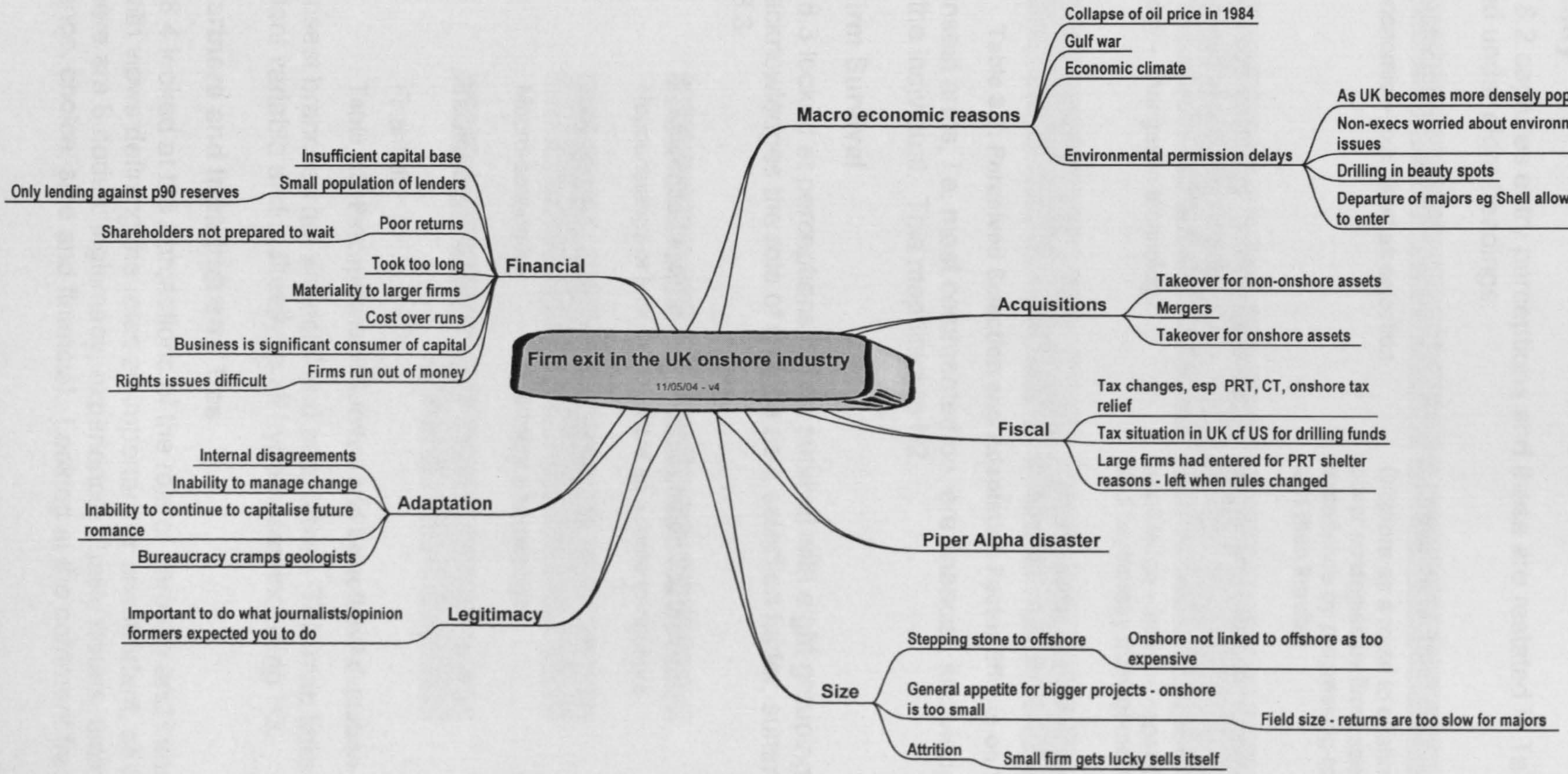

Figure 8.8: Interview data on perceptions of firm exit in the UK onshore oil industry

The findings from the meta-maps may be summarised as follows:

8.7.1 Entry

Figure 8.2 captures entry perceptions and these are restated in Table 8.2, grouped under eight headings:

Selection factors:	Adaptation factors:
Macro-economic – examined as selection factors	Onshore as a route to offshore - this would cover strategies by firms seeking to gain experience by progressing to operator status and then leaving
Financial – both costs and sources of finance, also examined as selection factors	Legitimacy – links to resource dependency theory
Technology – changes in technology	Knowledge – both as capability development and asymmetry management
Geology	Characteristics of individuals - probably linked to adaptation

Table 8.2: Perceived Selection and Adaptation Factor Effects on Entry

The densest arms, i.e. most commented on, are financial, knowledge and the role of the individual. This map links to H2.

8.7.2 Firm Survival

Figure 8.3 looked at perceptions of firm survival with eight groupings, one of which acknowledges the role of chance as a selection factor, summarised in Table 8.3.

Selection Factors:	Adaptation Factors:
Happenstance or luck	Onshore as a route to offshore
Geology	Adaptation
Macro-economics	Experience/knowledge
Technology	
Financial	

Table 8.3: Perceptions of Survival and Selection/Adaptation

The densest branches are financial and adaptation. This map links to the dependent variable and indirectly to all hypotheses including H3.

8.7.3 Partners and Intra-industry Ties

Figure 8.4 looked at the perceptions of the role of partners and intra-industry ties – with views defining the roles as important or unimportant, so links with H0, H4. There are 8 nodes: legitimacy, experience, quality issues, timing, importance, choice, size and financial. Looking at the comment frequency, this

would indicate that partnering is not viewed as a key factor. Weak partners can cause problems, and the anecdotal evidence of one of the interviewees suggests that the official screening procedure discussed in 5.5.1 are not working optimally. The partnering relationship is viewed dualistically – beneficial, but also challenging and antagonistic. Informants from smaller firms were not always positive about larger prestigious firms that they had partnered as a *"legitimising by association"* strategy. In particular, there were perceived problems with the large firms' lack of sensitivity to partners' smaller budgets.

A good illustration of this tension concerns a firm not included in this study as it has long since disappeared. It was a very small entity - two part-time staff, though publicly-listed and the jewel in its asset collection was a very small participation in an offshore North Sea license, held together with several of the *"Seven Sisters"* integrated oil giants. Each year the little company's management told its shareholders that it hoped that this would be the year that a well was drilled on the block, and would find an enormous field. Each year, the majors looked at the block and went elsewhere to spend their drilling money. For the small firm, the asset was very material; in the asset basket of the majors it was well down the prospect list for drilling.

8.7.4 Density Dependence and Demographic Considerations

Figure 8.5 considers perceptions of density dependence – discussed earlier in Chapter 3 with apparent tension between views that networks were a good thing to the more cynical and even emotional approaches describing *"feeding-frenzies"*, *"copy- cats"*, and *"herd mentalities"*. The imitation or mimicry demonstrates legitimating[38] behaviour (DiMaggio & Powell, 1983; Williamson, 1998, p.26) and links with H4. It also considers the role of networks as size proxies and the ideas of communities of practice (for learning) and communities for risk sharing (Wenger, 1998, 2000). Finance is also a factor here – with replication of firms when the market is booming, suggesting the existence of industry recipes (Spender, 1989).

8.7.5 Learning, Experience and Legitimacy (experience and becoming a field operator)

Figure 8.6 shows the perceptions of the reasons for becoming an operator – and links to legitimacy and organizational learning theory as well as H5. There were five nodes in this map: experience, control, technical, financial and legitimacy, with the latter the largest node. It included such comments as *"inner club membership*", "*perception of partners*" and "*credibility with investors*". There was also a warning that the listed operator my not be the true operator. My experience with the industry would support this comment – the community tends to close ranks if there is a problem - and a change in the operator of an oil or gas field for whatever reason, especially for a very small firm, may not be reported in the *"Brown Book"*, the principal source of the data for this research.

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[38] This is also referred to as legitimation and legitimisation (the UK form). Both are used interchangeably in this thesis.

8.7.6 Why do individuals stay in the industry?

Figure 8.7 looks at perceptions about staying in the industry and sentimental attachment to assets and also includes some data about the role of the leader or entrepreneur. There are five groupings: demographics (managers in the industry are getting older); staying in the industry for personal reasons; and also personality issues - bluffing, falling out with colleagues and trading assets. This grouping related to an earlier hypothesis (now dropped) that suggested that managers sometimes fell in love with assets – captured in a following section of the reanalysis of the maps as *"sentiment"*. It is the smallest of the maps.

8.7.7 Exits

Figure 8.8 presents perceptions of exits from the UK onshore oil production industry, i.e. H6. Again, financial, adaptation, legitimacy, macro-economic reasons occur, but there are variants – size now links to the onshore-to-offshore transition, fiscal reasons were split out as well as the impact of safety from a risk and cost perspective following the offshore Piper Alpha disaster. Acquisitions and fiscal reasons for exit are also present. The findings are entirely consistent with Pfeffer & Salancik (1978) and the hypotheses.

8.8 Summary Findings from the Informant Maps

In summary, the meta-maps of the interviews offered a rich picture of the real events, and informed the statistical findings. One future plan is to expand the informant group for a follow-on study and to attempt either a Nominal Group Technique (NGT) or Delphi technique exercise (Delbecq, Van de Ven & Gustafson, 1975; Rowe & Wright, 2001). The reason NGT was not used here was that there is a danger that it would promote a consensus memory of the industry factors rather than the diversity I was seeking from the different individual perspectives. It would also have been extremely difficult logistically to get this group together. The informant maps added richness to the archival data by offering explanations linked to the primary factors derived from the literature including such areas as sentiment.

8.9 Detailed Re-analysis using a Coding Schema derived from the Meta-maps and Content Analysis

Copies of the interview texts were then imported into NVivo™ software. Coding of text was based on a coding map derived from the meta-maps as discussed in Chapter 6 and text references to coding nodes were counted. Since the interviews were not recorded, counts are shown at the main node level only to provide a flavour of the perceived importance of these topics by informants, with a full analysis in Appendix L. Some predicted coding nodes based on industry information were included even if they were unoccupied, as the absence may be interesting, e.g. *"Influence of the Press"*. This offered a measure of relative espoused importance as compared with in-use importance (Argyris & Schön, 1974) of the various factors mentioned, and could also be linked back to the quantitative data. The coding schema combined entry and survival criteria recognising inertia as a factor, and separates out exit motives.

There were 13 key nodes and the relevant hypothesis is mentioned together with the theory supporting the node findings. Several hypotheses are not mentioned as they did not surface during the interviews.

Node title	Number of mentions	Hypothesis number	Major linking theory
1. Financial factors	37	H1	Resource Dependency
2. Macro-economic factors	33	H1	Resource Dependency
3. Knowledge/Capabilities	30	H5	Dynamic Capabilities
4. Legitimacy	21	H1	Resource Dependency
5. Offshore-related factors	12	H1	Resource Dependency
6. Importance of partners	11	H4	Networks/Partnering
7. Sentiment	11	N/A	Behavioural Finance
8. Individual characteristics of managers	9	N/A	Untested as no access to this data
9. Innovation	9	H1	Resource Dependency
10. Exits	8	H6	Population Ecology
11. Technological changes	7	H1	Resource Dependency
12. Environmental issues	3	H1	Resource Dependency
13. Geology	1	H1	Resource Dependency

Table 8.4: Coding Nodes, Hypotheses and Theoretical Links

Each major node is analysed with a short discussion and a commentary on findings in the order shown in Table 8.4. Some relevant quotes are also included. The heading of each section also makes reference to the additional literatures on survival covered in section 3.8.

8.9.1 Financial factors: links to literature on financing and survival and environmental munificence

"The City wasn't sophisticated ... look at X?"

"There was a view that the independents were 'worth a punt' as expressed by an equity investor."

"Technical advances have kept costs down compared with the North Sea."

There were twenty-one sub-nodes in this section grouped into three main bands:

"*City effects*", "*Costs*" and "*Capital Structure*". The three key nodes in the City section were: "*Financial punt*", "*City portfolio interest*" and "*Easy for stockmarket to understand*". At the same time, the two significant nodes in the Costs section were "*Layering of bureaucracy and costs*" and "*Lower costs than offshore*" and the significant node for capital structure was "*Can't raise debt*".

The investment model is clearly paramount for the small oil firms (Pollio, 1999). This allows us to look behind the quantitative measures and explore some of

the sentiments and perceptions behind them. Supply of capital is critical for all small businesses, especially capital-intensive ones like natural resources. The removal of layers of costs is discussed in the economic literature as agency theory (Jensen & Meckling, 1976) and comparative cost advantage for investments is analysed by Boone (2003). The importance of capital structure to survival is indirectly covered in Myers (1993).

Transparency of information is clearly perceived as important, as is a risk spreading or portfolio approach. De-layering of costs is perceived as an important inhibitor of survival - small organizations can ill-afford the luxury of expensive regulatory costs. The idea of onshore production as a low-cost alternative to offshore production and the use of tax breaks by Canadian firms were also interesting findings. Finally, the problem with ongoing financing, located in the "*Can't raise debt*" grouping and made by three informants, adds a dynamic perspective to survival and a reminder that adequate financing is an ongoing requirement.

8.9.2 Macro-economic factors: linked to Environmental Munificence and H1

"Agency costs related to regulation are the biggest problem."

"The key event in onshore terms was April 1986 and the withdrawal of PRT relief - firms had existing commitments so they left up to 2 years later."

"The Wytch Farm sale was a critical incident."

There were two groupings of concepts: *"Oil price"* and *"Government effects"* comprising *"Tax"; "Wytch Farm disposal"; "License awards"* and *"Over regulation".*

These follow important selection factors from the literature including Sadorsky (2001) on exchange rates, crude oil prices and inflation; Papapetrou (2001) on oil price and stock markets and Kemp & Crichton (1979) and Doroodian & Boyd (2003) on oil price, inflation and tax. These references would suggest that "*Oil price*" should be the most important criterion, but it was overshadowed by "*Tax*". Tax has been a major influence especially on small firms " ... *the proposed change in the fiscal regime (in 1986) makes planning difficult for small companies*"[39], when the changes in the mid 1980s caused a mass exodus from the industry. Those informants who focused on oil price were either from very large firms or very small ones and, with one notable exception, were not finance people. They were also with the same exception the more experienced members of the informant group.

"Tax" split into three sub-nodes, the largest of which was "*Petroleum Revenue Tax*" ("PRT"), the tax paid on oil or gas production which could be offset against

[39] Tod Floyd, Chairman of one of the firms in this study, quoted in the Financial Times, 23 March 1985.

exploration expenditure for a part of the period under consideration. Not surprisingly this was important to the finance professionals. Tax was dominant because of its immediate impact on mature production. Given the high marginal rate of well over 70% for most of the period, this was an issue for all firms which had additional offshore production and those which were Wytch Farm members.

One informant complained bitterly about over-regulation, sending me a follow-up clipping - interestingly this person had been involved with very small firms where agency costs associated with regulation would have been disproportionately large.

One unsuccessful bidder, three finance people and an informant working as an industry supplier at that point mentioned the Wytch Farm disposal. As an event that constituted the start of the industry and a recycling of an attractive asset, only four informants chose to mention it, but two others had been involved with it and knew of my involvement in the sale so may have thought it implicit.

8.9.3 Knowledge/Capabilities: linked to the Dynamic Capabilities literature and to the discussion on evolution in Chapter 3

"…. (A) big name has cachet by association – bootstrapping."

"…. control of the seismic and geology and being operator at this time controls (the firm's) destiny. Being (an) operator during drilling is time consuming – so less to gain."

"Partners are important so is the operator in (the) group structure."

The "*Knowledge*" node was split into two areas, "*Capabilities*" and "*Interest*", the latter representing a desire to acquire knowledge. Also included in this grouping were "*Importance of operating capability*", "*Build on existing capabilities*" and "*Interest relating to significant/contiguous/trend discoveries*".

Becoming an operator is a mark of distinction and acceptability in the industry (Meyer & Rowan, 1977), so it is not surprising that it was mentioned by all bar one informant. Ironically the one who didn't mention it heads a very successful operating group offshore in the North Sea. It also links to the next node on legitimacy, but has been treated separately as the context of these comments has been the acquisition of the technical knowledge to become an operator.

Capability development is unsurprising. The literature on the Resource Based View of the firm and the development of capabilities is vast and touched on in Chapter 3, as is the part of it devoted to learning and improvement/ enhancement of existing capabilities, e.g. Levinthal & March (1994).

The third grouping relates to the specific acquisition of intra-industry knowledge. When information about wells already drilled is released into the public domain, it can enhance the understanding of a firm's field interests by providing information about the geological structure of nearby oil deposits. It is not

surprising that in a secretive industry this node is considered important. Capability enhancement to gain recognition and status, organizational learning and information asymmetry management are probably the key challenges to smaller firms in this industry.

8.9.4 Legitimacy: linked to literature on ecology and evolution

"There were feeding frenzies. Onshore was a specific area for many firms, e.g. ABC – (Mr) ABC was the broker to XYZ so ABC (Petroleum) was a copycat firm."

"It was important to do things the few influential brokers and journalists wanted/expected you to do."

This node was split into four groupings. The first, "*Imitative effects*" is linked to isomorphism from organization theory/sociology and the institutional theory views of (DiMaggio & Powell, 1983) as well as the rules of the game, (North, 1990). There are two effects here, the competitive isomorphism suggested by Hannan & Freeman (1977) and the other forms of institutionally driven isomorphism resulting form the institutional environment associated with increasing bureaucracy suggested by DiMaggio & Powell (1983). The second grouping covers "*The effect of the majors*", linking to dominant coalitions (Said, 1976; Pfeffer & Salancik, 1978). The third sets out the "*Importance of journalists and the City*", though this was not explicitly mentioned as a legitimising force[40]. Finally, this node includes "*Density dependence*" effects (Hannan & Carroll, 1992) as a legitimising device.

Peer pressure and isomorphism are widespread in this industry. A dominant coalition effect is also observable in the quantitative data relating to the Wytch Farm firms. Another interpretation of dominance can encompass key individuals. Certainly partnerships in bidding rounds could often be explained by considering a common career heritage or personal links.

Tangible evidence of the power of the majors is less obvious in this population, but certainly in the much larger exploration industry, which is not the subject of this study, the exit of the majors following failure in planning enquiries to drill wells opened up the competitive landscape for smaller players in two distinct ways. The first route recycled acreage as a result of *"materiality"* also discussed in the quantitative data chapters, Chapters 7 and 9. For some of the majors onshore production was only marginally attractive as an investment, so it was a low priority or not material. This affected their partners, often smaller firms, and also those in contiguous acreage as information was not available. The exit of the majors therefore, provided opportunities for smaller firms to thrive and developed future operators as experience was gained by smaller firms. The second route was through offering opportunity by choosing new partners in new licenses.

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[40] Included because I expected it to be addressed – the Press are significant stakeholders in the fate of small firms.

Although the majors were reportedly seen as dominant, it is interesting to speculate on whether that has remained true as the industry matured and the majors concentrated in the Wytch Farm field. Certainly newer firms seem to be less isomorphic and more concerned with building networks.

The Press are a powerful stakeholder for small firms, and the lack of references was interesting. My past experience was that smaller firms courted any publicity to keep their name in front of investors, and that management of the Press was a powerful force in maintaining investor support.

Density dependence effects were thought to exist, described as *"feeding frenzies"* in one interview, and were specifically concurred with by five of the informants. One had an interesting view relating to information diffusion and the proliferation of firms, commenting that some external stakeholders in firms, e.g. stockbrokers, set up firms once they saw success for their clients. As part of their advisory role, they would, of course, have had access to information normally denied to external stakeholders, and thence been favoured concerning the prevailing industry secrecy.

8.9.5 Other Offshore-related factors

"Onshore was really a stepping-stone to offshore."

"Small firms that got to finding oil either used onshore as launching pad for money, or the North Sea (offshore) with bigger fields... (but) then onshore became immaterial (and) so they so left... (and) so the next generation enters."

This node was split into three groups, "*Route to Offshore*", "*Different from Offshore*" and the largest, "*Stepping-Stone to Offshore*"[41]. The latter was mentioned by all informants, some more than once.

As might be expected from the relative costs bases (offshore costs are many times more expensive than onshore) informants claimed that they used onshore as a stepping-stone to offshore. The idea of the stepping-stone also links to legitimacy as far as policy-makers are concerned. By developing a relationship with the industry gate-keepers (Department of Energy, now Oil and Gas Directorate) and achieving operator status onshore, favour may then be shown for offshore applications or future onshore applications. Certainly sanctions appeared to be imposed for rule breaking by participants in the offshore industry[42].

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[41] The difference between a route to offshore and a stepping-stone to offshore lies in the subtlety of intent. "Route to offshore" covered situations where the onshore presence was merely about gaining skills to enhance credibility with the regulator for offshore license awards, more akin to 'badge collection/validation'. "Stepping-stone to offshore" was a longer involvement and included the development of capabilities and relationships to take offshore including becoming a field operator.

[42] Though not formally covered in the Press, a major US oil firm upset an adjunct of the Department of Energy by purchasing a rig from outside the UK rather than a domestically built one, thus dropping the "local content" of the project. The license partners were very upset that

It was not possible, using this data, to test the suggestion that onshore experience assists offshore license seeking legitimacy, though industry informants felt it was a criterion.

8.9.6 Importance of partners: linked to Partnering/merging in the Literature Search and to Size Proxies via H4

"A sleeping partner (is) okay if (they) come up with (the) money; (a) problem partner is one who doesn't."

"... (partners are) very important – (it is) hugely significant who you are in bed with – (it) gives you credibility."

As a result of my earlier research at Cranfield, I fully expected this to be ranked very highly - it is covered by H4. However, there were fewer references than I expected, although all informants with one exception mentioned partners. The exceptional informant was probably less involved with the day-to-day management of partner relationships.

Selecting the right partner is a contributor to the success of an organization's activities according to a number of authors, (Berg, Duncan & Freedman, 1982; Killing, 1983; Harrigan, 1985; Beamish, 1987; Geringer, 1988). The partner selection decision is also part of a greater strategic choice by the organization (Child, 1972; Killing, 1983). Child notes that people (not organizations) take decisions that are informed by prior perception and evaluation processes. This reconciles the executives' characteristics (e.g. risk propensity) with the industry characteristics using a cognitive viewpoint.

The quantitative data suggests partnerships are more important than the interview data records. This could be because of power issues inside partnerships - weak partners that do not meet their obligations in a timely manner are a source of friction in many partnerships. It may be a perceived mark of success that a firm does not need to share its license. This is an area to explore further with the proposed follow-up Delphi Study, or possibly using a policy capture model (Hitt & Middlemist, 1979; Hitt & Tyler, 1991).

8.9.7 Sentiment: not addressed in this study, but may be covered in follow-up study

"All this (referring to tax changes) influenced sentiment and the 'capitalization of future romance'. Once firms stop doing things other people think are romantic, (they are) vulnerable to takeover... "

"X thought he was a bit in love with the field. He enjoyed ownership of the project - proving he could make money out of it."

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they would be included in the "freeze" thus prejudicing future license applications. The author was invited to help in the mediation process.

This node had two sub groupings: "*Expectation*" and "*Romance*"; it relates to perceived behaviour. Expectation looks to Prospect Theory (Tversky & Kahneman, 1985) and framing future decisions. The romance node draws on emotions and lies outside the scope of this thesis – it also partly relates to an earlier hypothesis about investors falling in love with specific assets which has links to behavioural finance (Ackert, Church & Deaves, 2003) and may be covered in a follow-up study.

Four informants did not discuss this node – of those four, three have now effectively left the UK onshore industry, as a result of restructuring or hostile take-overs though they remain active in the UK oil industry. Those informants who did discuss sentiment have a surprisingly upbeat image of survival and sentiment (see above). Sentiment must be important to convince investors and maintain the flow of money to support a firm until first revenues appear.

8.9.8 Individual characteristics of managers: links to literature on ownership/entrepreneurship and leadership and survival and to strategic choice discussion in Chapter 3

"In the 1970s and 1980s, Boards were technical people - geologists/engineers, all others were support people. In (the) 1980s (they were) taken over by (the) finance people – (the) industry changed so (the) new people coming in never had entrepreneurial example. Geologists nowadays have to be constrained by discounted cash flows etc – red tape = layers on top."

"Independents are idiosyncratic - dealmakers – take their character from the guy running it. Need to be entrepreneurial."

There were five groupings in this section: "*The desire for independence*", "*The possibility of personal wealth*", "*The possibility of owning a significant stake in the business* ", "*The gambling instinct*" and "*The importance of a vision.*"

Does the nature of individual managers impact on a firm's survival? Child (1972) suggests that managers are important and can influence a firm's fate. In a more recent paper (Child, 1997, p.68), he stresses again the importance of intentionality. There is a large body of research into the areas of leadership and top management teams (Goold & Campbell, 1987; Schneider, 2002) which discusses the criticality of vision and mission statements, though the latter was only mentioned once, surprisingly in my view.

The interview data suggests that these characteristics were not especially highly rated in terms of responses to the interview protocol, which does not dwell on the role of the internal team, but on survival of the firm. Many of the individuals interviewed are flamboyant characters, and may well have perceived survival of the firm to be related to their presence as key individuals, but this was not explicitly articulated – perhaps because it was thought to be a tacit understanding in their selection as informants, or possibly modesty. Again, bearing in mind that many of these firms have small numbers of employees, the vision may have been shared in a less formal or conscious way, explaining its

low reported priority. There is no access to data on individual firms at this point, but anecdotal and personal evidence suggested that share options form an important part of packages for employees, thus offering the possibility of the significant gain in personal wealth referred to by informants.

The link back to the research model and hypotheses lies in resource dependency theory and the leader, especially in a small firm, as standing *"in loco"* firm. Thus, the leader acts as the legitimising face of the firm as it interacts with its stakeholders and its external environment.

8.9.9 Product Innovation[43]

"Use (depleted) gas fields as gas storage."

"For CBM (you need to) drill into coal measures, then fracc, then de-water, then produce… (but)… nothing (has been) produced as yet. (It) works in US, but coal different there… Fraccing costs in UK also very expensive."

This is not the same as the technological innovation variable used in the quantitative study. Innovation in this context means new sources of potential oil and gas development, other opportunities, and changes to regulation allowing the development of shut-in gas fields once British Gas' monopoly role was ended. Groups in this node reflect new developments and the interest to incumbent players and include "*Gas Deregulation*" and "*Coal Bed Methane*" (CBM), also incidentally the name of one of the population firms.

The number of producing gas fields has increased since gas purchase was liberalised and combined cycle gas fired power stations came on stream providing electricity to business users. The presence of Scottish Power in the population is directly linked to this event, which also had significant impact on small, marginal and hitherto undeveloped offshore gas fields.

CBM production remains a future development. Firms entered the exploration industry once the licensing authority declared that this form of resource extraction would be pursued, but few have progressed to true CBM production as yet, as the US experience on which the geological assumptions are based is quite different from that found in the UK to date. It was hoped that old mine sites would offer CBM possibilities, but so far all that has been produced has been trapped mine gas.

8.9.10 Exits: links to selection, ecology and the mortality/exit literature and H6.

"Firms exit post April 1986 (when) onshore tax relief vanished."

"(… exit because of the) collapse of (the) oil price pre 1986 - in real terms pre 1984 – (led to) slow decline and collapse – some firms on life support."

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[43] NB: this has a different definition from that used in H1 and is not covered in the literature.

Closely linked with H6, this node includes "*Supply of Assets for Next Generation*[44]"; "*Ran Out of Money*"[45]; "*Acquisition for Offshore Assets*"; "*Acquisition for Expertise*" and "*Exit from Business*"[46].

Thompson (1967) and Pfeffer & Salancik (1978, p.108) refer to buffering as a mechanism for managing shocks, including those that may lead to exit. Agarwal & Gort (1996) link exit to the stage of market development and Carroll & Hannan (2000) also explore entries and exits of firms.

Many informants felt exits were covered in earlier questions on survival and thus did not specifically address this. The "*Supply of Assets for the Next Generation*" grouping is important as it explains the counter-intuitive finding in the quantitative data that the industry population size rises after a major selection event. This is because the space freed on the competitive landscape becomes open to colonisation from a larger number of smaller entering firms or to exploration/exploitation by incumbents.

8.9.11 Technological changes: links to Specific Literature on Technology, Survival and Environmental Munificence (H1) as well as the next node on Environmental Issues

"Technology is important – directional drilling, e.g. horizontal drilling, in the 1980s, was critical in the management of the environmental issues. 3D seismic was claimed to be a breakthrough. Horizontal wells improved productivity."

Technological changes took four distinctive forms:

- Directional or deviated drilling, where many wells could be drilled from one site, thus making the field more environmentally acceptable to locally resident stakeholders and environmental pressure groups;

- 3-Dimensional seismic, whereby as a result of increased computing power, a more accurate and multidimensional picture of the shape of the oil reservoir can be generated. Wells can be located in better positions for more efficient resource recovery;

- Cheaper computing power has allowed tools for 3D seismic and reservoir simulation to become available on local desk top machines as opposed to expensive main frame computers;

- Greater certainty concerning reserve assessments and costs, the latter permitting more wells to be drilled.

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[44] This node reflects the disappearance of firms opening up opportunities for a future generation of firms to enter and colonise the competitive landscape.
[45] This node was the result of two mentions by a finance–specialist informant.
[46] The two acquisition nodes refer to firms being the subject of acquisition for either offshore assets contained elsewhere in the firm grouping or for their expertise.

These four forms also link product innovation, technological innovation and the next two nodes of the environment and geology. Suarez & Utterback (1995) claim that the competitive environment of an industry, and therefore the survival of firms in it, is substantially affected by the evolution of the technology on which it is based. Kauffman (1995) also discusses the importance of innovation to provide escape from the *"Red Queen Effect"* on the competitive landscape.

The perception of the informants is that technology is linked to survival. Not surprisingly this area was of interest to the two most technically oriented members of the informant group, but also to one of the finance people with significant offshore experience and involvement with the initial introduction in the UK North Sea of some of the innovative techniques.

Technical staff were perceived to have lost ground to financial specialists in the hierarchies of oil firms in the UK, which may also explain the relatively low ranking of this topic.

"... geologists and related colleagues benefit tremendously from studying analogues in the field, although regrettably, many managers view these events more and more as rest and recreation rather than education. In addition as the current management philosophy allows more decision-makers with non–geological backgrounds to assume control of exploration aspects, then this attitude will only be strengthened...

A return to the rocks, in order to evaluate the more complex integrated solutions properly, will be shown to be an absolute necessity."

John Church in Moreton (1995, p.121).

8.9.12 Environmental issues: covered in Environmental Munificence and H1

"Shell (left after the) New Forest veto. Planning and public enquiries – some people (who are) able to charm farmers, etc., keep reappearing."

"(The) drilling at Ditchling Beacon (resulted in a) public outcry by....Vera Lynn."

By the time production begins, environmental problems should have been overcome. However, this node is critical to an understanding of the population movements in the larger UK oil industry, including the separate exploration population which is driven by very different industry dynamics. Two informants split this topic out separately, perceiving environmental issues as a potential barrier to survival. In one case the informants had partnered an oil major exploring in the South of England near well-known landmarks, and the major had subsequently left the onshore industry. In the other the informant had been involved previously with a different mineral extraction industry, and may thus have been sensitised to the issue.

In his introductory chapter, Huxley (1983, pp.4-5) introduces the issue of the environment and its importance, reminding us that even in the 1970s it took six years to bring Wytch Farm from discovery to first production. He also charts some of the issues that have surfaced over the years; the Hatfield Moor well blow-out was on television for several nights, and the influence of US television programmes such as *"Dallas"* and *"Dynasty"*, with pictures of messy crude oil and large rigs, caused local residents to react adversely to planning applications for drilling or production. Environmental issues are complex; the long stakeholder list was mentioned in Chapter 5 and these relationships are expensive to manage, even for major firms. Thus, when a planning decision went against Shell, the company's response was to leave the industry.

Environmental issues are important – they are linked to technology through environmental management techniques, such as the directional drilling mentioned as a component of the environmental and technological innovation variables in the quantitative study. On a small island like Great Britain most onshore oil or gas is close to someone, and an ownership structure whereby the landowner has no formal compensation rights can cause problems. Indirectly, smaller oil fields use tankers to move oil, increasing road traffic on small, crowded country lanes, thus involving a wider community of stakeholders in any decision, with more expense for the oil firm.

8.9.13 Geology: linked to Resource Dependency Literature

This was one of the biggest surprises in the interview data, with only a single mention about geology in the context of the potential of smaller fields, from an informant from one of the longer-term surviving firms.

This could be explained by tacit assumptions that I would understand the geological importance and that it was implicit, or that the geology of a firm's licenses is not critical to firm survival, because by using other resources, e.g. money or partnerships, it is possible to escape from this restriction by attempting to buy-in to other more successful partnerships producing from better fields, albeit at a premium. Many of the informants had survived some very disappointing well results, then going on to find spectacular successes, so there may be an element of a perceived lottery about this.

8.10 Discussion

The interviews revealed good fit between informant perceptions, the choice of variables in the environmental hypothesis (H1) and the results of the pilot study and mostly supports subsequent main study findings. Finance and macro-economic variables dominate, suggesting a selection bias, but are closely followed by the discretionary adaptation effects of knowledge, legitimacy, partners and sentiment. Interesting, too, is the predominance of offshore-related factors suggesting opportunistic surveillance (Thompson, 1967). The informants may have been biased towards finance as their previous relationship with me was, of course, a financial one, so the issue of anchoring and adjustment (Slovic, Fischhoff & Lichtenstein, 1982) in this context cannot be ruled out. As a follow-up study it would also be interesting to see if the same

selection/adaptation bias was found in interviews in different functions in the firm – directors, especially of public firms, are focused on external measures especially given the paucity of loan capital available and the competition for funds from institutional equity investors, which may also account for the high rating of legitimacy.

Gottschalk, Kluckholm & Angell (1945, p.35) cited in Bryman (1989, p.198) offers a four-point checklist for accuracy of ephemeral data, which is applied to the interviews in Table 8.5 below:

> *Was the ultimate source of the detail (the primary witness) able to tell the truth?*
>
> *Was the primary witness willing to tell the truth?*
>
> *Is the primary witness accurately reported with regard to the detail under examination?*
>
> *Is there any external corroboration of the detail under examination?*

Table 8.5: Checklist for Accuracy of Ephemeral Data Applied to the Interviews (Gottschalk et al, 1945)

It is impossible to answer the first question, except to say that there was no apparent incentive to lie, and that there was remarkable convergence between all the interviews and with the quantitative data findings. This could be attributed to a common culture, essentially transcending firm culture (Trice & Beyer, 1993), and shared industry level culture (Porac, Thomas, Wilson, Paton & Kanfer, 1995). The answer to Gottschalk et al.'s last two questions is "yes" for this interview analysis. Even though the individual transcripts were not returned to the informants, there were several examples of each of the major categories of analysis, and as a triangulation method for the theoretically derived data it was satisfactory.

Turning to the first two, truth-telling is of course subjective, but there would be no obvious reason to distort answers to the interview protocol. It was screened by a lawyer active in the industry, whose brief was to check that it would not raise sensitive issues, or cause unease or discomfort for informants. Informants were chosen from different known social industry groupings, i.e. there were no obvious close linkages between all of them other than historic industry ties. Two pairs of informants had worked together in two of the firms in the population, but otherwise experience was widely spread. Only one was a snowball-style recommendation. Despite this, there was a remarkable degree of unanimity in the informants' views of the industry, allowing me to believe that the first two parts of Gottschalk et al.'s test were also met.

8.11 Conclusion

The interview process and results revealed other issues relevant to the main hypotheses, so a semi-structured approach paid off in terms of enriching the support data. It also eliminated an earlier hypothesis, by offering a different explanation to that inferred from raw data observation, offering a warning about archival exploration of secretive industries.

Perhaps the most surprising outcome was the perceived stress on finance, macro-economic factors and knowledge, as drivers of survival. Informant perceptions suggest that it is possible to mitigate selection effects via knowledge or legitimacy. The other surprise was the role of sentiment ranked equally with the role of partners. The overall impression left by these interviews with this set of informants is one of fatalism mixed with hubris – as leaders, managers are important, but the environment also governs survival.

The next chapter reviews the main quantitative study, where the approach was amended after the pilot and interview programmes had been completed .

CHAPTER 9: THE MAIN QUANTITATIVE STUDY

9.1 Summary

The main study was completed after the interview data, discussed in Chapter 8, was collected, and offered an alignment of the choice of factors and measures used with industry expert views. The hypotheses were refined and the statistical analysis was also more detailed for the main study, with the split between selection and adaptation issues explored. Following cluster analysis, a model of survival strategies is postulated, based on pilot data and the main study.

This chapter is laid out as follows: the transition from the pilot to the main study, findings of the main study; regression analyses; distinctive survival strategies found in this industry and conclusions.

9.2 The Transition from the Pilot to the Main Study

The pilot offered the first attempt to use data to test the hypotheses, and its findings, together with the results from the interview programme, resulted in several changes being made to the data analysis before the main study was undertaken.

Industry conversations had warned that the Wytch Farm field was exceptional and should be excluded, along with Wareham, its related field, so the data was excluded from the pilot study. However, feedback from fellow academics on the research suggested that analysis of the population including Wytch Farm should be included, to show how much of an outlier influence it was, and also to offer completeness.

Following the pilot, there was also a perceived need to resolve an issue in the data concerning over-representation. If a firm was listed as present in a producing oil or gas field then it was included in the pilot data, but several of the fields are to be found in a single license area.

An example may help illustrate the problem: a single license covers the three separate Kirby Misperton, Marishes and Malton fields and those fields are developed as a single unit by the same operating group of firms. To all intents and purposes, including meetings and other administrative actions, these fields are treated as a single one. Firms appearing in those fields, therefore would appear three times and thus be over-represented in the data if this was not controlled for in the dataset. It has been addressed in the data censorship section covered in Chapter 6, Table 6.8 and shown specifically in Appendix H.

Again considering the pilot results, a re-examination of the operationalisation of survival, prompted by Disney et al (1999), led to a decision to use *"normalised"* post-entry survival as the dependent variable to eliminate what was a group of very short-lived firms, and to understand the drivers for longer-term survival.

Having reached production, these transient population members were either operating harvesting strategies (Harrigan, 1985), or had increased value as takeover targets.

Survival is now represented as a presence in the industry after the entry year. This caused a number of firms be dropped from the population studied as they had only been present for one year, the year of entry. This changes the time bands of each population. Including Wytch Farm, the post-entry population time span is 1983-99 (16 years post-entry), but excluding Wytch Farm it runs from 1984-99 (15 years). Some additional data was made available on unit operating costs inside the industry, wells drilled and onshore production data. High offshore costs cause some distortion as offshore wells cost many millions of dollars to drill, so fewer are drilled each year. Onshore wells are considerably less expensive, but environmentally more sensitive. Data was also made available to categorise onshore wells: deviated wells which are drilled from a single site, and are thus less demanding of the environment, are a comparatively recent technological innovation.

The pilot also highlighted the importance of exploration and exploitation events and their link to survival, and prompted the detailed approach to H3 laid out in Chapter 4. The industry population aggregation used in the pilot study was dropped except for H6 as it was decided to focus on firm level data.

The main study includes several regressions looking at weighting of the selection variables compared with discretionary adaptation responses and the impact on cumulative survival to date and with lagged variables to reflect decision-making timing delays, presence or absence of a firm in a year by year analysis. For the regression analysis, the data was additionally coded into annual entries for each firm for each field with the appropriate selection and adaptation variables included in that line of the data table. An exit year was included, and data lagged by one year to reflect the time needed to effect strategic decisions, i.e. the time from information receipt to decision-making and implementation. Again, this mirrors my experience in the industry - entry and exit decisions, as well as discretionary adaptation events such as new fields or taking over the interests of a field partner, are not made quickly because the bureaucratic process requires approval from other partners and/or the relevant Government department. (More comments about regulation surfaced in the interviews discussed in the previous chapter). This more detailed dataset was used to complete a series of regression analyses to examine the balance of selection and adaptation factors for each firm for each year it was present in the population.

The pilot study used a proxy size measure relating to corporate structure, and ownership in the form of a coding variable for state-ownership, subsidiary, etc. As more data became available, an additional measure for the main study was created, looking at size as the amount of oil equivalent generated from a firm's total field interests in the UK onshore production industry. This manages the distortion found when subsidiaries of large firms such as Elf are viewed inside

the industry context alongside very small firms. In these cases it would be incorrect to view Elf as the integrated giant, as opposed to Elf (onshore production UK) since, because of the tax asymmetries discussed in Chapter 5, all firms are competing for survival on a basis relating to their asset position inside this industry boundary.

9.3 Findings of the Main Study

The findings are summarised in Table 9.1 and discussed in detail below. The strongest findings relate to H3 and H4, and suggest that exploration/exploitation strategies and firm level industry ties enable survival. There is limited correlation with exogenous factors, suggesting selection is less important than adaptation for survival in this industry.

Paraphrased Hypothesis	Results	Correlations/ Comments	Pilot Results for Comparison
H0: Size (access to resources) matters above all	Size appears to be important but influence of a few dominant players is significant	Size appears to be dominant, but there are key data structure issues to consider.	Inconsistent with hypothesis
H1: Environment/ selection influences survival	Oil price consistent across both of the populations	Oil price seems key as would be expected; but different story once Wytch Farm excluded	Oil price, Eurodollar rates and technological innovation negatively correlated. Existing field numbers positively correlated.
H2: Early birds survive longer	Inconsistent with hypothesis	First mover advantage seems not to exist	Inconsistent with hypothesis
H3: Explorers and/or exploiters survive longer	Consistent with hypothesis	Exploitation appears to be the key event.	Consistent with hypothesis
H4: Large numbers of intra-industry ties support survival	Consistent with hypothesis	Applies at firm level, though only limited support for the view that small firms use networks as size proxies.	Consistent with hypothesis
H5: Longer intra-industry experience promotes survival, as does legitimising behaviour	Consistent with hypothesis	Applies at firm level	Consistent with hypothesis
H6: Major external shocks shake out firms	Consistent with hypothesis	Appears to be supported	Consistent with hypothesis

Table 9.1: Findings of the Main Study

H0: Within the industry, the larger the firm, the longer it survives.

The two major changes from the pilot study are the removal of the large firm *"industry samplers"* that appeared for 1 year only in the pilot study, and the

inclusion of the new measure of size, based on oil equivalent production by firm for each year. To test H0 two approaches were used:

The data was measured by firm and a correlation run for the total amount of onshore oil equivalent the firm owned against the number of post-entry survival years.

Results	Including Wytch Farm	Excluding Wytch Farm
Individual Firms	n= 54	n= 46
Oil equivalent production	r= 0.640**	r= 0.617**

** = significant at the 0.01 level

Table 9.2a: Results of Correlation Analysis for H0, Main Study

The results are shown in Table 9.2a. However, there are several issues that need to be considered; the production data figures are incomplete. Wytch Farm figures were unavailable until 1987, so the larger, longer-surviving Wytch Farm firms would be even larger. The spread of firms is not homogenous, nor is the distribution of fields: there is a large drop in firm reserve size below 9.26 million barrels of oil equivalent. When cases where size > 9.26 million barrels were excluded, the correlation between post-entry survival and firm size fell to r= 0.342, n= 43 for the Wytch Farm population excluding the longer lived Wytch Farm members and BG. For the non-Wytch Farm population, the results were r= 0.373 for n= 43, both weakly significant at the 0.05 level. The problem of research conclusions drawn where there may be effects of such dominance, particularly with respect to industry versus firm effects, is addressed in Hawawini et al (2003).

The measure used in the pilot, whereby individual firms are coded for organizational type and public/private/state/subsidiary are used as proxy variables, was also repeated, with the results shown in Table 9.2b. The category of public firms also includes privatized firms, since this change took place close to the start of the period of the study.

Measures	Including Wytch Farm	Excluding Wytch Farm
1. Number of firms in population	54	46
2. Average no of post-entry survival years	4.15	3.28
3. Number of public firms in population	29 (53.7%)	23 (50%)
4. Average no of post-entry survival years	4.28	3.3
5. All firms surviving 4 years or less	72.22%(39)	73.9% (36)
6. Public firms surviving 4 years or less as % of line 5	56.4% (22)	52.77% (19)
7. All firms surviving 6 years or more	20.37% (13)	15.21% (9)
8. Public firms surviving 6 years or more as % of line 7	76.9%(10)	77.78% (7)

Table 9.2b: Publicly-listed Firms as Constituents of All Post-entry Surviving Firms

Publicly traded firms comprise 53.7% of the population and mirror the population distribution well for firms that survive for shorter periods. They are considered to have easiest access to capital. As firms survive longer, however,

they need to have access to capital, and are more likely to become a public firm. Closer inspection in Table 9.2c shows that public firms also polarise into two groups when measured by size.

Measures	Including WYTCH FARM	Excluding WYTCH FARM
1. Number of public firms in population	29	23
2. Public firms surviving 4 years or fewer	21	18
3. Average reserves public 4 years or fewer	1.87	0.3533
4. All firms surviving 6 years or longer	8	5
5. Average reserves public 6 years or longer	19.675	3.854

Table 9.2c: Average Reserves (size) of Publicly-listed Firms and Survival

From this it is clear that many of these firms, though public, were very small in terms of size of reserves. It may be that they failed to demonstrate the *"capitalisation of the romance"* mentioned by one interview informant to generate adequate returns from this industry. The results suggest that there is a relationship between larger public firms and longer survival periods, but the causality is unclear and this data does not permit further investigation.

Once the dominant firms are removed, this hypothesis is weakly supported.

H1: Within the industry, the more munificent the environment, the larger the number of firms that survive.

This hypothesis tests an expanded number of key selection factors for survival based partially on findings from the interviews and also as a result of more metrics becoming available. Numbers of firms surviving in the population each year were examined against the exogenous variables shown in Table 9.3:

Variable	Measurement
Macro-economic:	UK GDP; IMF cost base.
Finance:	Eurodollar rates; UK base rates; $/£ exchange rate.
Technology innovation rate:	Proportion of vertical to deviated wells drilled each year.
Environmental effects:	Proportion of deviated wells to all wells drilled.
Industry climate variables:	Oil price; maximum tax; number of producing fields; total onshore production; drilling rig supply; number of wells drilled each year; number of wells drilled to date; industry operating costs.
Industry Finance:	Equally weighted sector betas; market capitalisation of the oil sector.

Table 9.3: Exogenous (to firm) Variables for the Main Study, H1

The full correlation tables are shown in appendices M and N.

There were relationships between the size of the total post-entry survivor population and variables shown in Table 9.4a:

Correlation	Population with Wytch Farm	Without Wytch Farm
Negatively with maximum tax	(r= - 0.537)*	Not significant
Negatively with crude oil price	(r= - 0.765)**	(r= -0.624)*
Negatively with Eurodollar rates	(r= - 0.655**	Not significant
Positively with onshore production	(r= +0.566)*	Not significant
Positively with existing onshore field numbers	(r= +0.653)**	Not significant
Negatively with equally weighted stock market betas	(r= -0.548)*	Not significant
Positively with the number of wells already drilled	(r= +0.712)**	Not significant
Negatively with technology innovation rate	(r= -0.730)**	Not significant
Positively with environmental effects	(r= +0.633)**	Not significant
Positively with the IMF cost index	(r= +0.629)**	Not significant

** = significant at the 0.01 level; * = significant at the 0.05 level.

Table 9.4a: Correlations Between Post-entry Survivor Population levels and H1 variables, Main Study

The differences between the population including the Wytch Farm fields and that excluding them are striking in as much as the impact of the 12 Wytch Farm member firms and their apparent susceptibility to selection pressures is very visible. One explanation for this might be that for these firms, mostly the subsidiaries of international major oil companies, Wytch Farm as an investment ranks alongside other major fields and thus the investment is assessed using the criteria described at the end of Chapter 5, notably oil price, time to recoup investment and absolute size of the oil or gas field. For the other smaller firms, there may not be investment choices hence the lower susceptibility. The negative relationship with oil price is no surprise for both populations, and mirrors the pilot study results. Similarly, funding costs and the oil price will affect materiality issues for large firms making marginal small onshore fields unattractive and opening up the competitive landscape to more, newer, smaller firms. Tax is less important to all fields other than Wytch Farm, so the absence of tax in the second column is no surprise – its significance is only at the 0.05 level for the group including the Wytch Farm firms.

A second group of positive relationships pertains to industry climate – this would include field numbers, onshore production, wells already drilled. It is probably to do with perceived industry attractiveness, possibly mirroring density dependence effects (Delacroix & Rao, 1994; Lomi, 2000). The field numbers variable was significantly correlated in the pilot.

Costs are clearly critical as a part of the investment decision, cf. Pollio (1999).

Technology innovation rate and environmental issues are of significance to the industry, see Chapters 6, 7 and the interviews, but only technology innovation rate was found as a significant variable in the pilot study.

A regression model using selection variables alone was not tested at this stage.

These results are an expanded version of those from the pilot study discussed in Chapter 7. The pilot data analysis also suggested that consideration be given to lagging the variables by one year to reflect decision times, shown in Table 9.4b:

Correlations with number of post-entry survivors	With Wytch Farm lagged one year	With Wytch Farm unlagged data	No Wytch Farm lagged one year	No Wytch Farm unlagged data
Negatively with maximum tax	--	(r= -0.537)*	--	--
Negatively with crude oil price	--	(r= -0.765)**	--	(r= -0.624)*
Negatively with Eurodollar rates	(r= -0.675)**	(r= -0.655)	--	--
Positively with onshore production	(r= +0.533)*	(r=+0.566)*	--	--
Positively with onshore field numbers	(r= +0.594)*	(r=+0.653)**	--	--
Negatively with equally weighted stock market betas	--	(r= -0.548)*	--	--
Positively with the number of wells already drilled	(r= +0.572)*	(r= +0.712)**	--	--
Negatively with innovation	--	(r= -0.730)**	--	--
Positively with environmental effects	--	(r= +0.663)**	--	--
Positively with the IMF cost index	(r= +0.580)*	(r= +0.629)**	--	--
Positively with $/£ exchange rates	--	--	(r= +0.597)*	--

** = significant at the 0.01 level; * = significant at the 0.05 level.

Table 9.4b: Correlations between Post-entry Survivor Population Levels and H1 variables lagged for one year, Main Study

This hypothesis is supported with limitations arising from the small dataset (n= 16 and 15 for the Wytch Farm population and non-Wytch Farm population respectively. It is supported for the population including Wytch Farm, but not supported for the population excluding Wytch Farm. This suggests that exogenous variables, other than alternative investment strategies linked to interest rates, and possible cashflow linked to conversion of dollar based oil revenues into sterling for costs, are of lesser importance for these smaller firms.

H2: Within the industry, early entrants are more likely to survive for longer than later entrants.

In the pilot study, the population was divided into three waves of six, six and five years and the composition of each wave was linked to the time line shown in Chapter 5. The difference in the new wave compositions is that the ranges allow for time for the various adverse selection events discussed in the

interviews to have had an impact. The more conventional hazard rate modelling is less straight forward as the nature of the data makes it complex (it is not all right censored). A Cox hazard rate study (Blossfeld & Gőtz, 2002) could be included in follow-up work for completeness.

For this study, the four waves shown in Table 9.5a and 9.5b were used:

	New survivors during period	Average life of survivors during period (adjusted figure in brackets)[47]	Survivors to next period	Exits
1983-1987	18	5.61 (1.40)	18	0
1988-1991	15	5.13 (1.71)	32	1
1992-1995	6	3.90 (1.95)	26	12
1996-1999	14	1.78 (1.78)	30	10

Table 9.5a: Four Wave Periods and All Survivors including Wytch Farm, H2 Main Study

The third wave was characterised by low entry rates as a result of lower oil prices and a slow conversion of exploration prospects into production. However, by the fourth period the impact of new gas deregulation is showing, and so the population of producers rises once more. This approach, though very simplistic, shows clearly that first mover advantage does appear to exist.

For the industry excluding Wytch Farm, the results are similar (three of the original entrants survived into the third wave) though the balancing point of the industry life-cycle can now clearly be seen in the last period, despite new fields being added.

	New survivors during period	Average life of survivors during period (adjusted figure in brackets)	Survivors to next period	Exits
1984-1987	15	6.3 (1.57)	15	0
1988-1991	14	4.5 (2.25)	28	1
1992-1995	6	3.0 (1.5)	23	11
1996-1999	11	1.72 (1.72)	22	12

Table 9.5b: Four Wave Periods and Survivors excluding Wytch Farm, H2 Main Study

The adjusted averages for each period suggest a slight improvement in survival after the first period for both populations, continuing with the third period for the population including Wytch Farm population. This would suggest that first mover advantage is outweighed by knowledge gained from observation of strategies of first movers.

A correlation between the entry year and the number of post-entry survival years was also run. This is highly negatively correlated, as would be expected following the pilot results (r= -0.510), significant at the 0.01 level for all firms

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[47] In order to compare by in effect adjusting for a probability of survival, the averages were multiplied by ¼, 1/3, 1/2, 1 respectively for periods 1983-87; 1988-91; 1992-95, 1995-99 for both populations.

including Wytch Farm and (r= -0.350), significant at the 0.05 level for the non-Wytch Farm
firms. For the populations, entrant numbers and surviving firm numbers are (r= -0.618) and (r= -0.747) for with and without Wytch Farm respectively.

Entry in early years, examined by cross tabulations of entry year with number of post-entry years of survival, only seems to be associated with longevity for the Wytch Farm firms and not across the population (both with or without Wytch Farm firms) being seemingly scattered randomly throughout the populations.

There is also a slight bias towards entry by acquisition and longevity in the Wytch Farm population.

The later the firm enters the less chance it has of surviving for a longer period. Kaplan-Meier plots (Lee, 1992), referred to in the SPSS™ *"Advanced Statistical Analysis Manual"* dated 1999, suggest some small advantage may exist for firms entering in years 1985 and 1989 for the non-Wytch Farm population.

To conclude, therefore, early entry does not appear to confer survival advantages other than incumbency rights in attractive investments, e.g. Wytch Farm, which would support survival.

H3: Within the industry, the greater the total number of exploration plus exploitation activities executed by a firm at the investment level, the longer it survives inside the industry.

H3 i: Within the industry, the greater the number of exploration activities executed by a firm at the investment level, the longer it survives inside the industry.

H3 ii: Within the industry, the greater the number of exploitation activities executed by a firm at the investment level, the longer it survives inside the industry.

Exploration activities are post-entry year entries or exits to or from oil or gas fields and exploitation activities are increases/decreases in individual oil or gas field interest. The post-entry year is to control for cases where a firm enters through acquisition and starts off with multiple investment sites. Exploration and exploitation activities and their totals are correlated with the survival years of each firm.

Results	Including Wytch Farm	Excluding Wytch Farm
Individual Firms	n= 54	n= 46
All Exploration/ Exploitation Events	r= 0.534**	r= 0.709**
Exploration Events	r= 0.490**	r= 0.713**
Exploitation Events	r= 0.416**	r= 0.819**

** significant at the 0.01 level

Table 9.6: Correlation between Number of Post–entry Survival Years and Total Number of Firm Exploration and Exploitation Events as well as the Number of Events in Each Category, H3 Hypotheses Grouping

The results are shown in Table 9.6. For the individual firms, the results of r= 0.534 and r= 0.709 also show a stronger link to exploration and exploitation events respectively. H3i and H3ii are each dominant for one of the populations.

There is no correlation between entry year and number of exploration or exploitation events completed by individual firms, suggesting that year of entry has no influence on a firm's propensity to develop this capability. However, the average number of these discretionary adaptive events is correlated with post-entry survival years for each firm for both populations (r= 0.293, significant at the 0.05 level for the Wytch farm population and r= 0.627, significant at the 0.01 level for the non-Wytch Farm level respectively), suggesting the link is spread across the years of participation.

March's (1991) conclusions concerning the importance of exploitation over exploration are unconfirmed in as much as exploration events dominate in numbers. Exploration events are also the first type of event that firms in this industry complete. However, March is supported in as much as the exploitation events completed are more closely linked to the number of years a firm survives inside the industry, possibly as a result of successful asymmetry of information management (Pfeffer & Salancik,1978). It is a less risky investment decision to seize the opportunity to buy more of an asset in which an incumbent has detailed *"insider knowledge"*, than to risk a new investment with limited access to information. In work in press, Massini, Lewin & Greve (2003) argue that most firms do little or no exploration and very few are early adopters or imitators. This view is supported by this study where some 44% and 37% of the Wytch Farm and non-Wytch Farm firms respectively complete neither exploration nor exploitation events, possibly arising from the *"efficiency of inertia"* discussed by Nickerson & Zenger (2002).

Chang (1996) suggests a firm's experience from entry and exit decisions affects future behaviour – this argument appears to be extended here where a few firms get into the habit of completing these discretionary activities and appear to survive longer (see also 9.5 in this chapter). Levinthal & March (1993) point out the dangers of competency traps with too much of one activity at the expense of another.

H4: Within the industry, the greater the number of a firm's intra-industry ties, the longer it will survive inside the industry. Smaller firms will be predisposed to use large numbers of ties to enhance survival.

In this hypothesis the total number of intra-industry ties for each firm is correlated with its post-entry survival years. In an industry where partnering is the norm, this would be expected to be high. The data was mapped as shown in the partial example in Table 9.7a.

Summary	AltaQ	Altwood	Ambrit	ARCO	Arcon	BG	Blackf	Blackl	BP	Britoil	Cairn
1983	0	0	0	0	0	1	0	0	1	0	0
1984	0	0	0	0	0	1	0	0	6	0	0
1985	0	0	0	0	0	5	0	0	10	6	0
1986	0	0	0	0	0	5	0	0	10	5	0
1987	0	0	0	0	0	6	0	0	18	5	0
1988	0	0	0	0	0	6	5	0	27	10	0
1989	0	0	0	5	0	5	4	2	21	0	0
1990	0	0	4	7	0	8	0	4	14	0	2
1991	0	0	4	7	0	6	0	4	10	0	2
1992	0	0	4	5	0	6	0	4	7	0	1
1993	0	0	0	5	4	1	0	3	5	0	4
1994	0	0	0	5	3	0	0	0	5	0	11
1995	0	0	0	5	3	0	0	0	5	0	11
1996	0	1	0	5	3	0	0	0	5	0	9
1997	0	2	0	5	0	0	0	0	5	0	4
1998	3	2	0	5	0	0	0	0	5	0	0
1999	4	4	0	5	0	0	0	0	5	0	0
Total	**7**	**9**	**12**	**59**	**13**	**50**	**9**	**17**	**159**	**26**	**44**

Table 9.7a: Partial Data Map of Intra-Industry Ties by Firm

Results	Including Wytch Farm	Excluding Wytch Farm
Individual Firms	n= 54	n= 46
Post-entry survival and <u>total</u> number of intra-industry ties	r= 0.700**	r= 0.795**
Post-entry survival and <u>average</u> number of total intra-industry ties	r= 0.219	r= 0.425**

** = Significant at the 0.01 level

Table 9.7b: Correlations Between Total Number of Intra-industry Ties, Average Number of Intra-industry Ties and Number of Years of Post–entry Survival, H4 Main Study

Results	Including Wytch Farm	Excluding Wytch Farm
Individual Firms	n= 54	n= 46
Total intra-industry ties and firm size	0.613**	0.458**

** = Significant at the 0.01 level

Table 9.7c: Correlations between Total Number of Intra-industry Ties and Firm Size, H4 Main Study

The correlation figures, shown in Table 9.7b, showing the total number of a firm's intra-industry ties, are significant for both populations of individual firms. When the number of average industry ties observed over the firm's presence in the population is used, shown in Table 9.7b, it is only significant for the population excluding Wytch Farm. Intra-industry ties are also not unexpectedly

linked to firm size as shown in Table 9.7c, so removing the three dominant firms in the non-Wytch Farm population reveals r= 0.340, still significant at the 0.05 level. There is, therefore, only limited support for intra-industry networks as size substitutes for smaller firms.

Future work arising from this hypothesis would be to look at the total industry network for each year and break it out by firm to firm using UCINET IV™ software (Borgatti, Everett & Freeman, 1992) on the complete version of Table 9.7a. This would show which firms occupy nodes in an industry network and if the total network size changes before exit.

Mitchell & Singh (1996) and Singh & Mitchell (1996) suggest advantages for businesses having ties or linkages, though warning of dependence on partners. This may be extended to form the question, Does having a large number of ties make a firm a valuable acquisition? Certainly in the total population, 56% of those acquired had a history of 20 inter-firm ties or greater over their period of incumbency.

There is a lot more research on industry ties and networks that could be completed using this dataset, some of which is discussed in Chapter 10. One future development would be to consider *"who your partners are"* and the network composition.

H5: Within the industry, the greater a firm's intra-industry experience, the longer it will survive within the industry.

This hypothesis considers the relationship between a firm's intra-industry experience and the number of post-entry years of survival. It also looks at a firm's experience as a field operator (a form of legitimacy discussed previously and also mentioned in the interviews).

Results	Including Wytch Farm	Excluding Wytch Farm
Individual firms	n= 54	n= 46
All experience (years)	r= 0.668**	r= 0.818**
Average experience (years)	r= 0.235	r= 0.591**
Operator experience	r= 0.468**	See note below
Average operator experience	r= 0.003	See note below

** = significant at the 0.01 level. Operator experience excluding Wytch Farm excludes only one field for BP, so it was not calculated separately as the impact is negligible.

Table 9.8a: Links between Experience and Post–entry Survival, H5 Main Study

This hypothesis is confirmed, but not surprisingly there is also a high correlation between experience and operating experience as well as between post-entry survival and experience as shown in Table 9.8a. There is also a high correlation between total industry experience, measured as the annual total of all firms' experience that year and several other selection variables. Those significant at the 0.01 level are shown below, in Table 9.8b using figures based on annual population level statistics:

Variable	Correlation All firms	Correlation Excluding Wytch Farm Firms
Maxtax	-0.629**	-0.588*
Oil price	-0.687**	
Euro$	-0.697**	-0.621*
Spot exchange rate	0.501*	
Total production	0.721**	0.858**
Field numbers	0.740**	0.687**
Wells to date	0.818**	0.753**
Environment	0.762**	0.614*
Innovation	-0.722**	
Onshore rig numbers	-0.703**	-0.760**
No of wells drilled that year	-0.700**	-0.762**
IMF costs	0.758**	0.720**
Partner years	0.748**	0.608*
Exploration/ exploitation Events	0.560*	

** = significant at the 0.01 level; * = significant at the 0.05 level.

Table 9.8b: Significant Correlations between Experience and Other Variables, H5 Main Study

So though the hypothesis is confirmed, the conclusion is possibly compromised as experience permeates all areas of a firm's activities, as an efficient system would predict.

H6: Within the industry, the greater an adverse environmental shock, the more firms will exit from the industry.

In this hypothesis, the industry time line in Chapter 5 was linked to a simple frequency count of firms departing in each year of exit. Two major shocks were chosen from major events identified in the Press and by the interview informants. The two major shocks identified were the loss of tax offsets announced in 1985 which took a few years to impact on firms and the decline in oil price in 1994.

	With Wytch	Farm	Without Wytch	Farm
	Frequency	Percent	Frequency	Percent
1987	1	1.9	1	2.2
1988	1	1.9	1	2.2
1989	9	16.7	8	17.4
1990	2	3.7	2	4.3
1991	0	0	0	0
1992	2	3.7	3	6.5
1993	2	3.7	3	6.5
1994	5	9.3	5	10.9
1995	1	1.9	1	2.2
1996	3	5.6	2	4.3
1997	3	5.6	2	4.3
1998	4	7.4	3	6.5
1999	3	5.6	3	6.5
Survivors	18	33.3	12	26.1
Total	**54**	**100.0**	**46**	**100**

Table 9.9: Exit Year Statistics for Both Populations, H6 All Firms and No Wytch Farm

As Tables 9.9 shows, significant numbers of exits did occur in 1989 and in 1994. The two events are treated as of equal importance as both have a profound effect on the economics of the industry, and the response to both would be driven by portfolio considerations balanced against an exit decision. The UK Government has always maintained that its oil taxation regime is competitive against others worldwide (Munns, 2002).

1989 was the year of major departures (nine, or eight excluding one Wytch Farm participant) because it took a long time for acquisitions to be completed and firms to exit as a result of crowding from the major exodus from both the onshore and offshore industries following the tax changes announcement. Data on both exploration and production firms made available very recently shows exits by exploration firms after 1985 when the legislation changed, followed by two further peaks in 1989 and 1990. The interview data suggests tax changes were a spur to exit.

In 1994 onshore producers had a slightly increased rate of exit, possibly because the financial climate allowed faster exits this time. Exit numbers are five for both Wytch Farm and non-Wytch Farm populations. However, 1992 and 1993 also showed slightly increased exit numbers. This is probably more to do with general disillusionment with the industry, or stockmarket effects, than linked to oil prices as the gas deregulation changes should have enhanced the industry attractiveness and slowed exits. Though this hypothesis is supported, the small numbers suggest caution.

9.4 Regression Analyses

The next stage, to see if either selection effects or adaptation decisions dominate post-entry survival, was a regression analysis of all the firms in all

years. From the hypotheses discussed above, it can be seen that the presence of the Wytch Farm firms clearly does affect the results through their positions as substantial outliers, so the detailed regression analyses concentrated on the population without the Wytch Farm firms.

The first regression, shown in Table 9.10a, looks at a year by year analysis for the population, considering only the selection variables, using a stepwise routine. The dependent variable was the size of the industry population in that year. In line with interviews, for the population including Wytch Farm, the Government tax-take was the key driver, with technology as the secondary driver. For the population excluding the Wytch Farm field, oil price and GDP confirm literature predictions. This need to be treated with caution as there were only a maximum of 15 cases (years of study).

Dataset	Key variables	R2	Adj. R2	Number of cases	Beta coeffs (std)	Significance
Population 1984-99 (incl. Wytch Farm)	Tax-take	0.663	0.638	15	0.815	0.008
	Tax-take +	0.872	0.850		1.263	0.000
	Technology Innovation				-0.639	0.001
Population 1985-99 (excl Wytch Farm)	Oil price	0.416	0.367	14	0.645	0.013
	Oil Price +	0.614	0.544		0.788	0.002
	GDP				0.467	0.037

Table 9.10a: Stepwise Linear Regression at Population Level Using Selection Variables

The second regression, shown in Tables 9.10bi and 9.10bii, looks at the population by firm, comparing each firm's total adaptation variables with its number of years of post-entry survival again using stepwise regression – selection variables are only available annually so cannot be included:

Dataset	Key variables	R2	Adj. R2	Number of cases	Beta coeffs (std)	Significance
All firms including Wytch Farm	Size	0.661	0.634	54	0.287	0.012
	Intra-industry Experience				1.475	0.000
	Exploration/ Exploitation				-0.649	0.008
	Exploitation				-0.386	0.047
All firms excluding Wytch Farm	Exploration/ Exploitation	0.707	0.694	46	0.516	0.002
	Intra-Industry ties				0.358	0.026

Table 9.10bi: Stepwise Linear Regression at Firm Level for Both Wytch Farm and Non-Wytch Farm Populations using Adaptation Variables and Including Size

Dataset	Key variables	R2	Adj. R2	Number of cases	Beta coeffs (std)	Significance
All firms including Wytch Farm	Intra-Industry ties	0.489	0.479	54	0.700	0.000
All firms excluding Wytch Farm	Exploration/ Exploitation	0.707	0.694	46	0.516	0.002
	Intra-Industry ties				0.358	0.026

Table 9.10bii: Stepwise Linear Regression at Firm Level for both Wytch Farm and Non-Wytch Farm Populations Using Adaptation Variables and Excluding Size

Here, as might be expected, industry ties and exploration/exploitation adaptation activity appear to offer some explanation for longevity. If the firm size proxy is included, it is the most important regression variable for the population including Wytch Farm, unsurprisingly as there are several very large Wytch Farm firms present, but for the non-Wytch Farm population the inclusion of a size variable does not affect the regression results, suggesting the dynamic capabilities are the determining factors.

The third regression, to see which selection effects or adaptation decisions appear to enhance post-entry survival prospects, looks at a regression analysis of all the firms for each of the years they were present, following the year of entry.

Each firm's survival entry was broken down into individual years for which selection variables could be calculated. Reflecting the importance of experience, adaptation variables such as exploration/exploitation events completed, experience and survival years to date were coded as both cumulative and annual figures from entry. The models with best fit for the two

populations contained the variables ranked in order of importance, ascertained from a stepwise entry regression shown in Table 9.10c:

With Wytch Farm firms (224 cases)	Standardised betas	Significance
R2= 0.524		
Adj. R2= 0.515		
Cumulative intra-industry ties	0.907	0.000
Number of wells drilled to date	-0.238	0.000
Cumulative number of exploitation events	-0.350	0.000
Crude oil price	0.176	0.000

Without Wytch Farm Firms (151 cases)	Standardised betas	Significance
R2= 0.655		
Adj. R2= 0.650		
Cumulative intra-industry experience	0.763	0.000
Number of wells drilled to date	0.139	0.006

Without Wytch Farm Firms (151 cases) excluding experience	Standardised betas	Significance
R2= 0.642		
Adj. R2= 0.635		
Cumulative exploration/ exploitation events	0.458	0.000
Number of wells drilled to date	0.175	0.001
Cumulative intra-industry ties	0.307	0.009

Table 9.10c: Total Stepwise Linear Regression on Annual Firm Participations in the Industry, Broken Down by Year of Survival Including Selection and Adaptation Variables

From these statistics it would be reasonable to conclude that, once inside the population, both industry effects and discretionary adaptation can enhance survival prospects (intra-industry ties, number of wells drilled to date). The experience factor, though closely related to post-entry survival years, when coupled with the number of wells drilled to date, suggests that industry knowledge is important. Exploration, exploitation and industry ties suggest the importance of acquiring information and resources and maintaining the linkages to continue to do this. The regressions suggest that the views on the importance of exploration and exploitation expressed in March (1991) and Levinthal and March (1993) are empirically supported at the investment level though the prevalence of exploration or exploitation in determining survival is unclear.

The penultimate regressions look at a dichotomous regression coding for survival/non-survival as the dependent variable where all variables were lagged by one year (so entry year variables were used in year 1) and for those firms exiting, an additional exit case was included. The lagging reflects the delay from information processed to decision implementation, and to look for discriminatory influences on exits. This attempts to see if there are distinctive

factors associated with both outcomes. For the entire dataset excluding Wytch Farm (n=184) this produced inconclusive results – one variable, the number of producing fields to date, a measure of industry attractiveness, had values of R2 = 0.036 and adjusted R2 = 0.030. However, by separating out the years, tables 9.10d and 9.10e were compiled.

Year of post-entry survival	Key variables	R2	Adj. R2	Number of cases	Beta coeffs (std)	Significance
1*	--	--	--	46	--	--
2**	--	--	--	41	--	--
3**	--	--	--	34	--	--
4	Operating costs Cumulative lagged intra-industry experience	0.614	0.573	22	0.547 0.371	0.003 0.030
5**	--	--	--	12	--	--
6	GDP; Mkt. Cap of sector, Operating costs	0.993	0.990	10	0.949 -0.637 -0.504	0.000 0.000 0.003
7-10	Eurodollar rates Cumulative exploration events	0.467	0.400	19	0.522 -0.400	0.012 0.044

* = Not computed as all firms survived; ** Model failed to generate result.

Table 9.10d: Regression of Cases Selected by Year of Industry Presence for Dichotomous Firm Survival Dependent Variable Against All Other Variables Lagged One Year and Using Cumulative Totals for Adaptation Variables to Reflect Industry Experience

Table 9.10e looks at the same variables (calculated on an annual basis rather than cumulative) by year of post-entry survival to examine the role of certain drivers at certain points in a firm's life inside the industry further (echoing back to Hawawini et al, 2003).

Year of post-entry survival	Key variables	R2	Adj. R2	Number of cases	Beta coeffs (std)	Significance
1*	--	--	--	46	--	--
2**	--	--	--	41	--	--
3**	--	--	--	34	--	--
4	Operating costs	0.503	0.478	22	0.709	0.000
5**				12		
6	GDP; Mkt. cap of sector, Operating costs	0.993	0.990	10	0.949 -0.637 -0.504	0.000 0.000 0.003
7-10	Eurodollar rates	0.308	0.267	19	0.555	0.014

* = Not computed as all firms survived; ** Model failed to generate result.

Table 9.10e: Regression of Cases Selected by Year of Industry Presence for Dichotomous Firm Survival Dependent Variable Against All Other Variables Lagged One Year and Using Annual Totals for Adaptation Variables

The clustering described in the next section suggests that there are groupings in the data. From the data groupings examined earlier in H0, there would appear to be a transition at various points in the firm's life-time, so the regression was first re-run using annual breakpoints as boundaries and when this was unsatisfactory as numbers were so small in some years, using the following points as boundaries with the results shown in Table 9.10f:

Years of PE survival	Key variables	R2	Adj. R2	Number of cases	Beta coeffs (std)	Significance
0-1				46		Model failed to compute – all firms survived
2-3	Cumulative lagged intra-industry ties Operating costs	--	--	75	--	Model failed to compute
4-6[48]	Intra-industry experience Oil price	0.359	0.328	44	0.511 0.353	0.000 0.008
7-10[49]	Eurodollar rates	0.308	0.267	19	0.555	0.014

Table 9.10f: Linear Regression on Clustered Dichotomous Survival by Firm Participation Data Disaggregated by Number of Years of Post-entry Survival and Grouped by Number of Years in a Firm's Intra-industry Survival Lifetime

The same drivers reappear: operating costs, intra-industry experience, GDP, sector market capitalisation, Eurodollar rates, cumulative exploration events and

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[48] Results shown for annual totals of adaptation variables lagged one year. For cumulative totals, the regression is slightly different, R2= 0.326, adj. R2= 0.294 with same drivers.
[49] Results shown for annual totals of adaptation variables lagged one year. For cumulative totals, the regression is slightly different, R2= 0.467, adj. R2= 0.400 with Eurodolar rates and cumulative exploration rates as drivers.

cumulative intra-industry ties, though with changing signs making consistent explanations difficult.

A regression was run using the key events from H6, i.e. 1989 and 1993 as boundary points to see if the calendar year made a difference, and to see if this would permit sensemaking of the earlier results. This is shown in Table 9.10g:

Years of PE survival	Key variables	R2	Adj. R2	Number of cases	Beta coeffs (std)	Significance
1985-1989	Onshore production	0.348	0.335	53	-0.590	0.000
1990-1993	--	--	--	53	--	Model failed to compute
1994-1999	--	--	--	78	--	Model failed to compute

Table 9.10g: Linear Regression on Clustered Dichotomous Survival by Firm Participation Data Disaggregated by Number of Years of Post-entry Survival in a Firm's Intra-industry Survival Lifetime and Grouped By Calendar Years

This suggests that there is no evidence of calendar time dependence in the data other than up to the first major exodus in 1989. Do different selection and adaptation variables drive survival in the population? Is it possible to segregate survival from demise clearly by looking at these influences? To look at this, a final regression was run on of pairs of firm years, comprising the last year of survival and the subsequent year of non-survival to see what appeared to make the difference, i.e. to look for discriminant factors. For this regression using all the selection and adaptation variables lagged one year, n= 66, that is 33 pairs, R2= 0.138 and adjusted R2= 0.125 from the independent variable *"number of fields in population to date"*, with a beta of 0.362 and significance of 0.003. This very small dataset suggests there is no determining variable, but with only 66 data points spread over 15 years, it would be interesting to reinvestigate on a larger population.

To reconcile the datasets, it might be suggested that industry ties play a part once a firm is inside the industry but that there is a weakly counter-active selection influence at the start and that there are some forms of threshold at 4 and 6-7 years of survival, but the results are inconclusive as the dataset is small.

9.5 Are there Distinctive Survival Strategies?

The distinctive groupings found in the H3 analysis in the pilot study initiated consideration of a model based on the main study data using groups and based on Hannan & Freeman (1984), March (1991) and Lewin & Volberda (1999) as well as Miles & Snow (1984) and Bierly & Chakrabarti (1996).

As a starting point, congruent with the model in Argyris & Schön (1974) and a systems perspective, the findings of the pilot study model were discussed with industry insiders not previously involved with the study (at a poster session on the research over three days at Petex 2002) to test how far this model might fit

with insiders' cognitive maps. Although this feedback was not formal or indeed formally collected, the view from at least 30 insiders (none of whom were on the original informant panel) was that this was plausible and that oil field partners and partnering relationships were critical to firms for their survival.

Once the main study was complete, in order to see if the model was still valid, the exhaustive CHAID clustering analysis, using AnswerTree™ software was re-run on the data without Wytch Farm. The removal of the transitory entrants has also altered the groupings in this model, shown in Appendices O and P, changing the number of groupings to the three distinct groups shown in Table 9.11a:

Clustering Variables	Node 1	Node 2	Node 3
Years of survival	1-3	2-8	4 -10
Number of exploration/exploitation events	0-1	2-4	5-26
Number of intra-industry ties	0-20	1-55	15-149
Number of firms	27	10	9

Table 9.11a: Analysis of Cluster Nodes for the Population Without the Wytch Farm Firms

Node 1, which was the largest (n= 27) and contained firms with short industry survival times, contains predominantly non-UK firms, and late entry firms enticed by gas development for private power generation. Eight of these firms are still present in the population; three in small power-generating gas fields and four Canadian entrants (reduced to three by merger after the end of this data period) bringing a successful approach to older acreage.

Node 2 (n= 10) contains more established oil companies and 2 non–oil firms. Many of this group were driven to exit when significant tax offset changes were introduced in the mid 1980s. There are only three members of this node still present in the population; one has substantially reduced its interest in its fields, a second went into financial reconstruction after the end of the study period and the third seems set to move into the super-survivor category.

Node 3 (n= 9) contains the super-survivors. With one exception, these firms all engaged in exploitation events, numbering from 1 to 16 in the case of the outstanding super-survivor. Nine are British firms, one Irish but listed on the UKSE and one is an unlisted subsidiary of a large US firm. Three of these firms are still surviving, with the longest, Edinburgh Oil and Gas, said to be contemplating a departure from onshore after participating in a large, new offshore field, and one other having departed in the last year of the study.

These moderate the pilot findings to produce three categories shown in Table 9.11b:

Category (number of firms in brackets)		
Sheep (27)	*Stuck in the middle (10)*	*Super-survivors (9)*
Little or no activity	Adaptation	High activity
Selection driven, Legacy-dependent.	Incumbent capitalising on existing investments or spreads to new investments. Exits on adverse selection.	Active co-evolver with high levels of exploration and exploitation
Short-term player: 1-3 years	Short-term player 1-6 years	Long-term player: 3-10 years
Few industry ties (0-12)	Lower intra-industry ties (13-26)	High intra industry ties (34-149)

Table 9.11b: Restated Survival Strategies Model Based on the Main Study Non-Wytch Farm Data

Again a different set of results from the pilot study; the middle two categories *("specialists"* and *"seekers")* have been merged and there is better separation between the second and the third category – the *"stuck in the middles"* and the *"super-survivors".* This could be partly as a result of the loss of those firms with only one year survival, i.e. no survival post-entry year, but is also as a result of some realignment between the super-survivors as duplicate fields have been removed. The more scientific approach to setting the boundaries of the clusters has also reset the levels for each group.

So, it seems as if there are some generic survival strategies in evidence in this population, supporting the firm level regression findings. Super-survival appears to be linked to dynamic capabilities such as the firm's ability to explore and exploit opportunities inside the industry boundary and independent of the size inside the industry, being more concerned with number of investment sites (fields) and partnerships, as well as experience. Though selection may play a part it seems this affects either larger firms, that is firms for which this is a relatively small part of their activity (possibly even a real option play), or very much smaller firms which are less embedded in the industry through partnerships and do not have the resilience to withstand the adverse change.

9.6 Conclusions

The pilot study and the interviews highlighted some important data issues that were then addressed in the main quantitative study. The hypotheses testing results from the main study were largely consistent with the pilot study. As a follow-up, several regression analyses were completed with contrasting results:

At the year level, the Government tax-take is the most important determinant for the population including Wytch Farm, with oil price and GDP for the non-Wytch farm population. This is entirely consistent with economic literature on the industry.

At the firm level, industry ties and exploration/exploitation activity appear to be the factors linked with the length of survival, again congruent with expectations from the literature in terms of dynamic capabilities and specifically discretionary adaptation.

At the firm by year level, the picture becomes more complex, but includes industry ties, completion of exploration/exploitation events, wells drilled to date and an experience measure, showing the overall importance of adaptation over selection.

Finally, in testing for a dichotomous predictor variable set, the results are inconclusive across the whole dataset, though there may be critical points in a firm's life-cycle within an industry where selection or adaptation factors prevail. The dataset is too small to support any claims based on this analysis.

Using clustering analysis to see if there were groups of firms with similar strategies, the simple generic survival strategies model was developed using the pilot and found to hold true for the main study data. The variables used were exploration/exploitation events completed and intra-industry ties for each firm. Transition across the categories was not investigated in this study.

The next chapter reviews the quantitative and qualitative findings, the limitations of this research project and looks forward to future research agendas.

CHAPTER 10: DISCUSSION, LIMITATIONS, CONCLUSIONS AND FUTURE DIRECTIONS

10.1 Summary

In this chapter the findings of the thesis and the limitations of the research are reviewed. They are linked to the results of the quantitative and qualitative analyses as well as back to the theoretical model. The research model is reviewed critically in the light of the pilot, main studies and interview data, and conclusions are reached. The different themes in the thesis are drawn together and the contribution to knowledge is formally re-presented. The limitations of the research are also described. A future research agenda is proposed building on this work, and papers given to date are also described.

The chapter concludes, as the thesis opened, with a very short personal observation on the process.

The chapter is laid out as follows: discussion of results, revisiting the research model, the survival strategies model, contribution to knowledge, limitations, future research directions, papers already presented and reflections.

10.2 Discussion of Results

This section looks at the links between the theoretical model, hypotheses, the interviews and archival data to draw overall conclusions and relate them to current theory.

10.2.1 Linking the theory to the quantitative and qualitative results

The research question, stated in Chapter 1, was:

> *"What factors, in particular the impact of environmental events (uncontrollable by firms) and the impact of adaptive actions (controllable by firms), appear to drive firm survival within an industry and why?"*

The sub questions posed were also stated:

- Which factors, exogenous and endogenous to the firm, appear to enhance firm survival?

- Are environmental (exogenous) factors more likely to influence survival than firm level (endogenous) factors?

- Does adaptation, and specifically discretionary adaptation appear to enhance survival?

10.2.2 The findings from the data analysis

In Chapter 4, a theoretical model was postulated, suggesting that survival was linked to selection and adaptation, especially discretionary adaptation. Seven hypotheses to test this model were proposed and analysed quantitatively in Chapter 7, triangulated with the qualitative interviews in Chapter 8 and then re-examined in Chapter 9. There seems to be consistency of response to the hypotheses within datasets, but as discussed later, there are two differing perceptions of the industry: the quantitative data suggests that adaptation factors, and specifically discretionary adaptations, are important to survival; in contrast the perception of industry informants is of a struggle for resources to manage selection pressures.

(H0): Does size determine survival? Although on first analysis there is an apparent advantage gained from size, there are some distribution issues in the quantitative data. Removing the few dominant players alters the results and mitigates the importance of the size variable. The regression analysis suggests that this variable is not important, and that other factors play a more significant role in firm survival. The hypothesis was not covered by the interviews. So size is only a partial explanation for survival.

(H1): Does a munificent environment lead to larger numbers of firms surviving? Oil (resource) price seems to be the key selection factor as would be expected in an extractive industry with a commodity output, although the correlation is negative - links to locations on the competitive landscape being opened up to more smaller firms when large firms leave and their investments are broken up as the tax synergies may be too much for individual remaining firms to absorb. This is in line with the industry investment model suggested by Nevitt (1989) and Pollio (1999) and is confirmed by the interview data. Other variables that appear to be significant include Eurodollar rates, again as a negative correlation, the number of fields in production and the rate of technology innovation. A conclusion from this might be that the investment model for the industry includes financial factors, but is also linked to two other factors – density dependence and the perceived attractiveness measured by the number of productive opportunities and an environmentally linked factor. The regression data suggests that selection variables become of greater importance later in a firm's life inside the industry boundary, possibly because all the discretionary adaptation possibilities have been exhausted, or possibly relating to size.

The interview data also suggest that financial and macro-economic factors were key determinants of survival – ranked above adaptational activity. Finance dominated the discussions, with macro-economic factors a close second. This reflects the dependence of the firms on the City for equity (and for the Wytch Farm firms, debt). It also supports the dominance of the investment model in the perception of the industry by insiders. Technological developments and environmental issues were also mentioned, paralleling the quantitative data. For this hypothesis, the two approaches are congruent – the espoused and in–

use models favour interest rates (finance) and oil price as factors affecting survival.

(H2): Early entry only confers limited survival advantage, contradicting the evidence from previous research (Mascarenhas, 1989, 1992b; Bryman, 1997; Rothermael, 2001; Vermeulen & Barkema, 2001). Entry linked to the industry clock as compared with calendar time as suggested (Mitchell, 1991) appears to be negatively correlated for this industry. In extractive industries, success and competitive advantage is linked to incumbency in good resource sites, or the capability to acquire them with some advantage to be gained by technology to enhance production, and thence cashflow. This is also consistent with comments on early entry not surfacing as an explanation for survival in the interviews with informants.

(H3): The completion of discretionary adaptation events (exploration and exploitation) is linked with longer survival at the individual firm level; exploiters in particular survive for longer, though completion of both types of events appears to confer survival advantages. The regression analysis suggests that these events are also linked to survival, measured on a dichotomous basis. Most firms in this context explore first and then move on to exploit, (March, 1991; Rothermael, 2001). Twenty-five firms explored, of which thirteen made an exploratory move in the year following entry. In contrast five firms made a first post-entry move that was exploitative. The optimal order is under debate in the literature (e.g. Volberda & Lewin, 2003). Holmqvist (2003) also considers the role of exploration and exploitation activity in intra- and inter-organizational learning. In this research, exploitation seems to be the key factor linking to survival

Though discretionary adaptation was not specifically addressed in the interviews, points surfaced that support the quantitative findings. For example, one informant spoke about the importance of contiguous trends giving an example of a potential exploration scanning strategy. The moves offshore offer a glimpse of some firms using onshore as a rehearsal for offshore, and offshore as a large exploration strategy. The interviews also addressed the role of those firms that hold 100% of a field, and whether this lack of a need to share has significance – an informant suggested it was a positive signal that a firm did not need to share with others. A sole licensee would also not need to go through consultation processes to make changes to operations, speeding up adaptation to external events at the field/investment level.

(H4): Large numbers of intra-industry ties support longer firm survival, congruent with the literature (Uzzi, 1997; Hagedoorn & Duysters, 2002). Industry ties are a feature of this industry, relating to risk sharing. Unsurprisingly therefore, the regression analyses also feature intra–industry ties among the key drivers for the populations.

Partnering was also considered significant in the interviews. Analysis of the interviews ranked partnership issues as the sixth most important group of

factors, but behind financial, selection–related factors, knowledge, legitimacy and offshore factors. Newer firms appear to be concentrating on building networks faster and may be copying a perceived successful industry recipe (Spender, 1989).

(H5): Intra-industry experience enhances survival. In the literature, industry experience is linked to survival (March, 1991; Miner & Anderson, 1999), but experience is difficult to disentangle from the interactive effects of other variables. Experience is related to industry ties and to exploration/exploitation events in as much as the longer a firm is incumbent, the greater the opportunity to enhance these adaptation mechanisms, either through discretion and pro-active decision-making (exploration/exploitation) or a mixture of discretion and non-discretion (industry ties and industry experience).

The interviews suggested that intra-industry experience (in the knowledge grouping, 8.9.3) is linked to survival. They also suggest that this is linked with legitimacy and institutional theory (DiMaggio & Powell, 1983). The progression to operatorship was ranked fourth in the listing of topics raised by informants. Additional evidence of institutional pressures is shown by isomorphism among firms, possibly coercive driven by the license-awarding Government body and financial stakeholders, or possibly mimetic as *"copy-cat"* firms appeared following successful industry recipes.

(H6): Firms are selected out by adverse environmental shocks. This confirms the findings of much of the population and organization ecology literatures and confirms the role of resource attraction as a buffering mechanism (Thompson, 1967; Pfeffer & Salancik, 1978, p.108).

The importance of the key shocks as exit drivers was also confirmed by the interview data which was used to confirm the choice of events to use. However, the exit meta-map suggests that adaptation (or failure to adapt) and legitimacy from stakeholder expectations can also have an impact.

10.2.3 Conclusions from the data analysis

Overall, examining the balance between selection and adaptation through the quantitative analysis, intra-industry ties and exploration/exploitation event completion (i.e. active partnering and new dynamic adaptation) appear to be the key adaptation drivers, with intra-industry experience also appearing as important in the middle years of survival. The sequence seems to be that selection pressures will have a greater impact in the early years and that adaptation capability builds up over time. However, the relatively small population and its distribution suggest results be treated with caution.

The quantitative data suggests that survival measured as years present in the population is linked with adaptation, and specifically discretionary adaptation, which appears to be a dynamic capability building up over time. In contrast, the interview data suggests that the balance of factors lay with selection factors both exogenous to the industry, e.g. financial/stockmarket and exogenous to the

firm (oil price). However, the interview programme was small and limited in its coverage – the proposed follow-up NGT study might surface and resolve some of the differences further.

This apparent tension between findings raises issues about the validity of drawing conclusions from either quantitative or qualitative approaches rather than triangulation using both approaches. Indeed, the differences in the findings may offer a good illustration of the contrast between espoused theory and theory-in-use found in Argyris & Schön (1974); perceptions of survival in an industry (Porac, Thomas, Wilson, Paton & Kanfer, 1995) and institutional control mechanisms that reinforce and reward *"acceptable"* behaviour (Park, 1996).

There are links between the adaptation drivers in the firm: Holmqvist (2003) links intra- and inter-organizational learning explicitly to exploration and exploitation, as Hagedoorn & Duysters (2002) link organizational learning to network density. Within-industry experience is also linked to organizational learning and thence to competitive advantage (March, 1991). However, in this thesis, March's framework of exploration and exploitation *("discretionary adaptation")* is applied to the more basic level of firm survival rather than firm competitive advantage, as it is possible to survive inside the industry boundary without ongoing competitive advantage, simply as a result of strategic legacy (Miller, 1994), especially after periods of prior success.

The findings are contra-indicative to theory about agency costs (Jensen & Meckling, 1976; Pearce, Robbins & Robinson, 1987); transaction costs (Williamson, 1975; Felder, 2001) and even separately evaluated information costs (Kulkarni & Heriot, 1999), especially in the context of joint ventures as investment form choices, e.g. Kogut (1988) and in the management of information asymmetry, e.g. (Balakrishnan & Koza, 1993; Doz & Shuen, 1995). In the oil industry studied, the cost of maintaining a large number of partnerships, developing experience and looking across the landscape for opportunities, rather than outsourcing, is accepted as a normal part of business. This is significantly different from industries where a market for goods and services can be developed and grown and the partnering model is more discretionary in nature. It is interesting to note that in Williamson & Masten (1999), a collection of readings including some empirical work on transaction costs, the focus is on the individual natural resource buyer/supplier contracts and the relationship between suppliers jointly developing resources is not covered. This exposes some of the downside of using a one–size fits all model in strategy, and cautions about the generalisibility from this study to non-primary industries.

10.3 Revisiting the Research Model

So to return to the research model, the findings appear to confirm that post-entry firm survival is driven by a mix of external selection and firm level adaptation. There is a powerful effect arising from discretionary adaptation mechanisms at the firm level, possibly related to the outcomes of strategic choice (Child, 1972) and arising from processes inside the *"black box"* of the

firm. The population ecology view and its successors discussed in Chapter 3, suggest that the role of managers is of lesser importance.

The balance between selection and adaptation appears to favour discretionary adaptation when measured at the individual firm level through regression analysis and the findings are that management develops dynamic capabilities (including discretionary adaptation) to manage access to information and thence to synthesize knowledge inside firms.

March (1991) considers the asymmetry of knowledge as a contributor to organizational learning (rather than asymmetry of information) and a key to an understanding of organizational knowledge and the struggle for primacy between organizations, i.e. success. Execution of exploration/exploitation events allows renewal and expansion for a firm through the active management of this process as a dynamic discretionary capability. Firms in the thesis populations begin by exploring (with very few exceptions). Unlike Proposition 1 of Koza & Lewin (1998), which anticipates a preponderance of exploitation driven alliances, exploitation is a less prevalent activity for this industry, even though it appears to be the more important activity associated with longer survival times. The findings of Flier, Van den Bosch & Volberda (2003) who also favour exploitation as a driver for strategic renewal (and thence implicitly survival), are supported in as much as the correlation analysis suggests exploitation as the dominant factor. Even though Levinthal & March (1993) warn against competency traps from over-indulgence in either exploration or exploitation, the longer survivors completed greater numbers of exploration and exploitation events, following Chang (1996).

An explanation of the specific adaptation forces could lie in the larger issue of the management of information asymmetries as an explanation in turn for the linkage of exploration and exploitation activity in the industry and the number of intra-industry ties with years of post-entry survival. In this secretive industry, information is the key source of competitive advantage coupled with cost management. Exploiting the information gained from being membership of oil field partnerships with high information barriers may offer an explanation for the findings in the hypotheses and in the regression analyses for the apparent key to survival. Networks and ties allow information to flow across firm boundaries, aided by social interactions not captured in this data.

The importance of industry ties develops the perspective offered in Hite & Hesterley (2001). Structural holes are continuously created by firms exiting from the industry, so the socially embedded networks formed from the ties observed at the beginning of the firms' existence are maintained as organizational forms by new entrants or dispersed in the short term to be built up again by longer surviving firms. The sparser network that characterises the more inert firm only appears relatively later in the population history and only in the case of the more mature investment sites, even though the calculative approach associated with this is espoused in the interviews. The idea of industry ties and networks as a management system for information is not new.

Gulati, Nohria & Zaheer (2000) offer ideas for theory and Dyer & Nobeoka (2000) look at the Toyota supplier network as a practical example of a management system for transferring knowledge.

When discussing the theory of incomplete contracting as a device for dealing with incomplete information (and its criticisms), Hart & Moore (1999) suggest that commitment (or its lack) is a crucial assumption. A dense network of industry partnerships or commitment to the industry can act as a brake to opportunistic behaviour by a firm. It is then rewarded by further partnerships and a *"preferred partner"* status ensuring access to a wide choice of investment opportunities and, therefore, the chance to select those with the best returns. This closes a virtuous circle to stakeholders by offering better returns to investors, who reward the firm by increasing the supply of capital for future investments. A closer examination of the networks and the constituent firms could be completed (using data and resources unavailable for this study) by using the UCINET IV™ software (Borgatti, Everett & Freeman, 1992).

The linkages of dynamic capabilities (including exploration/exploitation, network ties and industry experience) to post-entry survival discussed in this thesis suggest that there may also be trade-offs between the three that may enhance survival, though this study is statistically too small to investigate this further.

This thesis remains a preliminary investigation. It has found that there is only limited support for the theory that the external environment (i.e. selection) is the major determinant of firm survival, though the components of that environment affect firms differentially. It also confirms that though selection may be considered important by industry players, in fact discretionary adaptation appears to play the key role, and that the key survival drivers for this population of mostly small firms are intra-industry ties and adaptation, especially exploitation experience. Selection has a place, however, in the life-cycle of the firm inside the industry, returning to be a key survival driver at certain ages of the firm inside the industry boundary.

10.4 The survival strategies model

The pilot and main studies support the view that there are clearly defined groupings present in this industry based on the number of years of survival within the period 1985-99 and defined through total number of exploration/exploitation events completed and total number of intra-industry ties of a firm. The interviews suggested that longer lived firms become exemplars as their behaviour is legitimised.

Do firms move between the three categories identified? The data suggests that there are discontinuities between the categories and that firms pursue certain strategies such as engaging in as many intra-industry ties almost from entry. Only one firm, BP, shows evidence of a change of policy by changes to its industry ties over time, but inertia may play a role here in as much as firms lack resources or opportunities to make changes.

Are high levels of partnerships associated with the better fields? After Wytch Farm, the next three most attractive fields have been characterised by larger number of partners than other fields. (Wytch Farm has had six partners present for most years of presence in the study. The next largest, Horndean and Hatfield, have had a maximum of five and Humbly Grove a maximum of seven partners). The difference is that the smaller three have also concentrated ownership over time, with partner numbers falling. Industry levels of partnerships have also been falling as the industry matures. However, newer entrants such as Tullow, while not in these key fields, have accumulated dense intra-industry networks suggesting that there are two forces at work over time. New investment sites (oil or gas fields) may have many partners at the start to share risk and to develop industry knowledge. However, the size of the investment/production basket may not be sustainable for too many firms, so some become attractive targets for predators hungry for inside information. Another force is the decline in production/revenue as time goes by causing firms to either withdraw (exit) to more attractive investments elsewhere.

Although there were more fields in the industry in 1999 than any previous year, the average number of partners per field is falling. As the industry has matured, consolidators move in to buy up groups of fields and eventually hold 100%, awaiting an exit opportunity. These firms have no industry ties, i.e. zero partners. There are a few consolidators present but again a follow-up study may permit a closer scrutiny of this group. There are also invisible ties between individuals in an unexposed intra-industry web, that may either support or mitigate the findings of this study.

10.5 Contribution to Knowledge

Chapter 4 closed with some suggestions regarding the literature gap that this thesis was attempting to bridge. These could be summarised as a contribution to the understanding of the differential importance of selection mechanisms and adaptational responses in enhancing survival, and specifically the role of exploration and exploitation activities in this process. The contribution to knowledge of this research is in these areas but includes several others too:

10.5.1 Contribution to future research

This research has developed and used a unique dataset that permits the analysis of intra-firm processes of an industry population as determinants of survival over time. It uses a research context of micro-level firm movements in an extractive industry with high levels of secrecy, simultaneously addressing the unusual industry dynamics of the natural resource grouping of industries and including a significant population of smaller firms (Chapters 3, 4, 5, 7, 8 and 9). It overcomes some of the traditional limitations of archival research discussed in Bryman (1989) and Atkinson & Brandolini (2001) by using newly compiled panel data and examining changes year on year using both longitudinal and cross sectional research (Beck & Katz, 1995). It also offers an opportunity to explore changes at the sub-firm level in terms of partnerships, exploration and

exploitation. This rich dataset has a number of future development possibilities including :

- The possibility of using tools such as UCINET IV to look at the interfirm network and to examine the linkages between firms in greater detail to look for cliques, and key influences in the network;

- More detailed examination of the triggers for exploration and exploitation events;

- More investigation of the formation of strategic groups and their compositions and evolutionary trajectories over the period of study of the industry;

- Further study of the differential institutional effects on these groups

Sadly the antecedents of this data source will become more inaccessible to future researchers as the provider, the Department of Trade and Industry is now only providing it as live, constantly-updated material and the number of copies of the source material is constantly diminishing as files are destroyed, firms disappear, etc.

10.5.2 Contribution to methodology

The research also uses a unique blend of methodologies to achieve this, drawing on quantitative and qualitative techniques and extensive triangulation. This offers an unusual opportunity to compare mental models of the industry with those derived from the archival reported data, thus operationalising Argyris & Schőn (1974). By using Template Analysis (Crabtree & Miller, 1992; King, 1994) systematically derived by the meta-map technique to the interviews, replication is possible and the coding is now explicit, moving towards a more normative approach than is usual with qualitative data analysis. Indeed this theoretically-grounded distinctive methodology building on King (1998) to capture concepts from interviews and build a coding tree before using qualitative coding software, was not found anywhere else at this time (Chapters 6 and 8). This also contributes to the large body of research into cognitive mapping, especially Laukannen (1998) by extending it.

Triangulation and the virtuous circle created by moving between the pilot data, the interview and the main study not only allowed for further clarification of the data but also for enrichment of conclusions, again linking in to some of the other contributions in this section.

10.5.3 Key Contributions to the literature

The research draws together the hypotheses and the literatures discussed in Chapter 3 as shown in Table10.1 and the evolutionary/coevolutionary,

resource– and knowledge-based view literatures through the use of a *'spine'* of the principal literatures from Chapter 3, as shown in Figure 10.1

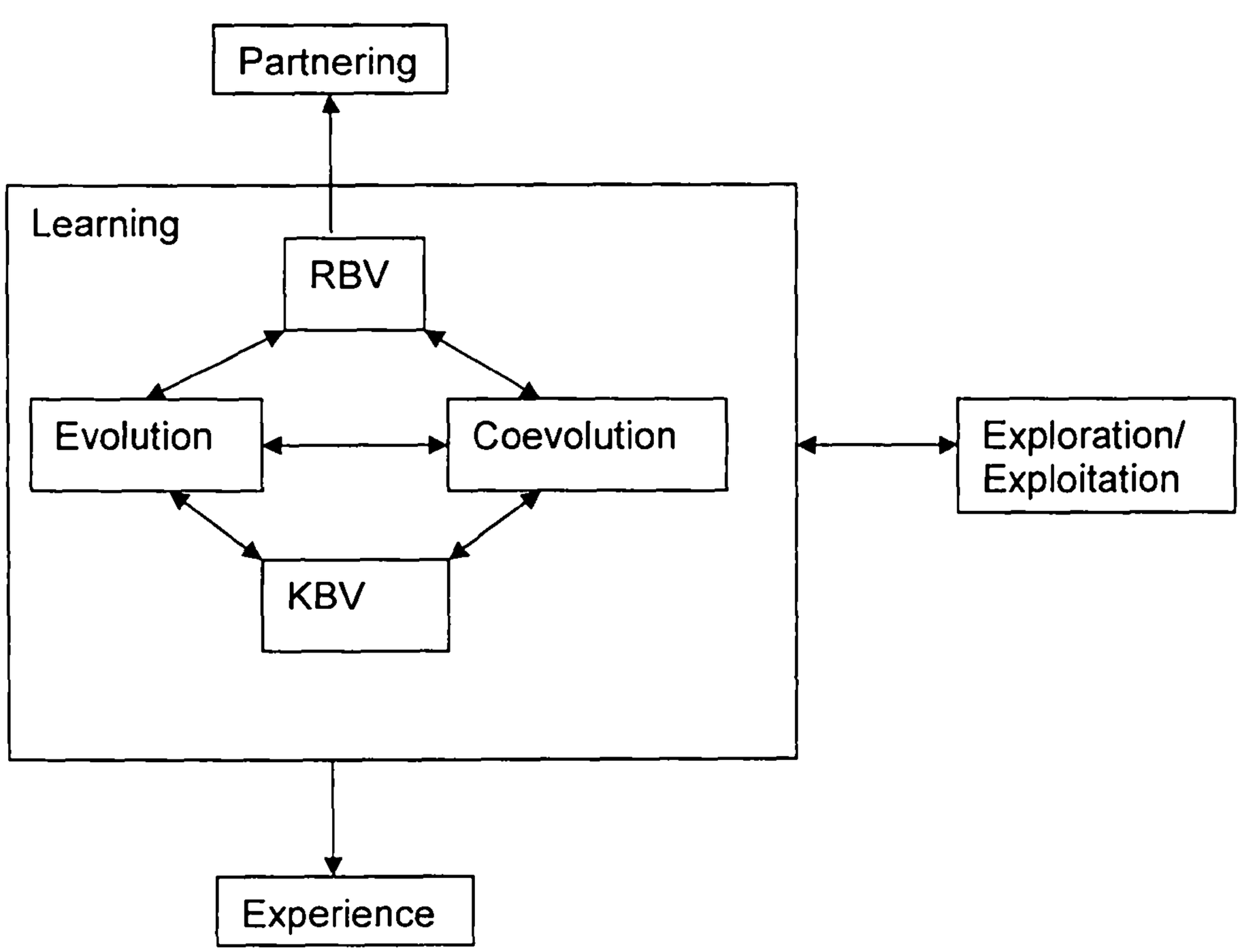

Figure 10.1: The Literature Spine

Hypotheses	Literatures	Contribution to Knowledge
(H0): Size only partially explains survival?	Size	The literature is divided on this. This study offers a partial resolution by suggesting that size is a limited contributor to survival and confirms that it is important to look at the masking effects of dominant players on the results.
(H1): The munificence of environment plays a greater part in survival as a firm remains longer in the industry. The perception of industry informants is that these are **the** key drivers, not borne out by the quantitative study.	Resource Dependency	This suggests that the importance of external selection factors varies over a firms life. It also emphasises the difference between the perceived schemas articulated by industry participants and the results from a quantitative analysis of data reported to Government by them.
(H2): Early entry only confers limited survival advantage	Population Ecology; Corporate Demography	The results contradict findings from other studies. However there may be industry specificity effects – for this study, incumbency in attractive investment site or having access to resources to buy these positions, is critical to survival.
(H3): The completion of discretionary adaptation events (exploration and exploitation) is linked with longer survival at the individual firm level; exploiters in particular survive for longer, though completion of both types of events appears to confer survival advantages.	Dynamic Capabilities; Organizational Learning	Firms acquire competence or capability in exploitation and exploration which longer survivors then use extensively. This finding also contributes to the literature. Exploration followed by exploitation is the dominant sequence in this study. The apparent literature conflicts concerning exploration/exploitation sequencing can be explained as follows from this research: Taking the multilevel system perspective used by coevolutionary scholars, it seems that firms use exploration/exploitation strategies **inside this industry** (viewed as an exploitation strategy when perceived at the inter-industry level) to rehearse for further exploration **into new industries**.
(H4): Large numbers of intra-industry ties support longer firm survival	Size; Networks and Partnerships	This study is congruent with existing literature – partnering as a means to share risks, costs and information is a feature of this industry where high asymmetries exist for these areas.
(H5): Intra-industry experience enhances survival.	Organizational Learning	This empirically confirms the literature, but a caveat is necessary as experience is difficult to separate from exploration/exploitation. Experience is also used here as a legitimising device by firms.
(H6): Firms are selected out by adverse environmental shocks.	Population Ecology; Corporate Demography; Resource Dependency; Strategic Groups	Again the literature is supported, though there is a suggestion that adaptation and legitimation can mitigate shock effects.

Table 10.1: Links between the Hypotheses results, the Literature and the Contribution to Knowledge

10.5.3a The contribution to the Evolutionary/Coevolutionary literature

Lewin et al (2003) describe a coevolutionary system in Figure 3.2, which is also echoed in Allen et al (2003) and the three levels of interaction in a self-organizing system: environmental, interactive and performance, which Gilles (1999) terms *'pillars'*. In Allen's descriptions of complexity, the search for the optimal new form mentioned by Lewin, or indeed any optimisation on the competitive landscape, is doomed to failure over time. Coevolution offers only transient supremacy as the equilibrium is punctuated, (Eldredge & Gould, 1972), not permanent. The landscape, the macroenvironment and the agents continue to coevolve and so advantage is short lived. Unlike traditional evolutionary theory which extols survival of the fittest, the determinants of differences tend to diffuse through the population, driven by institutional mimetic pressures towards isomorphism (DiMaggio & Powell, 1983) so that the differences that permitted differential survival become the new norms.

Though this research does not close the coevolutionary loop with a series of clear pictures of how learning and change to the system have occurred, a follow-up project will demonstrate this and also show the changing configurations of incumbent firms, building further on the work on strategic groups begun in this thesis, and continuing the contribution.

The research findings supports March (1991) and subsequent papers in that exploitation follows exploration – in this study it appears that, overall, exploitation may confer the survival advantage, possibly because of the high degree of information asymmetry in the industry. This, together with the explanation for the sequencing differences, relating them back to information barriers and asymmetries is one of the most important findings of this thesis (Chapters 7 and 9).

The research also supports the view that diversity of forms occurring in surviving populations, (Thompson 1999a, 1999b) are important as opposed to a single optional evolutionary form.

10.5.3b The contribution to the Resource–Based View of the firm

The research also contributes to the literatures on firm survival resulting from dynamic capabilities, specifically discretionary adaptation, through its findings that exploration and exploitation activities are important for survival (Chapters 3, 4, 7, 8 and 9). Work on dynamic capabilities, competitive positioning, game theory and more recently real-options approaches to strategy and the recognition that the dynamics of changes in strategy, and the processes and mechanisms provide important insights into the working of firm are still relatively recent strands of research.

The study offers two areas of contribution:

To the RBV by looking at the emergence of differential capability combinations (partnering, exploration/exploitation, experience) as contributors to superior

performance (i.e. adaptation –based competences) alongside the selection pressures generated by the external environment and its effects on Industry Key Success Factors (Grant, 1993), i.e. an absolute view.

To the Dynamic Capabilities approach by offering an examination of these capabilities over time, within an industry competitive milieu and against the turbulent external environment described in Appendix E as contributors to survival, i.e. a relative view. Porac, Thomas, Wilson, Paton & Kanfer (1995) identified perceived schemas for survival within an industry using strategic groups and Bogner, Thomas & McGee (1996) looked at dynamic strategic groups to examine entry strategies and linked the strategy to the resource endowment of the firm, congruent both with the dynamic capabilities view of strategy (Teece, Pisano & Shuen, 1997) and with Allen et al (2003). This has been demonstrated using the two clustering models described in Table 7.3 and Section 9.5, but will form the basis of some follow up work linked to that mentioned in the preceding section.

In summary, the research makes a contribution to the Resource Based View of the firm by providing empirical evidence for discretionary adaptation at the firm level as a basis for survival strategies (Chapters 3, 4, 7, 8 and 9) both statically and dynamically.

10.5.3c The contribution to the Knowledge-Based View of the firm

Allen (1999) and Allen, Strathern & Baldwin (2003) link complexity to evolutionary economics and this thesis addresses the legacy of Nelson and Winter and in particular the idea of dynamic capabilities or competences. The findings contribute to this literature because they provide empirical testing of competence development (and indeed evolution) and the links to strategy. However, the KBV suggests that knowledge is transferred between firms. This study finds that there is no evidence of knowledge transfer, indeed the discrepancy between the archivally-generated views of survival and the at produced by the informants is so strikingly different that is poses a future important research question. Learning was not directly investigated, but a future research project will examine this discrepancy further as it challenges current theory, or can certainly offer important limitations to it. One potential explanation might lie in the observation that the archival data is provided by the firms who may wish to manipulate the public perception, but since the data is factual, this does not suffice. The response from industry participants when I ran the poster session, suggested that they did indeed think of these things as being important, so another potential explanation could be that they are so ingrained in the industry to form normalised routines, almost an autonomic response (to use a biological metaphor) and therefore did not appear as important issues in the interviews because they were a part of the industry routine.

So to summarise, the contribution is to suggest that there may be limitations to the transfer of knowledge between firms in an industry and there is also a

potential discrepancy between what constitutes learning as a contributor to survival based on the reported data and the informant data.

10.5.3d Looking back to the Systems Approach

However, it is also possible to link all of these areas together by looking back to the discussion of complexity in Chapters 1, and 2 and further developed in Chapter 6. Allen et al (2003) discusses the '*complex systems dialogue between exploration (of possible futures) at one level and the unpredictable effects of this both at the level below and the level above*'. This is exactly what is mentioned in Table 10.1 under H3, but because we are able to specify the system quite tightly because of the unusual nature of the extractive industry and the data set, we can also limit the unpredictability of the effects and define them in terms already used. However we need to be heedful of the dangers of overspecifying the microscopic diversity and thus compromise the macroscopic model, (Allen & McGlade, 1987). Allen discusses qualitative evolution of the exchanges between the multiple agents that compose the system and this is partially borne out by the interview data, though oil, with a well developed commodity market could be valued within a fairly narrow range of agents' policies to also look at this quantitatively and develop this work further. Finally Allen's views on structural attractors (Allen, 2003) as emergent complex systems and thence representatives of the creating of *'new types'* (Allen & McGlade, 1987) from search routines in his models are also present here.

10.5.4 Other contributions to theory

This research makes an additional minor contribution to a number of other theoretical areas.

As well as the contributions mentioned in Table 10.3, there is a contribution to practice through an analysis of the influence of government policy, expressed through macro-economic measures, on the successful development of an indigenous industry, building on Dobbin & Dowd (1997). This finding has relevance for other countries attempting to develop natural resources and managing technology transfer (Chapters 1, 3, 7 and 9).

The research posits and tests a model of survival strategies in this industry. By mapping firms on to this grid, governments and industry analysts can assess survivability as a proxy for profits for smaller firms, and consider ways to foster better industry ties (Chapters 7 and 9).

Finally, the research addresses the request in McKelvey (1994) for research into a significant population by Organization Scientists (Chapters 2 and 3).

10.6 Limitations

Inevitably there are some general limitations to this study. The key limitation is that this is a single industry study with a small number of firms. It is an exploratory study; the industry size and distribution assumptions mean that the conclusions must be viewed with caution, especially concerning generalisibility

other than to natural resource contexts. One alternative approach of Structural Equation Modelling which has been used to deal with small non-parametric datasets would still encounter problems with the dataset limitations. There is little that could be done to change this as alternative data offering access to investment level changes for an industry is uncommon.

There are issues about the reliability and robustness of secondary data, although this should have been addressed by the interviews and the extensive data cleaning. The triangulation between the quantitative and qualitative data and the good congruence between the conclusions suggests that these issues have been addressed. Should the Wytch Farm field have been excluded? Findings from both populations have been included for much of the quantitative data analysis showing the distortions arising from inclusion of this data. The Wytch Farm firms are large and long-lived because the field or investment asset is so attractive, but the interviews suggest the atypical nature of the asset, referred to as *"an offshore field onshore"* by industry experts. The compromise was to include it for comparative purposes. A follow-up study on offshore firms would enable better differentiation between larger and smaller firms.

Does the use of changes in investments in this study accurately capture the concepts of exploration and exploitation? One anonymous reviewer has already pointed out that this context is atypical as it is finite as opposed to the assumption that more consumer-type traditional markets can grow infinitely (in theory!)[50]. Much of the work to date has been done on alliances and supplier/buyer relationships. One of the contributions of this study is that though work exists on bank branches, etc. as contexts, operationalisation of exploration and exploitation in a direct industry investment context is unusual. The study permits investigation of the robustness of the metaphor when used in less common settings, probing its limitations.

10.6.1 Theoretical Limitations

This research chose a series of particular standpoints based in theory, but there are alternatives such as strategic choice and population ecology, which are shown in Appendix B. Several of these alternative approaches are the subject of proposed future work, enabling the investigation of survival to be made more robust, such as in institutional theory. There are factors missing from the theory and the model, such as the quality of the CEO, which link to strategic choice. As discussed earlier, the design of this study and the nature of the firms means data collection would have been difficult. Thus by default this study follows a naïve selection path (Volberda & Lewin, 2003). Longitudinal studies are dynamic and firms grow in size during their incumbency, so though some firms may enter as comparatively small firms, by the end of the period of the study many are large. The research assumes equivalent capital rationing to this industry by external stakeholders as by internal stakeholders for large divisions of multinationals, which has not been empirically tested. The dichotomous regression also uses a common baseline to compare firms in terms of their

[50] In contrast with industrial markets which are finite. This is an industrial application.

length of time in the industry. A larger study could expand some of these potential areas for further study.

10.6.2 Qualitative Data Limitations

The informant interviews were not tape-recorded, though it is unlikely that there would have had very different results had this taken place. Note-taking is an established technique (Eden & Ackerman, 1998) and recording would have been useful for a different design including Discourse Analysis. Institutional pressures in the industry would have resulted in content censorship issues of transcripts, thus limiting data that could have been used. Almost all of the informants are still active in the industry or are public figures and thus are very sensitive to the risk of a tape discussing the industry getting into the wrong hands. To overcome this, notes were taken through the interviews and written up promptly; there was convergence between the informants' views and the data was still very rich, so this was not a problem. Sensitivity to censorship and the desire to maintain anonymity of informants suggested that a verification route would be optimally achieved by circulation of a synopsis of the thesis findings to informants.

There may have been issues with the interview coding schema which was subjective though its components were triangulated against the literature.

My proximity to the industry and its issues as well as my prior knowledge of the informants might have blinded me to external observations. A ten-year gap in close contact with this sector should have placed some distance and perspective, but the trade-off was that without prior knowledge access would have been near impossible and also the barriers of industry jargon, practices and history would have been time consuming to overcome to maintain credibility and thus accurate data. There could be ethnographic undertones, suggesting a degree of involvement by the researcher, especially as this study sets out to favour the Objectivist approach as set out in the Organization Science agenda (McKelvey, 1997), but this divide is not clear-cut and a valuable lesson that I have learned is that there are many shades of grey between the polar perspectives discussed in Chapter 2 and Chapter 6.

10.6.3 Quantitative Data limitations

The small datasets have already been mentioned, so detailed statistical regression on more than two independent variables becomes open to challenge at the population level. Even looking at the firm level data, where n= 54 or 45 depending on whether Wytch Farm is included, this is barely acceptable in the statistics literature, e.g. Tabachnik & Fidell (1996, pp.132-133). There are also issues with the interrelationships of the variables and the entry rates - over 20% of all firms entered in the last 3 years of the study.

The standard regression analysis technique used in many papers in the literature is also limited here because of the relatively small numbers of firms and years. By electing to carry out a longitudinal study statistical methods are limited as a result of the data structure as well as problems with traditional

cross-sectional time series approaches (Beck & Katz, 1995). One way to attempt to overcome this, to consider each firm's survival in each field for each year as a separate survival event, has produced inconclusive results. Structural equation modelling (SEM) might have offered an alternative approach and could be used in a follow-up study though it requires larger datasets.

10.6.4 Methodology Limitations

Inevitably there are dangers concerning conclusions drawn from either quantitative data or qualitative data alone, where there may be other explanations. The study combined quantitative methods with qualitative methods in line with the epistemological stance taken, and to triangulate findings, following practice in the literature (Smith, 1975). It used a version of the template analysis discussed in King (1998). The latter is a Phenomenological approach, and thus inconsistent with the philosophy espoused in Chapter 2 - but interview analysis is always going to be affected by prejudices of the researcher, and it offers both triangulation possibilities and illumination of archival datasets as major counterbalances to this potential drawback. My earlier comments about the blurring of the boundaries between the polarities discussed in much of the epistemological literature apply here, but I feel Campbellian Realism is consistent with both the quantitative and the qualitative approaches I have used, as well as the triangulation.

10.7 Future Research Directions

10.7.1 Proposed Future Research on Onshore Oil and Gas

One next step would be to expand the study to look at all firms onshore in the UK and see how replicable the conclusions of this study are. This addresses the issue of survivor bias (Denrell, 2003) implicit in the data by looking at all potential entrants to the industry at the level below production. In this scenario, the complete potential population of all industry entrants would be evaluated using confidential proprietary data going back to 1960. An analysis of all the data on the 1960-1999 population of all firms that had entered or left the onshore oil and gas industry including those that had not survived until production occurred – a major scale up from the data used in this thesis - would allow observation of differential effects of selection and discretionary adaptation on those firms less embedded in the industry, i.e. with smaller financial stakes at risk. It would also give an opportunity to see what happened to the oil majors, largely absent from the production industry.

There are also possibilities to look at some detailed analysis on the structure of the industry networks; Structured Equation Modelling analysis (though on a different population) and some work on the role of leadership and entrepreneurship in this population, e.g. as suggested in the previous chapters, a study of leadership characteristics to test for their impact on survival could be completed, though data could be difficult to collect.

Another potential area of work would be the Delphi study discussed in Chapters 6 and 8 to explore consensus views of industry success, probably as part of the comparative study of the offshore and onshore oil industries described next .

Finally, a study on the links between emotion and the behavioural view of investment (Ackert, Church & Deaves, 2003) was mentioned as a spin-off from the findings of Chapter 8.

10.7.2 Moving Offshore and International Collaboration

The much bigger research challenge is the inclusion of offshore oil and gas, and a contrast between the populations, though detailed data is proprietary and not in the public domain.

The research on policy-driven selection factors lends itself to an international comparison study, and an extension would be to compare the effects of governmental regimes in the UK, Norway and Holland on firm survival, especially looking at the tension between policy issues and discretionary adaptation strategies at the firm level.

10.7.3 Institutional Theory Approaches

Yet another future theoretical research project lies in the collection of career histories and other data to explore the *"fault line"* between the sociological view of institutional theory (DiMaggio & Powell, 1983; Meyer & Rowan, 1977) and the economists' view of institutional theory (North, 1990; Williamson, 1998).

10.8 Papers already presented

At the close of 2003, four papers had been presented on this research with one more accepted for the US Academy of Management meeting in 2004:

1. Association of Business Historians, May 2003: *Survival of the fittest, or survival of the fattest: firm survival in the UK onshore industry.*

Abstract: This research looks at the survival of firms inside an industry boundary - that of onshore oil and gas exploration and production in the UK over the period from 1983 to 1999. The preliminary results suggest that firms follow one of four strategies over time, and that one strategy is clearly linked to longer-term survival inside an industry boundary, independent of firm size.

This was an invited paper from the head of the BP History Project, who was also the Chairman of the Association. The conference consisted of business historians, sociologists, historians, economists, organization theorists and longitudinal study methodologists from many traditions.

2. European Group for Organization Studies (EGOS), July 2003*: Survival strategies, information and networks: Adaptation in UK onshore oil firms, 1983-99.*

Abstract: This paper looks at the survival of organizations inside the industry boundary and links it to the successful management of information asymmetries through a coevolutionary process. The relationship between post-entry survival and successful coevolution is considered as well as the role of inter-organizational partnerships. Using a mixture of quantitative and qualitative techniques the link is confirmed, and some strategic groups are identified in this research context, a highly secretive natural resource industry. Lessons are drawn for policy-makers, organizations and theorists.

This short paper, co-authored with Mitchell Koza, my former supervisor, was presented to the New Organizational Forms track.

3. British Academy of Management, September 2003: *Getting a move on: exploration and exploitation strategies inside an industry boundary.*

Abstract: March (1991) discusses the concepts of exploration and exploitation in the context of organizational learning. His research has been tested empirically by several researchers who use a series of different perspectives. In this paper, exploration and exploitation is considered in the context of a natural resource industry in a 15-year total industry population study. Five hypotheses are tested, some based on existing research, with mixed results. Industry-related effects might offer a partial explanation, but as an integrating explanation for the differences, a new model based on concepts from systems-theory is proposed.

This working paper, the first development paper from the thesis, was presented to the Strategy track.

4. Strategic Management Society, November 2003: *How does your garden grow? An exploration of the interaction of government policy and the UK onshore petroleum industry, 1960-1999.*

Abstract: There is much public rhetoric by host governments pertaining to the fostering of industries, and especially indigenous industries in the context of resource development. However, there appears to be very little investigation of the effectiveness of various governmental policies. In this study the case of the UK onshore petroleum industry over the period 1960-1999 is examined alongside the impact of various governmental policies on the industry population size. Entries and exits and clusters of firms following shared trajectories are analysed and lessons for policy-makers and firms about survival within an industry boundary are drawn, as well as theory extended.

This paper looks at the early results from the follow-up study, and was presented to the Public Policy track.

5. Academy of Management (AoM), August 2004: *The causes of survival: balancing exploration and exploitation.*

Abstract: What drives some firms to survive for long periods within an industry and some firms to exit after a short period? This paper looks at the adaptive actions of a firm as a cause of its survival. It provides empirical evidence that a balance between exploration actions and exploitation actions is important in predicting survival.

This paper, co-authored with Bob Phelps, is being presented at AOM in August 2004 in the Business Policy track.

10.9 Reflections

The thesis opened with some personal observations about my role in this research project, and so it closes in a similar vein. In the process of completing this research project, I have learned a great deal about research and also about myself as a researcher. I can summarise my findings as follows:

1. A better understanding of the need to use simplicity in research projects and to temper ambition with practicality;

2. The acceptance that everyone has a view on a research project and would like to influence it;

3. A development of my own teaching and project supervision skills (I am completing a Post-graduate Certificate in Education);

4. An improvement in my own knowledge and understanding of statistics;

5. The recognition that all researchers lie on a continuum between Objectivity and Subjectivity, and that it is possible to combine an Ethnographic bias with a quantitative study through a Realist agenda;

6. The discovery that interviews are short to complete and endless to analyse;

7. The practical application of theory: intra-industry ties are important in this research project and also important for researchers; exploration and exploitation approaches to research projects are also appropriate;

8. Communication and the ability to produce a short explanation of a research project in layman's terms, especially on social occasions, is a very important core competence.

Finally, the journey to get to the end of this thesis has been enlightening and also not without difficulties - I would like to thank all who helped me along the path.

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APPENDICES

Appendix A: Single-Lens Theories Informing Selection-Adaptation Discourse: Lewin & Volberda (1999);

Appendix B: Theoretical Perspectives, Evolutionary Processes and Outcomes: Aldrich (1999, p. 44);

Appendix C: Evolutionary Economics - Another Possible Taxonomy: Hodgson (1999b, p.35);

Appendix D: Antecedents of Coevolution: Lewin & Volberda (1999);

Appendix E: Industry Time Line from 1973-1999;

Appendix F: Firms in the Research Population Discussed in the Thesis;

Appendix G: Onshore Oilfields Discussed in the Thesis;

Appendix H: List of All Fields Showing License Numbers to Explain Duplications;

Appendix I: Correlation of Selection Variables with Firm Survival Years for the Pilot Study, (H1);

Appendix J: Interview Solicitation Letter;

Appendix K: Interview Protocol used for Semi-Structured Interviews with Industry Informants;

Appendix L: Coding Schema for NVivo derived from Mind maps and Meta-maps;

Appendix M: Correlation Table of Selection Variables with Post-entry Survival for the 1984-99 Population including Wytch Farm Firms, (H1);

Appendix N: Correlation Table of selection variables with post-entry survival for the 1985-99 population excluding Wytch Farm firms, (H1);

Appendix O: Answer Tree Exhaustive CHAID Classification of Onshore Pilot Firm level Data into Groups;

Appendix P: Answer Tree Exhaustive CHAID Classification of Onshore Main Study Firm level Data into Groups.

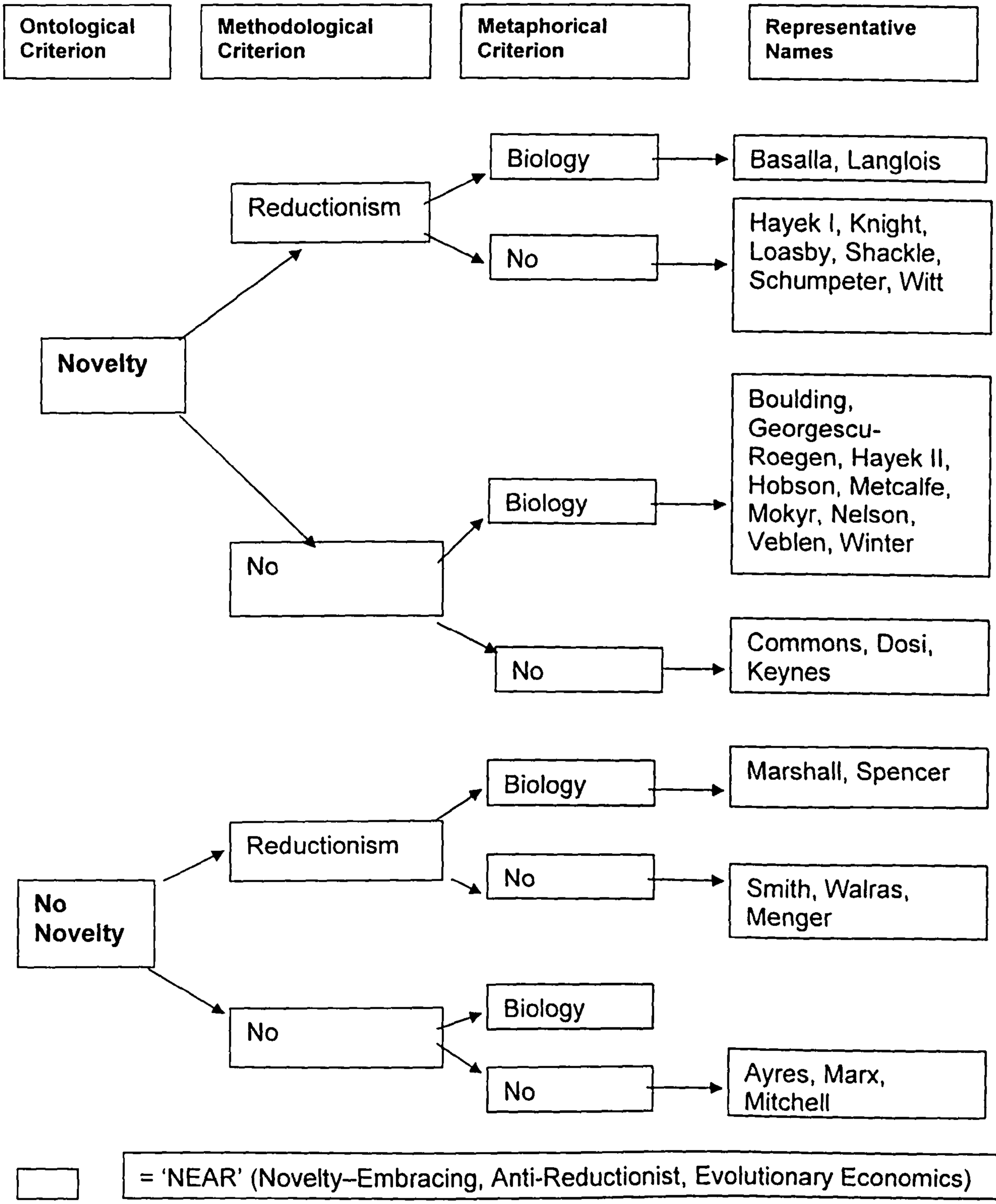
Appendix A: Single-Lens Theories Informing Selection-Adaptation Discourse: Lewin & Volberda (1999)

Theoretical Roots	Dominant Paradigm	Selection/Adaptation	Managerial Implications
Sociology	Population ecology	Population selection and structural inertia	Management makes no difference; new entrants redefine industries; established firms should focus on what they do best until selected out
	Institutional theories	Population isomorphism based on industry norms and shared logics	Established firms should adopt fast follower strategy for aligning organizational form with prevalent institutional norms and values; population dominant logic
Economics	Industrial organization	Level of industry attractiveness and competitive advantage within that industry	Managers should choose an attractive industry; define performance frontier for a generic strategy; reduce intra-industry rivalry and create barriers to entry
	Transaction costs	Minimization of transactions costs within and between firms	Managers should focus on relative coordination costs of transacting inside versus outside the firm by minimizing transaction costs
	Behavioral theory of the firm	Satisfying multiple stakeholders, structural inertia due to satisficing, uncertainty avoidance and slack	Periodic restructuring and rationalization. Exploration requires strategic intent to allocate slack to innovation. Negotiate environment to reduce uncertainty
	Evolutionary theories	Success reinforces incremental improvements and proliferation of routines as source of inertia (e.g. sunk costs, commitments, social structures)	Managers should overcome preference for improvement of prior and commensurate skills that result in incremental innovations
	Resource Dependence Theory	Organizations have discretion and power to shape and enact their environments which themselves represent opportunities for strategic alternatives. Dependence reduction and dependence restructuring are generic strategies for controlling or enacting the environment	Managers should reduce environmental uncertainty by selecting, enacting and/or negotiating their environment. Control and shape access to resources through a mix of dependence reduction or dependence restructuring strategies
	Resource-Based theory of the firm	Idiosyncratic resources basis of sustained competitive advantage, causal ambiguity in evaluating own and competitor core competencies source of sub optimal performance	Managers should maximize unique core competency, correct causal ambiguity in judging own and competitors core competencies
	Dynamic Capabilities/ Knowledge-based theory of the firm	Sustained competitive advantage based on dynamic capabilities and intellectual capital	Management should focus on knowledge creation and integration, continuously renew knowledge base
	Contingency theory	Environment source of variation in performance	Top management must interpret and react to changes in environment, maintain fit through changes to organization form
Strategy and Organization Design	Strategic choice	Variation in performance results from environmental changes and from firm shaping of environment	Managers should achieve dynamic fit through monitoring and shaping of environment
	Organizational learning	Variation in performance results from changes in environment and organization ability to adapt through learning	Managers need to balance single and double loop learning
	Life-cycle/punctuated equilibrium	Periods of adaptation and consolidation are followed by periods of radical competence-destroying change	Managers should anticipate radical change by managing dichotomy between incremental and radical innovation

Appendix B: Theoretical Perspectives, Evolutionary Processes and Outcomes: Aldrich (1999, p.44)

Perspective	Variation, selection and retention	Transformation
Ecological	• Variation introduced via new organizations • Selection results from fit between organizations and environment • Retention through external pressures and internal inertia	• Organizations are structurally inert and slow to change • Selection and transformation are fundamentally related
Institutional	• Variations introduced from external origins such as imitation • Selection via conformity • Retention through transmission of shared understandings	• Organizations change when forced to do so • Institutionalization makes many kinds of change unimaginable
Interpretive	• Variation introduced as people negotiate meaning through interaction • Selection via emergent understandings and compromise • Retention is problematic – depends on learning and sharing	• Organizations are not very inert • Discontinuities are frequent
Organizational learning	• Variation introduced via problemistic search or information discontinuities • Selection results from fit to target aspiration level or existing organizational knowledge • Retention in program(me)s. culture and routines	• Organizations are open to change • Most change is incremental rather than radical

Appendix C: Evolutionary Economics - Another Possible Taxonomy: Hodgson (1999b, p.35)



Appendix D: Antecedents of Coevolution: Lewin & Volberda (1999)

Aspects of Coevolution	Contributors
Historical Embeddedness	• Replacement of medieval guilds by mercantilist factories (Kieser, 1989) • Emergence of bureaucracy (Weber, 1910) • Diffusion of M-form (Chandler, 1962) • Historical institutional analysis of French and British firms (Calori et al, 1997)
Levels of Coevolution	• Micro and macro coevolution (McKelvey, 1997) • Intra-organization, organization, population, and community coevolution (Baum and Singh, 1994) • Internal and external context (Pettigrew, 1995)
Interaction Genealogical and Ecological Processes	• Enactment, double interacts (Weick, 1979) • Variation, selection, retention (Aldrich, 1979) • Mutual learning (Nelson and Winter, 1982; Levitt and March, 1988) • Coevolution of capabilities and competition (Huygens 1999; Levinthal and Myatt, 1994) • Synthesis of ecological and genealogical processes (Baum and Singh, 1994; Levinthal, 1991; Mezias and Lant, 1994)
Zero-sum Competitive Coevolutionary Systems	• Red Queen Race (Beinhocker, 1997; Kauffman, 1995; Van Valen, 1973) • Hypercompetition (D'Aveni, 1994) • Adaptation on various fitness landscapes (Levinthal, 1997)
Pluralistic Competitive Coevolutionary Systems	• Competitive coevolutionary configurations (Baum, 1999; Heylighen and Campbell, 1995)
Cooperative Coevolutionary Systems	• Learning alliances (Hamel, 1991) • Coevolution of alliances (Koza and Lewin, 1998)
Micro Coevolution	• Intra-organizational ecological processes (Burgelman, 1991, 1994, 1996) • Selection and adaptation at intracorporate levels of analysis (Barnett et al, 1994; Galunic and Eisenhardt, 1996

Appendix E: Industry Time Line from 1973-1999

Year	Institutional Environment Changes	License Rounds	Oil Price Change	Maximum Oil Tax Rates	Extra Institutional/Other Events
1973			Shock 1 rise		1st Large onshore oil find;
1974	Labour Govt;				
1975	Major tax changes; Burmah Oil Co rescue; Govt guarantees 2 oil loans to independents; Production level assurances given;			76.9	
1976	State equity participation introduced; IMF intervention in UK;	Off 5		76.9	
1977				76.9	
1978			Shock 2 rise	76.9	1st offshore platform removed; UK now all natural gas;
1979	Conservative Government; State role redefined;	Off 6		83.2	
1980				87.4	US/UK tax treaty; UK self-sufficient;
1981	State role changed to option; Tax increase (20%); State gas monopoly break-up begins; New depletion policy announced;	Off 7		90.3	New gas gathering system planned; Shell New Forest application contested; Hatfield Moor onshore gas blow out;
1982	Onshore license changes; State oil participations break-up begins; Britoil OFS – 1; BP share sale to Kuwaitis;			91.9	New gas gathering system aborted; FLAGS pipeline on line;
1983	Tax decreases	Off 8		88	Shell leaves onshore after new Forest application decined; Forties/Claymore offshore tax-based production sales – large influx of 7th Round companies seeking tax shelter
1984	Wytch Farm Onshore Sale - new entrants;		Shock 3 fall	87.5	EOR programme begins;
1985	Tax relief for onshore withdrawn;	Off 9		86.25	
1986	More tax changes;	On 1		85	Wytch Farm has 10-fold increase in production - onshore becoming more attractive;

Appendix E: Industry Time Line from 1973-1999 (continued)

Year	Institutional Environment Changes	License Rounds	Oil Price Change	Maximum Oil Tax Rates	Extra Institutional/Other Events
1987		Off 10 On 2		83.75	Abandonment provision phased in, so costs rise; UK/US stockmarket crash
1988	BGC monopoly investigation - changes in gas sales to BGC means more gas fields could be developed;		Shock 4 rise	83.75	Piper Alpha offshore tragedy;
1989		Off 11; On 3		83.75	BP major onshore license disposal;
1990	BGC monopsony/monopoly abolished;		Shock 5 fall	83.75	Cullen Report on Piper Alpha safety improvements, costs rise; First gas–fired power stations agreed;
1991		Off 12/13; On 4/5		83.5	
1992		On 6		83.25	
1993	Some tax abolished for new fields;	Off 14		70.7	
1994		Off 15	Shock 6 rise	70.7	
1995		Off 16; On 7		70.7	
1996		On 8	Shock 7 fall	70.7	Coal–bed methane development begins;
1997	Labour Govt; Tax reductions;	Off 17		69.8	Gas-fired power on hold;
1998		Off 18		69.8	
1999		On 9		69.37	Gas-fired power restarts.

Appendix E: Industry Time Line from 1973-1999

Key:

- Institutional environment changes = Legal/structural changes for this industry.
- Oil Price Change = Significant oil price shocks/changes.
- Maximum offshore tax = The maximum marginal tax rate for offshore oil production.
- BGC = British Gas - gas purchasing monopsonist and distribution monopolist.
- BNOC = British National Oil Company – State participation vehicle.
- EOR = Enhanced Oil Recovery.
- Forties/Claymore Sales = BP and Oxy auctioned ¼% units of mature offshore tax paying production in these fields, which were hitting the decline curve. They were an attractive purchase to an exploration company with unused tax losses. However, the Government subsequently denied tax offsets by onshore companies against off-shore production, so smaller companies, were forced into mergers, sales etc.
- Off = Offshore Licensing Round - date awarded
- On = Onshore licensing Round. The year is the date the round was announced, not completed as the round may have been open for a year.
- OFS = Offer For Sale (of shares) – part of the Government's Privatization scheme.
- Wytch Farm Sale = British Gas was forced to sell its interest in the largest onshore oil field by the Government. They procrastinated for 2 years, and eventually sold it to a consortium of UK independents. This deal, together with the Forties/Claymore deals, appears to be the critical event in kick-starting the development of the independent oil sector.

The events on this time-line were validated by cross-checking against a much larger independently prepared industry timeline for a research project by the Exploration and Production Technical Services Manager of one of the US oil majors present in the UK.

Appendix F: Firms in the Research Population Discussed in the Thesis

Firm names	Firm names (cont'd)
AltaQuest Energy Corp (UK) Ltd	Altwood Petroleum Ltd
Ambrit	ARCO
Arcon Minerals & Petroleum	Blackland Exploration Ltd / Blackland Park
Blackfriars	Brabant
BP	British Gas (BGC)/BG plc
Britoil	Cairn Energy
Caribe Natural Gas Ltd	Carless Petroleum
Charterhouse Petroleum	Cirque Energy (UK) Ltd
Clyde Petroleum	Coal Bed Methane
Conroy Petroleum (NI)	Courage Energy UK Ltd
DSM Energy (UK)	EDC (Europe) Ltd
Edinburgh Oil and Gas	Elf Aquitaine
Fina	Floyd Oil & Gas
Fortune Oil & Gas	Goal Petroleum
Hardy Oil & Gas	Independent Energy Resources Ltd
International Petroleum Corp	Industrial Scotland Energy
James Finlay	Kelt Energy
Kerr-McGee	LASMO
Marinex	Melrose
Mermain Resources (UK) Ltd	Middlefield Morrison Resources (UK) Ltd
Monument	ONEPM
Pentex	Perenco
Pict Petroleum	Premier Consolidated
Providence Res (NI)	Purbeck Exploration
RTZ Oil & GAS	Scotpower
SOCO International plc	Sulpetro (UK)
Talisman	Taywood
Teredo	Total Oil Marine
Trafalgar House Oil and Gas	Tricentrol
Tullow	Ultramar
United Energy plc	

Appendix G: Onshore Oilfields Discussed in the Thesis

Field names	Field names (continued)
Airth	Albury
Arns Farm**	Beckingham West
Calow	Caythorpe
Cold Hanworth	Crosby Warren
Elswick	Farleys Wood
Fiskerton	Glentworth East
Goodworth	Hatfield Moor
Horndean	Humbly Grove
Keddington	Kirby Misperton
Kirklington	Long Clawson
Malton**	Marishes**
Nettlesham	Newton
Palmers Wood	Rempstone**
Saltfleetby*	Scampton North**
Scampton**	Singleton
Stainton**	Stockbridge
Storrington	Trumfleet
Wareham**	Welton
West Firsby	Whisby
Wytch Farm	

* denotes a field removed after right censoring data
** denotes a field removed as potential duplication

Appendix H: List of All Fields Showing License Numbers to Explain Duplications

	Discovery	Annex B	Production start	Peak production	AB/PS[51]	License no.
Airth	1993	1996	2000		4	exl 237
Albury	1987	1993	1994	1994	1	dl004/pl 242
Arns Farm	1998	1998	2000	2001	2	exl237
BeckW	1985	1987	1987	1988	0	pl178
Calow	1965	1999	2000	2001	1	pl213
Caythorpe	1987	1992	1992	1993	0	pl234b
Cold Hanworth	1997	1998	1998	1998	0	pedl006
Crosby Warren	1986	1987	1987	1987	0	dl001
Elswick	1990	1995	1995	1996	0	exl269
Farleys Wood	1983	1985	1985	1986	0	pl215-1
Fiskerton	1997	1998	1998	2000	0	exl294
Glentworth	1987	1992	1993	1998	1	pl179-1
East Goodworth	1987	1998	1998	1999	0	pedl021
Hatfield	1981	1985	1986	1986	1	**pl161/pl162**
Horndean	1982	1988	1988	1989	0	pl211
Humbly Grove	1980	1985	1985	1987	0	pl116
Keddington	1998	1998	1998	1998	0	pedl005
Kirby Misperton	1985	1994	1995	1996	1	pl080a
Kirklington	1985	1991	1991	1991	0	pl216
Long Clawson	1996	1990	1990	1997	0	pl220-1
Malton	1985	1994	1995	1997	1	pl080a
Marishes	1988	1994	1995	1996	1	dl005
Nettlesham	1983	1985	1985	1990	0	**pl179-2**
Newton	1998	1999	1999	1999	0	exl141
Palmers Wood	1983	1989	1990	1991	1	pl182
Rempstone	1985	1991	1991	1992	0	pl220-2
Saltfleetby	1997	1998	1998	2000	0	pedl005
Scampton	1985	1996	1996	1996	0	p179-2
Scampton (N)	1985	1988	1989	1990	1	p179-2
Singleton	1989	1991	1991	1993	0	pl240
Stainton	1984	1986	1987	1988	1	p179-2
Stockbridge	1984	1989	1990	1991	1	pl233/pl249/dl002
Storrington	1986	1997	1998	1998	1	pl205
Trumfleet	1957	1997	1998	1998	1	exl288
Wareham	1964	1990	1991	1992	1	pl089
Welton	1981	1984	1984	1990	0	p179-2
West Firsby	1988	1991	1991	1993	0	dl003
Whisby	1985	1990	1990	1990	0	pl199-2/pl215-2
Wytch Farm	1975	1976	1979	n/a	3	pl089

[51] AB/PS = the number of years from development approval to production start.

Appendix I: Correlation of Selection Variables with Firm Survival Years for the Pilot Study, (H1)

N=16		Surviving companies	Oil price	Max tax charge	GDP	UK base rates YE	Eurodollar 6 month rates	Annual onshore production	Field numbers	Market cap of oil sector	New field entries	Vertical wells to deviated wells	Annual number of deviated wells
Surviving companies	Pearson Correlation	1.00	-0.77	0.28	-0.18	-0.35	-0.74	0.48	0.53	0.26	0.31	-0.64	-0.25
Oil price	Pearson Correlation	-0.77	1.00	-0.31	-0.26	0.27	0.59	-0.37	-0.45	-0.25	-0.18	0.63	0.11
Max tax charge	Pearson Correlation	0.28	-0.31	1.00	-0.06	-0.36	-0.22	0.40	0.60	0.60	-0.13	-0.17	-0.10
GDP	Pearson Correlation	-0.18	-0.26	-0.06	1.00	-0.03	0.02	-0.27	-0.19	0.09	-0.12	-0.11	0.55
UK base rates YE	Pearson Correlation	-0.35	0.27	-0.36	-0.03	1.00	0.79	-0.78	-0.73	-0.63	0.01	0.58	-0.17
Eurodollar 6 mo rates	Pearson Correlation	-0.74	0.59	-0.22	0.02	0.79	1.00	-0.75	-0.74	-0.44	-0.36	0.80	0.11
Annual onshore production	Pearson Correlation	0.48	-0.37	0.40	-0.27	-0.78	-0.75	1.00	0.95	0.77	0.11	-0.68	0.01
Field numbers	Pearson Correlation	0.53	-0.45	0.60	-0.19	-0.73	-0.74	0.95	1.00	0.84	0.18	-0.71	-0.02
Mkt. cap of oil sector	Pearson Correlation	0.26	-0.25	0.60	0.09	-0.63	-0.44	0.77	0.84	1.00	-0.13	-0.47	0.32
New field entries	Pearson Correlation	0.31	-0.18	-0.13	-0.12	0.01	-0.36	0.11	0.18	-0.13	1.00	-0.27	-0.28
Vertical wells to deviated wells	Pearson Correlation	-0.64	0.63	-0.17	-0.11	0.58	0.80	-0.68	-0.71	-0.47	-0.27	1.00	-0.12
Annual number of deviated wells	Pearson Correlation	-0.25	0.11	-0.10	0.55	-0.17	0.11	0.01	-0.02	0.32	-0.28	-0.12	1.00

Appendix J: Interview Solicitation Letter

Dear

Thanks very much for agreeing to see me next week. As I said, I would like to talk about the UK onshore oil and gas scene over the last 25 or so years from your perspective as a participant in it during this period, and especially the events that you feel shaped both the industry and the history of the firms during that time. All discussions will remain confidential and would only be used as an anonymous aggregate to either confirm existing research findings or to offer new directions that have not been obvious up to now ...(and I hope not too many of these!!).

Once again, thanks for agreeing to spare me your time – I look forward to seeing you again next week.

Kind regards,

Appendix K: Interview Protocol Used for Semi-Structured Interviews with Industry Informants

Name .....

Onshore Firm (now).....

Onshore Firm (past).....

Previous industry experience.....

Education.....

Nationality.....

First involvement with oil.....

First involvement with oil in UK.....

First involvement with onshore oil.....

Onshore Farm-in/out .....

Onshore Acquisitions/disposals.....

Onshore exits : License/Firm

Looking backwards, when do you think the onshore industry began in the UK?

And when did your personal interest begin? What sparked that off?

What do you think caused firms to enter the onshore oil industry in the UK?

Do you think UK onshore entry decisions were linked to other things? What were they?

Do you think UK onshore entry mode was linked to other things? What were they?

Examples.....

Do you think that the number of firms in the onshore oil industry has any influence on the birth or death of new firms interested in the onshore industry - founding/mortality rates?

Do you think that the number of firms in the onshore oil industry has any influence on entry, survival or exit of firms – crowding effect?

Turning to survival or longevity of onshore oil firms in the UK, what do you think caused some firms to endure for longer than others?

Factor 1..... Example.....

Factor 2..... Example.....

Factor 3..... Example.....

Others that might be applicable.....

What do you think are the key criteria for being awarded onshore licenses?

How do you perceive the role of field partners in the onshore oil industry?

How do you perceive the operator role in the onshore oil industry?

Do you think it matters whether you are a licensee from the beginning or you farm in or acquire the license interest in terms of onshore firm survival?

What factors might affect the decision to be a licensee from the beginning or a farm in or acquisition of an onshore license interest?

Do you think this changes over time?

What do you think caused firms to leave the onshore oil industry in the UK?

Do you think exit decisions were linked to other factors? What were they?

Do you think exit mode was linked to other things? What were they?

Examples.....

Even though firms have left the onshore industry, does this mean that key individuals, e.g. chairmen, managing directors, exploration directors, finance directors, do as well?

Examples.....

Any other factors you think are important to consider when looking at firm survival in the UK onshore oil and gas industry?

Appendix L: Coding Schema for NVivo derived from Mind maps and Meta-maps.

(NB: This was reapplied to clean uncoded interview notes.)

NVivo revision 1.3.146; Licensee: School of Management; Project: Oilintervus; User: Administrator; Date: 17/02/2003 - 16:38:09

NODE LISTING

Nodes in Set: All Nodes; Created: 10/02/2003 - 10:01:44
Modified: 17/02/2003 - 16:27:42; Number of Nodes: 94

(1)	/Individual characteristics
(1 1)	/Individual characteristics/Independence
(1 2)	/Individual characteristics/Possibility of personal wealth
(1 3)	/Individual characteristics/Possibility of significant stake
(1 4)	/Individual characteristics/Gambling instinct
(1 5)	/Individual characteristics/Vision important
(2)	/Financial factors
(2 1)	/Financial factors/City effects
(2 1 1)	/Financial factors/City effects/Financial punt
(2 1 2)	/Financial factors/City effects/Offers investment route for City money
(2 1 3)	/Financial factors/City effects/City portfolio interest
(2 1 4)	/Financial factors/City effects/Easy for stockmarket to understand
(2 1 5)	/Financial factors/City effects/Texas~Dallas effect
(2 1 6)	/Financial factors/City effects/RoE good in past
(2 1 7)	/Financial factors/City effects/Diversification desires
(2 1 8)	/Financial factors/City effects/Re-entry as post acquisition unwinding
(2 1 9)	/Financial factors/City effects/Changing profile of firms
(2 1 10)	/Financial factors/City effects/Supply of capital linked to activity
(2 2)	/Financial factors/Costs
(2 2 1)	/Financial factors/Costs/Lower costs than offshore
(2 2 2)	/Financial factors/Costs/Lower tax than offshore
(2 2 3)	/Financial factors/Costs/Favourable taxbreaks for Canadians

(2 2 4) /Financial factors/Costs/Fast payback from early production

(2 2 5) /Financial factors/Costs/Layering of bureaucracy and costs

(2 2 6) /Financial factors/Costs/Fast return potential

(2 3) /Financial factors/Capital structure

(2 3 1) /Financial factors/Capital structure/Can't raise debt

(2 3 2) /Financial factors/Capital structure/Ownership issues

(3) /Offshore

(3 1) /Offshore/Route to Offshore

(3 2) /Offshore/Similar to Offshore

(3 3) /Offshore/Different from Offshore

(3 4) /Offshore/Stepping-stone to Offshore

(4) /Macro-economics

(4 1) /Macro-economics/Oil price effects

(4 2) /Macro-economics/Government effects

(4 2 1) /Macro-economics/Government effects/Tax

(4 2 1 2) /Macro-economics/Government effects/Tax/Sale of Forties units

(4 2 1 3) /Macro-economics/Government effects/Tax/1983 changes to allow write-offs

(4 2 1 4) /Macro-economics/Government effects/Tax/PRT- shelter reasons

(4 2 2) /Macro-economics/Government effects/Wytch Farm forced disposal

(4 2 2 1) /Macro-economics/Government effects/Wytch Farm forced disposal/Recycled attractive asset

(4 2 2 2) /Macro-economics/Government effects/Wytch Farm forced disposal/Perceived start of industry

(4 2 3) /Macro-economics/Government effects/License awards issues

(4 2 3 1) /Macro-economics/Government effects/License awards issues/Licence availability

(4 2 3 2) /Macro-economics/Government effects/License awards issues/Easier to get onshore acreage

(4 2 3 3) /Macro-economics/Government effects/License awards issues/Lower cost to build portfolio

(4 2 3 3 4) /Macro-economics/Government effects/License awards issues/Lower cost to build portfolio/License awards criteria

(4 2 4) /Macro-economics/Government effects/Over-Regulation

(5) /Technological changes

(5 1) /Technological changes/Directional drilling~enviro. issues

(5 2) /Technological changes/3D seismic

(5 3) /Technological changes/Cheaper computing power

(5 4) /Technological changes/More certainty re reserves

(6) /Innovations

(6 1) /Innovations/Mine gas

(6 2) /Innovations/Gas deregulation

(6 3) /Innovations/Depleted gas fields for storage

(6 4) /Innovations/CBM

(6 5) /Innovations/Innovations

(7) /Geology

(7 1) /Geology/Potential of smaller fields

(8) /Legitimacy

(8 1) /Legitimacy/Imitative strategies

(8 2) /Legitimacy/Effect of the majors

(8 2 1) /Legitimacy/Effect of the majors/Marginal activity for majors

(8 2 2) /Legitimacy/Effect of the majors/Development inhibition by majors

(8 2 3) /Legitimacy/Effect of the majors/Desire to associate with majors

(8 2 4) /Legitimacy/Effect of the majors/Departure offers opportunities for small companies

(8 3) /Legitimacy/Importance of journalists and City

(8 4) /Legitimacy/Density dependence effects

(9) /Knowledge

(9 1) /Knowledge/Capabilities

(9 1 1) /Knowledge/Capabilities/Importance of operating capability

(9 1 2) /Knowledge/Capabilities/Build on existing capabilities

(9 2) /Knowledge/Interest

(9 2 1) /Knowledge/Interest/Rises post significant discoveries

(9 2 2) /Knowledge/Interest/Rises with contiguous discoveries

(9 2 3) /Knowledge/Interest/Rises with trend discoveries

(10) /Environmental issues

(10 1) /Environmental issues/Barrier to survival

(10 2) /Environmental issues/Delays in reconciling

(11) /Sentiment

(11 1) /Sentiment/Capitalising romance

(11 2) /Sentiment/Expectations

(12) /Exits

(12 1) /Exits/Acquisition for offshore assets

(12 2) /Exits/Acquisition for expertise

(12 3) /Exits/Exit from business

(12 4) /Exits/Ran out of money

(12 5) /Exits/Supply of assets for next generation

(13) /Importance of partners

(14) /Search Results

(14 1) /Search Results/Single Text Lookup

Appendix M: Correlation Table of Selection Variables With Post-entry Survival for the 1984-99 Population Including Wytch Farm Firms, (H1)

		Post-entry survivors	GDP	Max tax	Oil price	UK base rates	Euro$ rates	$/£ spot	Onshore production	fld#s	Oil sector betas	Mkt. cap oils	Wells already drilled	Environ mental	Innov-ation	Rig #s	# of wells drilled in yr	IMF cost	Op costs
Post-entry survivors	Pearson Correlation	1.00	-0.05	-0.54	-0.76	0.29	-0.66	0.46	0.57	0.65	-0.55	0.41	0.71	0.66	-0.73	-0.49	-0.49	0.63	0.03
	Sig. (2-tailed)	.	0.85	0.03	0.00	0.28	0.01	0.08	0.02	0.01	0.03	0.12	0.00	0.01	0.00	0.05	0.05	0.01	0.91
GDP	Pearson Correlation	-0.05	1.00	-0.11	-0.26	-0.05	0.49	-0.15	-0.25	-0.19	-0.17	0.09	-0.27	0.18	-0.25	0.30	0.58	-0.29	-0.69
	Sig. (2-tailed)	0.85	.	0.69	0.33	0.84	0.05	0.57	0.35	0.48	0.54	0.74	0.31	0.50	0.35	0.26	0.02	0.28	0.00
Max tax	Pearson Correlation	-0.54	-0.11	1.00	0.46	-0.45	0.53	-0.04	-0.88	-0.92	0.54	-0.83	-0.84	-0.89	0.71	0.82	0.45	-0.89	0.33
	Sig. (2-tailed)	0.03	0.69	.	0.07	0.08	0.04	0.88	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.22
Oil price	Pearson Correlation	-0.76	-0.26	0.46	1.00	-0.33	0.38	-0.32	-0.35	-0.45	0.51	-0.25	-0.52	-0.63	0.70	0.27	0.25	-0.41	0.17
	Sig. (2-tailed)	0.00	0.33	0.07	.	0.22	0.15	0.23	0.18	0.08	0.05	0.35	0.04	0.01	0.00	0.31	0.36	0.12	0.53
UK base rates	Pearson Correlation	0.29	-0.05	-0.45	-0.33	1.00	-0.18	0.04	0.37	0.61	-0.41	0.59	0.52	0.29	-0.23	-0.32	-0.16	0.51	-0.42
	Sig. (2-tailed)	0.28	0.84	0.08	0.22	.	0.50	0.88	0.16	0.01	0.13	0.02	0.04	0.27	0.40	0.22	0.56	0.04	0.10
Euro$ rates	Pearson Correlation	-0.66	0.49	0.53	0.38	-0.18	1.00	-0.03	-0.71	-0.65	0.54	-0.28	-0.63	-0.45	0.43	0.61	0.65	-0.67	-0.35
	Sig. (2-tailed)	0.01	0.05	0.04	0.15	0.50	.	0.90	0.00	0.01	0.04	0.30	0.01	0.08	0.10	0.01	0.01	0.00	0.18
$/£ spot	Pearson Correlation	0.46	-0.15	-0.04	-0.32	0.04	-0.03	1.00	0.10	0.20	0.18	0.05	0.37	0.27	-0.38	-0.14	-0.18	0.22	0.22
	Sig. (2-tailed)	0.08	0.57	0.88	0.23	0.88	0.90	.	0.72	0.46	0.52	0.85	0.16	0.32	0.14	0.61	0.50	0.42	0.40
On-shore Product'n	Pearson Correlation	0.57	-0.25	-0.88	-0.35	0.37	-0.71	0.10	1.00	0.93	-0.42	0.76	0.88	0.76	-0.58	-0.93	-0.61	0.95	-0.07
	Sig. (2-tailed)	0.02	0.35	0.00	0.18	0.16	0.00	0.72	.	0.00	0.12	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.80
Fld #s	Pearson Correlation	0.65	-0.19	-0.92	-0.45	0.61	-0.65	0.20	0.93	1.00	-0.46	0.84	0.96	0.82	-0.68	-0.88	-0.59	0.98	-0.16
	Sig. (2-tailed)	0.01	0.48	0.00	0.08	0.01	0.01	0.46	0.00	.	0.08	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.55

Appendix M: Correlation Table of Selection Variables With Post-entry Survival for the 1984-99 Population Including Wytch Farm Firms, (H1)

Inc WF N=16		Post-entry survivors	GDP	Max tax	Oil price	UK base rates	Euro$ rates	$/£ spot	Onshore produc-tion	Fld #s	Oil sector betas	Mkt. cap oils	Wells already drilled	Environ mental	Innov-ation	Rig #s	# of wells drilled in yr	IMF cost	Op costs
Oil sector betas	Pearson Correlation	-0.55	-0.17	0.54	0.51	-0.41	0.54	0.18	-0.42	-0.46	1.00	-0.31	-0.34	-0.43	0.37	0.36	0.34	-0.39	0.20
	Sig. (2-tailed)	0.03	0.54	0.04	0.05	0.13	0.04	0.52	0.12	0.08	.	0.27	0.21	0.11	0.17	0.19	0.22	0.15	0.47
Mkt. cap oil sector	Pearson Correlation	0.41	0.09	-0.83	-0.25	0.59	-0.28	0.05	0.76	0.84	-0.31	1.00	0.76	0.66	-0.51	-0.67	-0.18	0.81	-0.55
	Sig. (2-tailed)	0.12	0.74	0.00	0.35	0.02	0.30	0.85	0.00	0.00	0.27	.	0.00	0.01	0.04	0.00	0.50	0.00	0.03
# wells already drilled	Pearson Correlation	0.71	-0.27	-0.84	-0.52	0.52	-0.63	0.37	0.88	0.96	-0.34	0.76	1.00	0.83	-0.73	-0.86	-0.65	0.97	-0.03
	Sig. (2-tailed)	0.00	0.31	0.00	0.04	0.04	0.01	0.16	0.00	0.00	0.21	0.00	.	0.00	0.00	0.00	0.01	0.00	0.91
Environ-mental	Pearson Correlation	0.66	0.18	-0.89	-0.63	0.29	-0.45	0.27	0.76	0.82	-0.43	0.66	0.83	1.00	-0.93	-0.73	-0.44	0.81	-0.16
	Sig. (2-tailed)	0.01	0.50	0.00	0.01	0.27	0.08	0.32	0.00	0.00	0.11	0.01	0.00	.	0.00	0.00	0.09	0.00	0.56
Innov-ation	Pearson Correlation	-0.73	-0.25	0.71	0.70	-0.23	0.43	-0.38	-0.58	-0.68	0.37	-0.51	-0.73	-0.93	1.00	0.53	0.32	-0.67	0.09
	Sig. (2-tailed)	0.00	0.35	0.00	0.00	0.40	0.10	0.14	0.02	0.00	0.17	0.04	0.00	0.00	.	0.03	0.23	0.00	0.73
Rig #s	Pearson Correlation	-0.49	0.30	0.82	0.27	-0.32	0.61	-0.14	-0.93	-0.88	0.36	-0.67	-0.86	-0.73	0.53	1.00	0.77	-0.91	0.00
	Sig. (2-tailed)	0.05	0.26	0.00	0.31	0.22	0.01	0.61	0.00	0.00	0.19	0.00	0.00	0.00	0.03	.	0.00	0.00	0.99
# of wells drilled In year	Pearson Correlation	-0.49	0.58	0.45	0.25	-0.16	0.65	-0.18	-0.61	-0.59	0.34	-0.18	-0.65	-0.44	0.32	0.77	1.00	-0.63	-0.44
	Sig. (2-tailed)	0.05	0.02	0.08	0.36	0.56	0.01	0.50	0.01	0.02	0.22	0.50	0.01	0.09	0.23	0.00	.	0.01	0.09
IMF costs	Pearson Correlation	0.63	-0.29	-0.89	-0.41	0.51	-0.67	0.22	0.95	0.98	-0.39	0.81	0.97	0.81	-0.67	-0.91	-0.63	1.00	-0.06
	Sig. (2-tailed)	0.01	0.28	0.00	0.12	0.04	0.00	0.42	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.01	.	0.83
Op costs	Pearson Correlation	0.03	-0.69	0.33	0.17	-0.42	-0.35	0.22	-0.07	-0.16	0.20	-0.55	-0.03	-0.16	0.09	0.00	-0.44	-0.06	1.00
	Sig. (2-tailed)	0.91	0.00	0.22	0.53	0.10	0.18	0.40	0.80	0.55	0.47	0.03	0.91	0.56	0.73	0.99	0.09	0.83	.

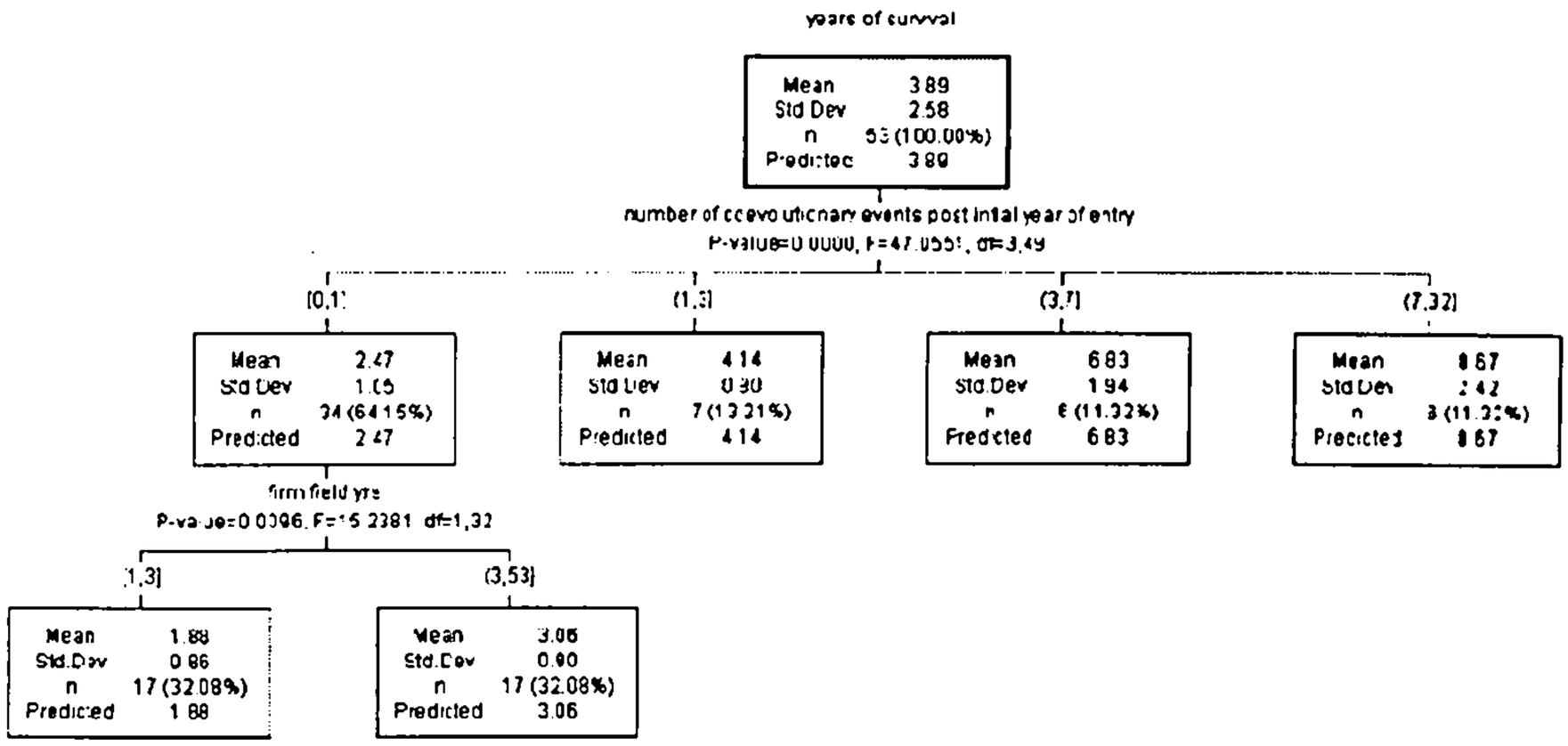
Appendix N: Correlation Table of Selection Variables with Post-entry Survival for the 1985-99 Population Excluding Wytch Farm Firms, (H1)

no WF		Post entry survivors	GDP	Max tax	Oil price	UK base rates	Euro$ rates	$/£ spot	Onshore prod no WF	fld#s	Oil sector betas	Mkt. Cap oils	Wells already drilled	Enviro-nmental	Inno-vation	Rig #s	Wells drilled that year	IMF cost	Op costs
Post-entry Survivors	Pearson Correlation	1.00	-0.20	-0.23	-0.62	0.24	-0.47	0.20	0.49	0.38	-0.42	0.23	0.46	0.20	-0.16	-0.32	-0.43	0.37	-0.10
	Sig. (2-tailed)	.	0.48	0.41	0.01	0.38	0.08	0.47	0.07	0.16	0.13	0.42	0.09	0.48	0.56	0.25	0.11	0.18	0.71
GDP	Pearson Correlation	-0.20	1.00	-0.10	-0.29	-0.06	0.56	-0.22	-0.43	-0.22	-0.17	0.09	-0.34	0.21	-0.38	0.31	0.60	-0.33	-0.72
	Sig. (2-tailed)	0.48	.	0.71	0.29	0.84	0.03	0.43	0.11	0.42	0.56	0.76	0.22	0.46	0.16	0.26	0.02	0.23	0.00
Max tax	Pearson Correlation	-0.23	-0.10	1.00	0.35	-0.45	0.45	0.23	-0.76	-0.91	0.51	-0.83	-0.83	-0.92	0.81	0.81	0.41	-0.87	0.45
	Sig. (2-tailed)	0.41	0.71	.	0.21	0.09	0.09	0.40	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.09
Oil price	Pearson Correlation	-0.62	-0.29	0.35	1.00	-0.33	0.17	0.08	-0.24	-0.29	0.49	-0.17	-0.31	-0.42	0.48	0.17	0.15	-0.23	0.39
	Sig. (2-tailed)	0.01	0.29	0.21	.	0.22	0.53	0.78	0.38	0.30	0.07	0.54	0.26	0.12	0.07	0.54	0.58	0.42	0.15
UK base rates	Pearson Correlation	0.24	-0.06	-0.45	-0.33	1.00	-0.15	-0.03	0.22	0.63	-0.40	0.59	0.56	0.30	-0.25	-0.31	-0.14	0.52	-0.46
	Sig. (2-tailed)	0.38	0.84	0.09	0.22	.	0.58	0.93	0.44	0.01	0.16	0.02	0.03	0.28	0.36	0.26	0.62	0.05	0.08
Euro$ rates	Pearson Correlation	-0.47	0.56	0.45	0.17	-0.15	1.00	0.33	-0.72	-0.57	0.52	-0.22	-0.53	-0.27	0.16	0.57	0.63	-0.60	-0.28
	Sig. (2-tailed)	0.08	0.03	0.09	0.53	0.58	.	0.23	0.00	0.03	0.06	0.43	0.04	0.33	0.58	0.03	0.01	0.02	0.31
$/£ spot	Pearson Correlation	0.20	-0.22	0.23	0.08	-0.03	0.33	1.00	0.04	-0.09	0.40	-0.09	0.07	-0.19	0.28	0.01	-0.07	-0.07	0.09
	Sig. (2-tailed)	0.47	0.43	0.40	0.78	0.93	0.23	.	0.88	0.74	0.15	0.74	0.81	0.49	0.31	0.96	0.81	0.82	0.74
Onshore Prod'n	Pearson Correlation	0.49	-0.43	-0.76	-0.24	0.22	-0.72	0.04	1.00	0.85	-0.32	0.59	0.88	0.70	-0.52	-0.92	-0.73	0.91	0.04
	Sig. (2-tailed)	0.07	0.11	0.00	0.38	0.44	0.00	0.88	.	0.00	0.27	0.02	0.00	0.00	0.05	0.00	0.00	0.00	0.87
Fld #s	Pearson Correlation	0.38	-0.22	-0.91	-0.29	0.63	-0.57	-0.09	0.85	1.00	-0.42	0.85	0.96	0.78	-0.64	-0.88	-0.57	0.98	-0.30
	Sig. (2-tailed)	0.16	0.42	0.00	0.30	0.01	0.03	0.74	0.00	.	0.13	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.28

Appendix N: Correlation Table of Selection Variables with Post-entry Survival for the 1985-99 Population Excluding Wytch Farm Firms, (H1)

no WF N=16		Post-entry survivors	GDP	Max tax	Oil price	UK base	Euro$ rates	$/£ spot	Onshore prod no WF	fld#s	Oil sector betas	Mkt. cap oils	Wells already drilled	Enviro-nmental	Inno-vation	Rig #s	Wells drilled that year	IMF cost	Op costs
Oil sector betas	Pearson Correlation	-0.42	-0.17	0.51	0.49	-0.40	0.52	0.40	-0.32	-0.42	1.00	-0.28	-0.28	-0.39	0.37	0.33	0.31	-0.34	0.27
	Sig. (2-tailed)	0.13	0.56	0.06	0.07	0.16	0.06	0.15	0.27	0.13	.	0.33	0.33	0.17	0.20	0.25	0.29	0.23	0.36
Mkt. cap oils	Pearson Correlation	0.23	0.09	-0.83	-0.17	0.59	-0.22	-0.09	0.59	0.85	-0.28	1.00	0.78	0.70	-0.61	-0.66	-0.15	0.81	-0.63
	Sig. (2-tailed)	0.42	0.76	0.00	0.54	0.02	0.43	0.74	0.02	0.00	0.33	.	0.00	0.00	0.02	0.01	0.60	0.00	0.01
# all wells drilled to date	Pearson Correlation	0.46	-0.34	-0.83	-0.31	0.56	-0.53	0.07	0.88	0.96	-0.28	0.78	1.00	0.76	-0.62	-0.89	-0.65	0.98	-0.19
	Sig. (2-tailed)	0.09	0.22	0.00	0.26	0.03	0.04	0.81	0.00	0.00	0.33	0.00	.	0.00	0.01	0.00	0.01	0.00	0.50
Enviro-nmental	Pearson Correlation	0.20	0.21	-0.92	-0.42	0.30	-0.27	-0.19	0.70	0.78	-0.39	0.70	0.76	1.00	-0.94	-0.76	-0.40	0.78	-0.40
	Sig. (2-tailed)	0.48	0.46	0.00	0.12	0.28	0.33	0.49	0.00	0.00	0.17	0.00	0.00	.	0.00	0.00	0.13	0.00	0.14
Innov-ation	Pearson Correlation	-0.16	-0.38	0.81	0.48	-0.25	0.16	0.28	-0.52	-0.64	0.37	-0.61	-0.62	-0.94	1.00	0.60	0.25	-0.62	0.52
	Sig. (2-tailed)	0.56	0.16	0.00	0.07	0.36	0.58	0.31	0.05	0.01	0.20	0.02	0.01	0.00	.	0.02	0.36	0.01	0.05
Rig #s	Pearson Correlation	-0.32	0.31	0.81	0.17	-0.31	0.57	0.01	-0.92	-0.88	0.33	-0.66	-0.89	-0.76	0.60	1.00	0.76	-0.92	0.07
	Sig. (2-tailed)	0.25	0.26	0.00	0.54	0.26	0.03	0.96	0.00	0.00	0.25	0.01	0.00	0.00	0.02	.	0.00	0.00	0.82
# of wells drilled that year	Pearson Correlation	-0.43	0.60	0.41	0.15	-0.14	0.63	-0.07	-0.73	-0.57	0.31	-0.15	-0.65	-0.40	0.25	0.76	1.00	-0.61	-0.41
	Sig. (2-tailed)	0.11	0.02	0.13	0.58	0.62	0.01	0.81	0.00	0.03	0.29	0.60	0.01	0.13	0.36	0.00	.	0.01	0.13
IMF cost	Pearson Correlation	0.37	-0.33	-0.87	-0.23	0.52	-0.60	-0.07	0.91	0.98	-0.34	0.81	0.98	0.78	-0.62	-0.92	-0.61	1.00	-0.18
	Sig. (2-tailed)	0.18	0.23	0.00	0.42	0.05	0.02	0.82	0.00	0.00	0.23	0.00	0.00	0.00	0.01	0.00	0.01	.	0.52
Op costs	Pearson Correlation	-0.10	-0.72	0.45	0.39	-0.46	-0.28	0.09	0.04	-0.30	0.27	-0.63	-0.19	-0.40	0.52	0.07	-0.41	-0.18	1.00
	Sig. (2-tailed)	0.71	0.00	0.09	0.15	0.08	0.31	0.74	0.87	0.28	0.36	0.01	0.50	0.14	0.05	0.82	0.13	0.52	.

Appendix O: AnswerTree™ Exhaustive CHAID Classification of Onshore Pilot Firm level Data into Groups



Resubstitution

Risk Estimate	1.4666
SE of Risk Estimate	0.329794

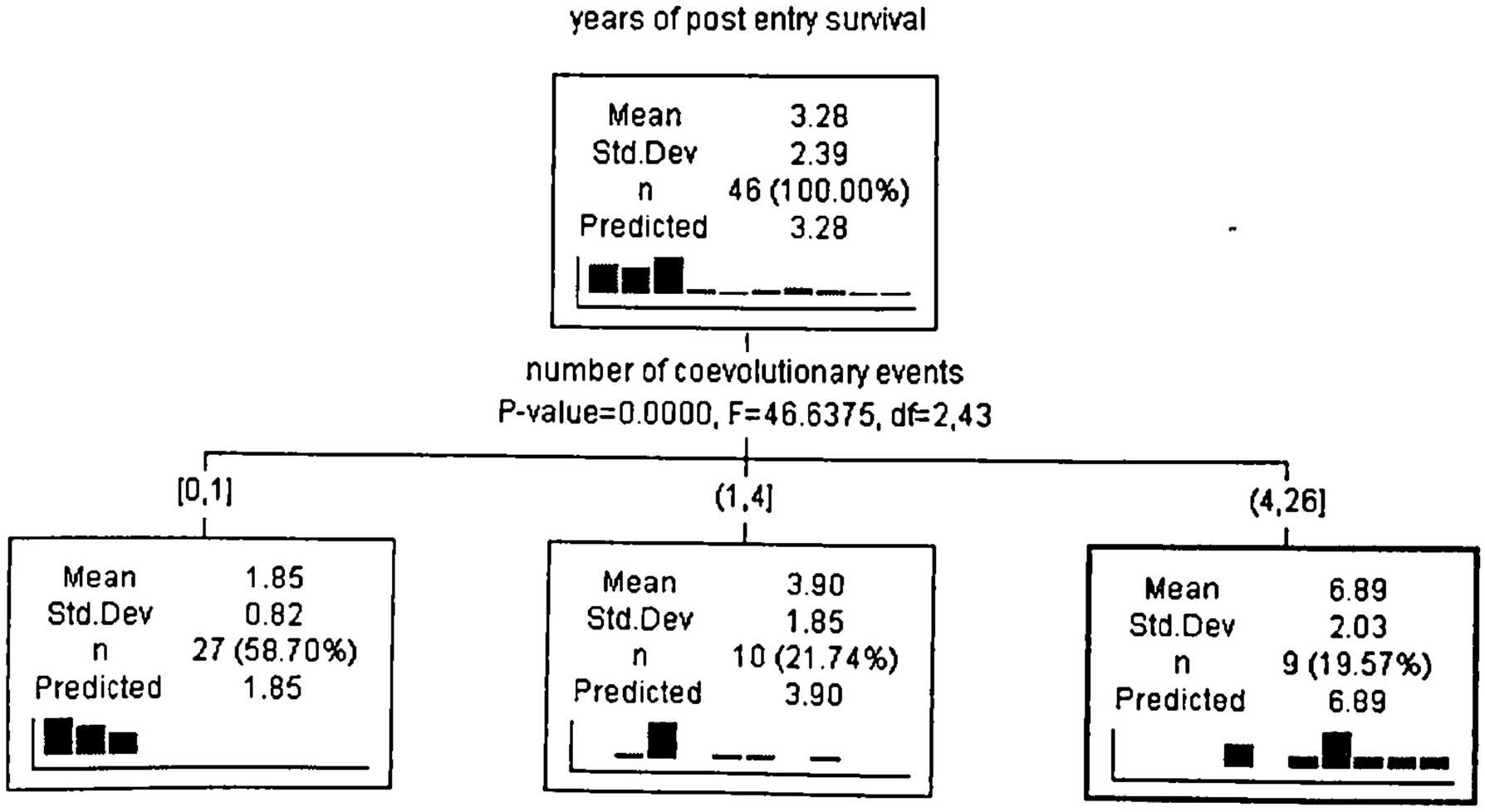
Gain Summary

Target variable: years of survival

Statistics

Node	Node: n	Node: %	Gain	Index (%)
4	6	11.32	8.67	222.98
3	6	11.32	6.83	175.81
2	7	13.21	4.14	106.59
6	17	32.08	3.06	78.70
5	17	32.08	1.88	48.43

Appendix P: AnswerTree™ Exhaustive CHAID Classification of Onshore Main Study Firm level Data into Groups



Resubstitution

Risk Estimate	1.76514
SE of Risk Estimate	0.461203

Gain Summary

Target variable: Post-entry years of survival

Statistics

Node	Node: n	Node: %	Gain	Index (%)
3	9	19.57	6.89	209.8
2	10	21.74	3.90	118.8
1	27	58.70	1.85	56.41